Our Shared Journey

– a roadmap towards achieving a green power system

FINGRID

Preface

In spring 2016, Fingrid published a discussion paper describing the current state and potential development paths of the electricity market. We also requested the views of market participants and other stakeholders on the state of affairs that we had outlined. In autumn 2016, we published a summary of the feedback that we received and outlined our own principles concerning the development of the electricity market.

We have now reached the third phase of our work. In the roadmap presented in this report, we have compiled Fingrid's views on the targets and measures that are important for the electricity market. Many of the measures call for extensive co-operation between electricity market stakeholders, both in Finland and internationally.

The roadmap aims to offer all those interested in the electricity market comprehensive information on ongoing projects and stakeholders' opportunities to influence them. We will update the roadmap by adding new projects and adjusting the descriptions of existing projects. We will also publish information on the progress of the projects on our website.

Many of the roadmap measures involve not only Finland, but also more broadly the entire Baltic Sea region. Following a few quieter years, there is also more demand for Nordic co-operation. As an example of this, the Nordic Council of Ministers has commissioned Jorma Ollila, former Nokia CEO, to undertake a review of energy co-operation in the Nordic region. At the same time, co-operation in the Baltic Sea region is also growing stronger.

Nordic Transmission System Operators have also jointly assessed the key challenges affecting the power system in their report Challenges and opportunities in the Nordic power system, which was published in August 2016. The work continues with an assessment of different solutions. A key issue is how the market rules could be developed to better meet the needs of the changing power system. A report on the results will be published in summer 2017.

Changes in market rules have broad impacts on different electricity market stakeholders. In view of this, we have strived for an open exchange of ideas with stakeholders on numerous occasions on the impacts of the roadmap measures. We hope that this open discussion will continue.

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1 Introduction

The power system is currently under pressure to change in a number of ways. On one hand, market rules are being reformed at a rapid rate to comply with the European Union's requirements for the common electricity market. On the other hand, updating practices is necessary as the production structure changes, in order to guarantee the availability of sufficient flexible resources for balancing the power system at any given moment.

This report describes measures that form the starting point for transitioning to a carbon-neutral, green power system. These measures are market-based and rely on the ability of electricity market parties to make well-informed choices. They start with efforts aimed at solving the acute problems faced by the power system, and continue towards longer-term sustainable solutions. A special challenge during the transition period relates to the exit of existing electricity production capacity, while the storage and other solutions required by the new system are not yet commercially available. This makes the active participation of flexible resources all the more important.

In terms of the functioning of the markets, key issues include the profitability of investments and the willingness of new operators to enter the electricity market. The first of these is largely dependent on political decisions in both Finland and the wider Baltic Sea region. A green power system also requires solving many challenges related to technological development. The biggest challenges concern long-term storing of electricity.

A green power system must be supported by strong transmission connections, which help balance the major fluctuations in production and consumption in terms of time and location. In Finland, this means that cross-border interconnections and internal transmission lines need to be strengthened.

The journey towards a green power system is long. Functional markets can help reform the power system cost-effectively for the needs of future generations. The measures described in this report represent one step in that journey. These measures alone, however, are not enough – additional political support is required in order to continue on a market-based path. New solutions are needed when taking care of the increasingly challenging balancing of the power system.

2 Extensive markets support a cost-effective transition to a green power system

Extensive, connected markets and sufficient cross-regional transmission connections help to balance the inherent fluctuations in a green power system. Co-operation ensures the effective use of resources across national borders. The common markets also guarantee the free movement of electricity in line with the EU's targets for the internal market. Fingrid targets extensive, effective electricity market in the Baltic Sea Region.

2.1 Functional markets and a secure power system require strong infrastructure

Effective functioning of the different marketplaces for electricity is contingent upon the adequacy of the transmission grid's capacity. In recent years, the need for additional import capacity from Sweden to Finland has been highlighted. Fingrid and its Swedish counterpart, Svenska Kraftnät, have made a decision in principle to build a new cross-border transmission connection in the north by 2025. The new connection will increase the cross-border transmission capacity by 800 MW, which will improve the functioning of the Baltic Sea region's electricity market, the security of the synchronous inter-Nordic system, the opportunities for renewable energy investments in both countries and the sufficiency of electricity in Finland during periods of freezing temperatures.

