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Theme 3: Flexibility Platforms and the Role of future DSO's

Initial experience from the first CoordiNet demonstration

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Abstract: The CoordiNet project within Horizon 2020 programme aims to demonstrate how distribution system operators and transmission system operators can act in a coordinated manner to procure and activate grid services in the most cost-effective and reliable way. This is done through the implementation of three large-scale demonstrations in Sweden, Greece and Spain. The first market to be set into operation was within the Swedish demo in the winter of 2019/2020. The outcome of the flexibility market during the first winter with congestion management day-ahead is described in this study. The results from implementation of the platform, user interface, learnings on stakeholder interaction and initial evaluation of key performance indicators are described.

1 Introduction

As industry and transportation sector strive to become fossil-free distribution system operator (DSO) experience a significant increase in requests for capacity. Together with rapid urbanisation and reduced CHP power generation in larger cities this has led to an imminent capacity shortage in several areas in Sweden. Regional grid constraints and limits on the possible power from the transmission network cannot be solved by present market mechanisms. At the same time more wind power in the system creates an increased need for system services. In response to these challenges, the EU financed Horizon 2020 project CoordiNet has been set-up to enable city and economic growth through a new way of using capacity more flexible over time.

1.1 Swedish flexibility for congestion management

The purpose of the congestion management on the flexibility market is to locally increase or decrease energy to avoid constraint violation defined by subscription level of the overlying grid. The congestion management is considered at the interface between local DSO and regional DSO and at the interface between regional DSO and transmission system operator (TSO) shown in Fig. 1.

The Swedish demonstration went live on 8 November 2019 and is the first demonstration of several focusing on congestion management day-ahead. The demonstration is performed in three regions in Sweden. The flexibility market will demonstrate congestion management at the local DSO and the regional DSO on a day-ahead market:

- Day-ahead capacity (pay as cleared per MWh).
- Firm bid cleared day-ahead (cost of real availability contracts).

The grid will be optimised regarding subscription level of the local and the regional DSO. 150 MW of flexibility of different types participated.

Table 1 lists flexibility providers in Uppsala participating in the demonstration for the winter 2019/2020. The sources of flexibility constitute a versatile mix of different technologies including generation from waste disposal, aggregated consumer load, storage, gensets and electrical vehicles.

1.2 Market model

The market is set-up using a cascade model as shown in Fig. 2. Flexibility providers enter bid to the market platform one day before the delivery day. A time window is set for the local DSO and the regional DSO to procure capacity so that those selling capacity on the CoordiNet flexibility market can trade on day-ahead and intraday market to maintain their energy balance. The market chronology is set-up through a coordination between TSO–DSO and existing electricity market and balancing markets. The local DSO flexibility market and the regional DSO flex market are mainly performed day-ahead to limit the interference in the energy market. In the demonstration intraday market will be used to avoid unwanted situation in the grid. This market coordination has been chosen after dialogue within the Swedish energy sector through a standing forum arranged by the Swedish CoordiNet demonstration and the Swedish Energy Authority. To be able to act day-ahead forecasting is required, which is a new capability for the DSO.

In the grid operational process grid need exceeding load forecast can be managed in two ways, exclusively or in combination namely purchase flexibility on flexibility platform day-ahead or temporary subscription overlaying grid. When load forecast exceeds subscription to overlaying grid, flexibility can be purchased according to each operator's business rules, e.g. delegation agreements with an upper cost limit. Recommended bid selection as well as bids individually from flexibility providers are presented on the flexibility platform and the grid operator can select the recommend bid or one or several bids, in one- or several-time frames. Operation is in advance provided with different handling alternatives to manage congestion.

1.3 Market platform

Market operator is the regional DSO. This is for Uppsala Vattenfall Eldistribution, in Skåne E.ON Energidistribution and in Gotland Vattenfall Eldistribution subsidy, GEAB.