Of the current transmission connections with Sweden, Fenno-Skan 1 will reach the end of its life by the late 2020s. The connection's transmission power had to be reduced already to control the aging of the sea cable. The plan is to replace this connection, which will be decommissioned, with a higher power connection at a new location near Vaasa, across Kvarken to Sweden. This option is supported by the management of grid bottlenecks, system security reasons and the functioning of the markets. The connection is expected to be commissioned in 2027, once the new northern cross-border transmission line is ready.

The cross-border transmission line from northern Sweden and the increasing power production in northern Finland also increase the need for transmission capacity from north to south within Finland. A new 400 kV line (Coastal Line) to Ostrobothnia was recently completed, in addition to which a new line (Forest Line) from Oulu region to central Finland is in the planning stage. The new connection is due to be finished before the northern cross-border transmission line to Sweden, in order to avoid a bottleneck in Finland's transmission grid. The transmission need is expected to increase in future, and it is possible that a new north–south 400 kV connection will be needed in the 2030s. The development of transmission needs in different scenarios is constantly assessed using market simulations as part of grid planning.

Increasing the capacity of cross-border connections alone does not guarantee functional markets or system security; the availability and reliability of the connections must be at a very high level. Reaching a high level has proved to be challenging, especially with regard to high-voltage DC connections, which will account for more than half of the Baltic Sea region's cross-border transmission capacity by 2025. Fingrid has successfully introduced practices and methods to improve the reliability and availability of cross-border connections. We will continue this work together with other transmission system operators (TSOs) in the Baltic Sea region and in Europe in order to secure the availability of cross-border capacity for the current and future needs of the electricity market.

2.2 Cross-border co-operation ensures effective use of transmission capacity

The goal in the common market is to provide the markets with as much transmission capacity as possible without compromising system security. In order to achieve this goal, the calculation of cross-border capacity must be improved. Nordic TSOs are currently developing a new method for the Nordic capacity calculation region. Nordic TSOs propose that a Flow-Based (FB) calculation methodology be used on the day-ahead market. The Flow-Based calculation methodology is also targeted on the intraday market, but initially the Coordinated Net Transfer Capacity (C-NTC) calculation methodology will be used. The introduction of the Flow-Based calculation methodology is conditional upon the reliability of the calculations, transparency for market operators and benefits gained from the change in the calculation methodology. The new methodologies are expected to be taken into use at the turn of the 2020s.

In the Nordic countries, the calculation of transmission capacity will be gradually transferred to a regional co-operation organisation as of the beginning of 2018. In addition to the capacity calculation, the Regional Security Coordinator, located in Copenhagen, will handle regional tasks related to system security. In future, the aim is to expand the co-operation across the entire Baltic Sea region. In addition to short-term planning, the RSC would be a natural body to be in charge of the execution of the regional, long-term sufficiency monitoring of electricity. As the integration of the electricity market continues and mutual dependence between countries increases, it will be necessary to shift from a national power adequacy approach to at least a regional approach.

2.3 European electricity market integration expanding and deepening

The European electricity market is in a phase of intense transformation. Changes can be expected both in trading rules and in the methods used to calculate the capacity to be allocated to the markets. The purpose of the market rules is to promote electricity trading in the common market and to ensure the effective and equal use of transmission connections.

Along with the new market rules, the number of electricity market operators, or power exchanges, in Finland may increase. In the common markets, the product structures of different power exchanges will be similar in order to promote effective cross-border trading. Prices will be calculated using a common European algorithm, and the market price limits will be identical, regardless of which exchange the market operators conduct trade in. The power exchanges have jointly proposed day-ahead price limits of €3,000/MWh and €-500/MWh. The proposed price limits on the intraday market are €9,999/MWh and €-9,999/MWh. Decisions by the authorities on the price limits are expected in autumn 2017.

In Fingrid's view, it is important that electricity market operators that are capable of a quick response have the incentive to trade close to the hour of delivery. This means that the price caps in the intraday market must be higher than they are in the day-ahead market. This is implemented in the exchanges' proposal. Similarly, the price caps in the balancing power market must be higher than they are in the intraday market.

In Fingrid's view, the price cap in the balancing power market and of imbalance power must be raised especially if the price cap in the intraday market is raised, as proposed by the power exchanges. This would make it worthwhile for flexible resources to enter the balancing power market and for the market operators to ensure their power balance also during scarcity situations. According to Fingrid, the price limits of the balancing power market and imbalance power could be in the range of €15,000/MWh and €-15,000/MWh, which is generally considered to be in line with the harm caused by the administrative decision to disconnect electricity consumption.

In the intraday market, the preparation of a new trading system, XBID, is underway, and the system is due to be introduced in the first quarter of 2018. The trading times in the intraday market will also change. Trading in the common market is proposed to be opened as late as at 11 pm Finnish time. The target of the Nordic TSOs, however, is to enable the opening of the market in the afternoon at around 4 pm.

In the intraday market, the proposed closure time in trading across bidding zones is 60 minutes before the start of a delivery period. For Finland, this means that the power exchange Nord Pool's pilot project to carry on ELBAS trading between Finland, Estonia and Latvia up until 30 minutes before the start of the delivery period could not continue. The 60-minute closure rule does not apply to trading within bidding zones, for instance within Finland, and therefore carrying on trading closer to the delivery period will be possible in future, if power exchanges so decide.

Fingrid considers the 60-minute time limit for closing the trading between bidding zones very unfortunate. The time limit is long with respect to market needs and the requirements of system security. Fingrid is in favour of allowing trading as close to the start of the delivery period as possible without compromising system security. It is important that TSOs are left with sufficient time to plan the necessary balancing measures and the use of imbalance power connections before the delivery period starts.

In Fingrid's view, trading both within and between bidding zones should be possible up until 30 minutes before the start of the delivery period, provided that it does not compromise the system security of the neighbouring country's TSO. Fingrid encourages extending trading up until 30 minutes before the start of the delivery period. Shortening the deadline for production plans from the current 45 minutes to approximately 30 minutes would facilitate this goal.

2.4 Cross-border trading in the balancing power and reserve markets on the rise

Along with the integration of the electricity market, the reserve market also expands. Fingrid is actively promoting the integration of the Baltic countries with the Nordic balancing power market and is also involved in preparing a balancing power marketplace that covers all of Western Europe. The implementation of these projects takes time, however, and results can be expected at the turn of the decade.

As regards the reserve market, Nordic TSOs are renewing the technical product specifications for the frequency controlled reserves reacting fast to changes in the power system and harmonising their requirements. Currently, the requirements are partly national. Another problem is that the requirements no longer fully meet the changed requirements of the power system. As rapid changes become more frequent, new types of fast, automatically activated reserves are needed. Technical surveys on the need to reform the reserve requirements will be completed by the summer, after which the planning of their introduction will begin.

The goal is to have broad cross-border markets for reserve products, which will enable improved cost-effectiveness in the purchase of reserves. Fingrid welcomes the increase in cross-border trading in the reserve markets. At the same time, compliance with acceptable and as market-based procedures as possible must be ensured when reserving cross-border capacity for the needs of the reserve market. It is essential that cross-border capacity for the reserve market is reserved at an hourly level, taking into account the impacts on the intraday and day-ahead markets and electricity's area price difference. Fingrid is not in favour of fixed cross-border capacity being allocated for the reserve markets.

Securing a cost-effective transition to a green power system by increasing competition and promoting the effective use of resources over a broad area		
Goals	**Measures and schedules**	**Parties responsible**
Implementation of new transmission connection investments to improve the functioning of markets and power system security, and to reduce bottlenecks	'Forest Line' to improve connections between northern and southern parts of Finland in 2023	Fingrid
	New AC connection between northern Finland and northern Sweden by 2025	Fingrid and Svenska kraftnät together
	New DC connection in Kvarken in 2027	Fingrid and Svenska kraftnät together
	New transmission connection to improve connections between northern and southern parts of Finland in 2035	Fingrid
	Improving reliability, availability and properties of cross-border connections	Fingrid, and Baltic Sea and European TSOs together
Strengthening Nordic co-operation in developing the power system	Nordic System Development Plan 2017	Nordic TSOs
Ensuring effective use of transmission capacity in the common markets	Improving the transmission capacity calculation method and preparation for its introduction with the Nordic Capacity Calculation Method project in 2017–2019	Nordic TSOs together
	Introduction of a joint Nordic transmission capacity calculation method in Q4/2019	Nordic TSOs together
	Launch of the operations of the joint Nordic operational planning office RSC at the start of December 2017	Nordic TSOs together
Expanding and deepening market integration in the dayahead and intraday markets and in the trading of balancing and imbalance power.	Development of the XBID trading system and introduction of the European intraday market in Q1/2018	European TSOs, energy market authorities and power exchanges together with stakeholder groups.
	Preparing a joint European balancing power marketplace 2017–2021	
Developing cross-border co-operation in acquiring reserves in the Nordic countries and deepening balancing power market co-operation with the Baltic Countries.	Planning and preparing the introduction of co-operation models 2017–2018	In technical issues, Fingrid together with Nordic and Baltic TSOs In political and legislation issues, the ministries of the Baltic Sea region
	Harmonising the rules of use of peak load capacity in the Nordic countries 2017	Nordic TSOs