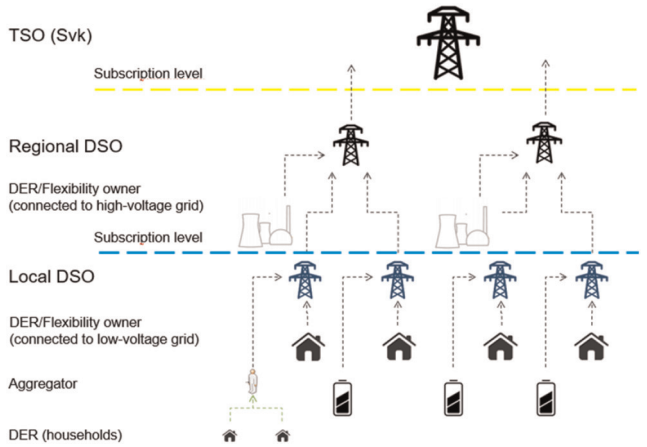

Fig. 1 *Principle levels in the Swedish transmission grid*

Table 1 Flexibility resources in Uppsala congestion market

FSP	Grid connection	Installed capacity
aggregator (340 domestic heating pumps)	local grid	1.5 MW
heating pump (industry)	local grid	1 MW
heating pumps (housing)	local grid	3*0.15 MW
electric vehicle charger (housing)	local grid	0.025 MW
electric boiler (district heating)	regional grid	60 MW
heat pump (heating company)	local grid	8 MW
waste incineration (heating company)	local grid	10 MW
gas turbine (heating company)	local grid	16 MW

The market platform is developed by E.ON and allows the FSP to manually enter bids through a web interface (Fig. 3). Alternatively, a production plan can be uploaded for the flexibility resource. Day-ahead forecast (Fig. 4) is generated outside the platform and sent to the market platform. The DSO gets recommendation of bids to clear based on the forecast but can also modify proposal (Fig. 5).

1.4 Stakeholder interactions

Paramount to the success of the Swedish CoordiNet flexibility market has been active work to engage and train potential flexibility providers (FSP). This is a joint journey between multiple stakeholders. Cooperation with aggregators is important to gain market knowledge as well as to find technical solutions for controlling the flexible resources. Some two dozen external activities have been performed to reach out to and engage potential FSP. Quarterly stakeholder meetings have been held with between 40 and 80 participants. The objective of these activities has been to find and engage customers and make their flexibility available for the market, through the design of purposeful and scalable flexibility products. The work has been conducted in an iterative, agile manner with workshops in which both grid operation staff and customers have attended, in order to fully understand needs and opportunities on both sides. Several of these interactions were also targeting mapping and analysis of grid operator and planning gaps with regard to flexibility dispatching, the outcome of which is available in the referenced documents in Section 5.

1.5 Learnings from the Swedish demonstration

In the first winters demonstration day-ahead congestion management has been tested. Upcoming demonstrations in 2020 will also include intraday market for DSO, passing on bids to the TSOs manual Frequency Restoration Reserve market, as well as establishing peer-to-peer markets.

In Sweden there is a large difference between the winter and summer load, driven by among other things the use of electricity for spatial heating. This means the winter peak load in grids dominated by residential loads can often be five times higher than summer peak load and implying that congestion of the grid is limited to between November and March. Also, the volume of the flexibility market for congestion management will be strongly weather depended, heavily impacting the demand for flexibility and thus the business case for flexibility providers. The market may even become be obsolete in a mild winter.

The winter of 2019/2020 has been mild, an entire degree warmer than the second warmest winter on record since measurement began in Uppsala in 1722. This has significantly impacted the market. The demand was so much lower that there was no need to use congestion management in Gotland during the demonstration and only an occasional need in Skåne. In Uppsala there was no need for congestion management in the local DSO grid. There was still need in the regional DSO grid, even though the winter was mild. For this reason, the paper focuses on the learnings from Uppsala regional DSO grid experience.

The Uppsala CoordiNet congestion market was operated during the period from the 9th of January to the 31st of March.

2 Results from Uppsala regional DSO market

In Uppsala the grid operator has historically been functioning as a distribution network operator. From winter 2017/2018 the grid operator started acting as a DSO by also contracting and manually steering one larger asset in the regional grid.

Fig. 6 shows the subscription level between TSO and regional DSO for the last 5 years. Since winter 2017/2019 DSO has manually steered the flexibility provider, limiting the number of times and MWh the subscription was exceeded in 2017/2017 and 2018/2019, however the maximum peak could not be sufficiently decreased.