3 Increasing importance of real-time market

The majority of physical electricity trading has traditionally taken place in the day-ahead market. The intraday market has provided market operators with a means of fine-tuning their electricity balance. The shift to a green power system will transform this set-up. As the production structure changes, some of the current power plants will be replaced by plants with poorer availability and predictability. From the power system's perspective, this poses a challenge, since maintaining the system's balance requires that electricity is generated in exactly the same amount as is consumed at any given moment.

As variable electricity generation increases, more opportunities to trade closer to the delivery time are required. This change poses a challenge to develop the market rules such that they encourage the active participation of all parties capable of fast alterations in production and consumption. In Fingrid's view, this means, for example, increasing the transparency of pricing in the balancing power markets, publishing bid curves and making market entry easier. Furthermore, the reassessment of the current balance model is necessary in order to address the changes. The European balancing power market integration also calls for similar reforms in the Nordic market structures.

3.1 Balancing power markets provide new earning opportunities for flexible resources

The need for balancing measures increases with the rise in variable production, which creates new earning opportunities for the operators of flexible resources capable of fast changes. In order to make market entry easier, Fingrid has already lowered the minimum bid size to 5 MW and introduced electronic activation in the balancing power markets. In order to increase market transparency, Fingrid also implemented, in the winter of 2016–2017, a pilot project on the publication of balancing market prices during scarcity situations.

In the development of the balancing power markets, Fingrid supports solutions that increase liquidity in the markets and facilitate the use of a smaller bid size. Fingrid is willing to lower the minimum bid size further and is looking into the possibilities of introducing 1 MW bids. Lowering the bid size requires the Nordic bid activation process to be changed. It is necessary that the required balancing measures can be performed flexibly and fast under all circumstances. This means, for example, increasing automation in the activation of bids.

Fingrid considers it important that balancing power prices are published in real-time, especially in scarcity situations. The equal treatment of market parties supports the publishing. Currently, some balancing power market parties have a view of the price level of balancing power. This information is not available to all balancing power market parties or electricity market parties outside the markets. A view of the price level is created in a situation where a party's own bid is accepted on the markets. Real-time price information increases parties' opportunities to support the power system's power adequacy in scarcity situations. At the same time, it increases opportunities for risk management related to own operations and improves the cost-effectiveness of balance management.

Fingrid has decided to continue the pilot project on publishing balancing power market prices in up-regulation situations where Finland forms a balancing area of its own and supply is scarce. Fingrid is also looking into implementing a pilot in down-regulation situations.

3.2 Length of the trading period influences the management of power system balance

An effective electricity market requires that the trade period reflects the physical properties of the power system. The current one-hour period is problematic in terms of variable electricity generation and the use of cross-regional transmission connections. Some of the demand side management (DSM) potential in electricity consumption is also left unused in the current situation. The European electricity market is in the process of introducing a shorter, 15-minute trade period. The EU code approved in March 2017, which establishes a guideline on electricity balancing, also basically requires the implementation of a shorter trading period around 2020–2021. In Germany, for example, trading in short products is already possible in the intraday market. Shortening the trade period makes electricity system balancing more market-driven and reduces the adjustment need arising from, for example, the large production and consumption changes at the turn of the hour.

Fingrid is currently examining, together with other Nordic TSOs, how the transition to a 15-minute trade period should be implemented in the Nordic countries. The project includes performing a cost benefit analysis, comparing the socioeconomic impacts of different transition options. Voluntary, national models and common regional implementation, for instance, are being examined as alternative implementation models. The survey is expected to be completed during the first half of 2017.

In Fingrid's view, the transition could take place gradually in different marketplaces. Initially, the 15-minute trade period could be taken into use in the balancing power market, followed by the intraday market. The joint Nordic XBID marketplace will enable 15-minute-trade-period products during 2018. The switch to shorter products in the day-ahead market will become possible later in the 2020s.