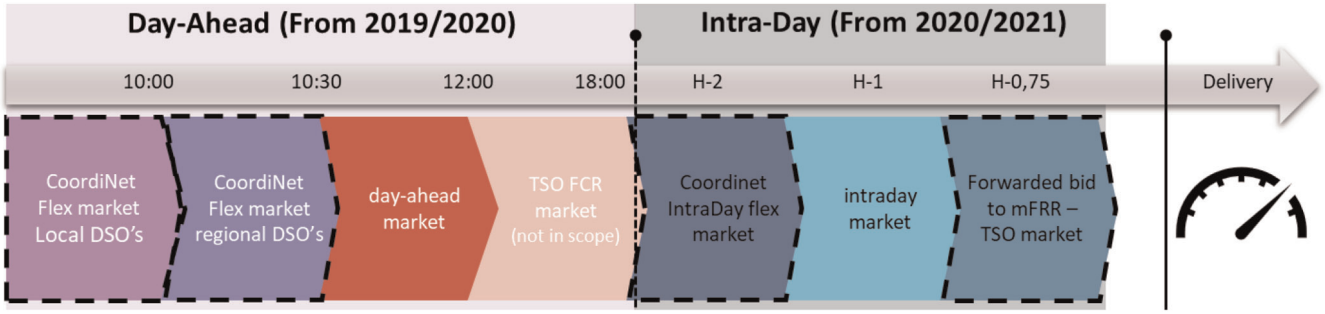

Fig. 2 *Congestion management on the flexibility market have closing times that are synchronised with the established energy markets*

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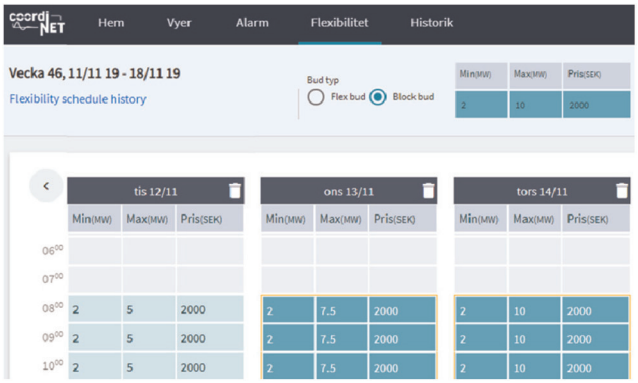

Fig. 3 *Web interface for flexibility service providers*

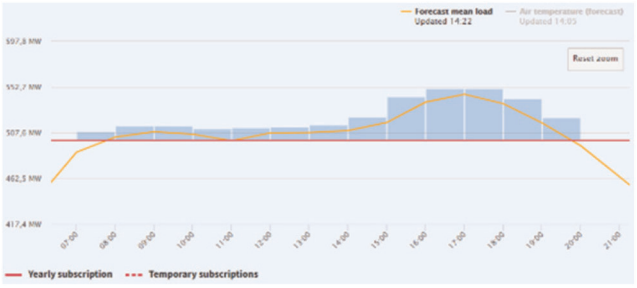

Fig. 4 *DSO view showing if selected flexibility is sufficient to avoid violation of subscription level*

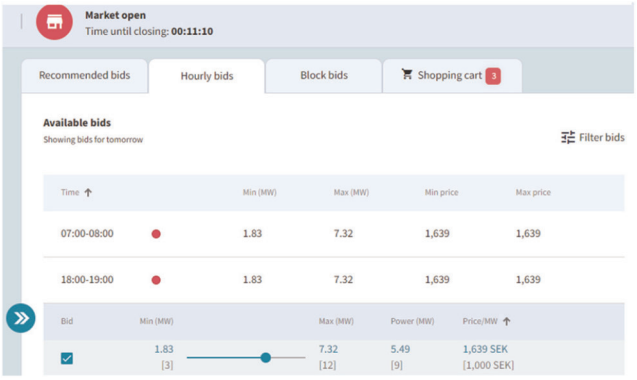

Fig. 5 *DSO view of bids, slider selects amount to procure*

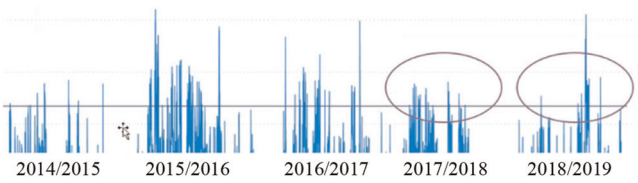

Fig. 6 *Subscription level and 5 years winter load data at TSO–DSO grid connection point*

In the CoordiNet project the ability was created to steer flexibility day-ahead with a platform and market as support. During the 83 days the market was open in the winter 2019/2020 a total of 3.26 GWh of load reduction was cleared during 172 h on 16 different days. The volumes, load forecasting and resulting net flow at regional DSO and TSO connection points are shown in Fig. 7 for the period of between 22nd January and 19th February. As seen the flexibility

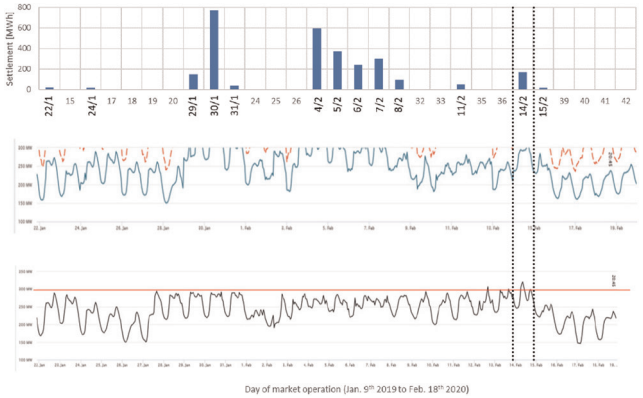

Fig. 7 *Cleared volume of flexibility, forecast and resulting power flow at regional DSO/TSO connection points*

market successfully kept the power flow below subscription level on all but one day (the day is indicated with vertical dotted lines in Fig. 7).

The result, as shown in Fig. 7, was that the subscription level for the first time in many years could be kept during the winter of 2019/2020. As the volumes clearly show this was not due to the mild winter but the CoordiNet flexibility market forecast enabling procurement of correct amount of load reduction on the day-ahead congestion market. This result indicates that using a platform day-ahead is more efficient than manually steering flexibility over the phone.

3 Conclusions

The flexibility service for congestion management day-ahead has successfully been demonstrated in the winter of 2019/2020 on three of the four planned sites for flexibility markets in Sweden within the EU-financed Horizon 2020 project CoordiNet. In the business use case demonstrated the DSO uses the flexibility service to lower peak demand in the grid during the winter season November to March. The novel local markets have demonstrated how to coordinate with and complement the existing markets for electricity trade and system services as well as coordination between flexibility providers, DSOs and TSO. The result is the first major demonstration of the possibility, as well as ability, for a flexibility provider to participate in a coordinated way on different markets, as well as contributing with a new flexibility service in a market-based way. The Swedish CoordiNet also showed a more dynamic and digitalised way for DSOs to utilise flexibility for the operation of the network.

The liquidity on the flexibility markets for congestion management was enough, but mainly due to participation of one big-scale flexibility provider combine with a small need for flexibility due to low power consumption as an effect of a historically warm winter. The liquidity in terms of competition among bids though was not good enough with lower level of bids available than hoped from some flexibility providers. Several flexibility providers underestimated the effort and time needed for preparation to provide flexibility. This resulted in fewer bids than the DSOs and they themselves had hoped for. Better knowledge from the provider of control systems is needed for unlocking flexibility more widely in the two coming years of the demonstration.

Other conclusions include:

- The platform proved its value to DSO control room operators by greatly increased visibility of the upcoming grid situation.
- The development of the platform and the flexibility market by a DSO has shown to be extremely valuable in competence development, mindset and culture.
- Developing and operating the platform as an integral part of the DSO grid planning and operations provides understanding for

needs, changes and possibilities when acting DSO with higher level of visibility.

- Compensation to flexibility providers needs to be evaluated to find the right balance between availability and activation renumeration.
- The needed dialogue between DSO and TSO creates new values in understanding how better coordination can lead to a more efficient grid use.
- To manage a more congested grid with greater production flexibility requires a shift from being network operator to acting as a system operator.
- Acting as a system operator the DSO gains the ability to use the grid more efficiently. This provides major gains for the DSO arising through new possibilities to use the infrastructure for electricity and heating in a more coordinated manner. In the future this will also strengthen the capability to cope with new kind of loads like electric charging.

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5 References

This paper presents a summary of results from CoordiNet deliverable 4.5. '*Report on Lessons learned, bug fixes and adjustments in products and routines*', available from June 2020 at: https://coordinet-project.eu/publications/deliverables.

Further information on CoordiNet regulatory framework, customer engagement plans, products, business case and key performance indicators can be found online at the above site:

1. CoordiNet Deliverable 1.1. Market and regulatory analysis: analysis of current market and regulatory framework in the involved areas.
2. CoordiNet Deliverable 1.2. User and Customer-engagement plan: validated plan for users' recruitment and operation of the cascading funds.
3. CoordiNet Deliverable 1.3. Scenarios and products: definition of scenarios and products for the demonstration campaigns.
4. CoordiNet Deliverable 1.5. Business use case: business use case definition.

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