Fingrid considers it important that the switch to a shorter trade period in different marketplaces takes place synchronously with the other Nordic countries. This will guarantee that Finnish market operators have equal trading opportunities in relation to other Nordic operators. It is, however, necessary to determine whether some operators could remain, if they so wish, outside the 15-minute imbalance settlement period during the transition period.

3.3 Price of imbalance power encourages participation in the balancing of the power system

Imbalance power reflects the difference in the market operators' planned and actual electricity consumption or generation. The Nordic countries use a harmonised imbalance power model that is based on separate production balances and consumption balances. A two-price system is applied to the production balance and a single-price system to the consumption balance. The price of imbalance power is determined on the basis of the value of the balance management measures carried out during each trade period.

The Nordic imbalance power system is exceptional in Europe. Many other European countries apply a model based on a one-price system, and the Baltic countries, for example, will switch to a one-price system in 2018. The new EU code, establishing guidelines on electricity balancing, requires that the pricing principles of production and consumption balances are in harmony in future. This creates a need to change the current Nordic pricing principles.

In autumn 2016, the Nordic TSOs launched a project related to the development of the balance model. The aim is to find out how the balance model could encourage more active participation of market operators in the electricity markets and in this way improve the cost-effectiveness of balance management. The project looks into the different options of expanding the use of the "polluter pays principle" in the pricing of imbalance power. The ways in which the energy cost of the automatic frequency regulating reserve (aFRR) should be allocated to imbalance power price, for example, are being looked into. New legislative requirements are being taken into account in the project. The first phase of the project is expected to be completed in summer 2017.

Fingrid's objective is to create new opportunities for electricity market operators to participate in balancing the electricity system in real time. As an imbalance power model, this would mean a one-price system, in which the price and bid curves of imbalance power would be available to the electricity market operators in real time. During a transition period, the real-time price information could be available at least in scarcity situations.

An imbalance power model based on a one-price model is fair in terms of production and consumption. Especially in scarcity situations, a one-price system allows market operators to participate in supporting the power system. It is estimated that this would also promote a market-based increase in renewable energy and decentralised small-scale production. Fingrid considers it important that, also in future, the key balance management principles and imbalance power pricing are harmonised in the Nordic countries.

3.4 Role of automation is increasing in balancing power and the reserve markets

The structural change in the power system and the increasingly active participation of operators will weaken the predictability of the power system, and the need for automatic balancing will grow. In the Nordic balancing power market, automatic balancing mechanisms are becoming an alternative to the current manual balancing mechanisms.

In response to the need for change, Nordic TSOs have agreed on establishing a joint Nordic market for the automatic frequency regulating reserve, with trading in the joint market due to begin in 2018. Currently the markets are national. Before trade is begun, principles concerning the reservation of cross-border capacity must be agreed on for aFRR capacity.

Fingrid welcomes the new Nordic aFRR market. At the same time, Fingrid underlines that the benefits of trading must be assessed by always taking into account the hourly market situation when making cross-border capacity reservations beforehand. Long-term fixed reservations of capacity are not acceptable.

Increasing market operators' trading opportunities in real-time markets close to the delivery hour		
Goals	**Measures and schedules**	**Parties responsible**
Developing the balance model by taking more of a "polluter pays" approach in allocating costs and by strengthening market operators' incentives to participate in the balancing of the power system.	Agreeing on the main principles in the Nordic Full Cost Balancing project during 2017 Preparation of implementation 2018–2019 Changes effective as of 2020	Fingrid together with Nordic TSOs
Shortening the trade period to 15 minutes	Agreeing on the way forward in the Nordic **Finer Time Resolution** project during 2017 Gradual implementation as of 2018	Fingrid together with Nordic TSOs
Boosting trading opportunities in the balancing market by lowering the minimum bid size	Launching of surveys in 2017 into lowering the bid size to 1 MW	Fingrid together with Nordic TSOs
Implementation of the Nordic Automatic Frequency Restoration Reserve (aFRR)	Agreeing on the principles of cross-border capacity reservation in 2017 Implementation in 2018	Fingrid together with Nordic TSOs
Renewal of technical product specifications of frequency containment reserves (FCR) capable of reacting fast to changes in the Nordic countries	Investigating the need for the renewal of product specifications in 2017	Fingrid together with Nordic TSOs

4 Consumer at centre stage

The changing electricity production structure increasingly requires the effective and market-based utilisation of the demand side management (DSM) potential. In European debate this is evident, for example, in the clean energy package published by the European Commission late in 2016. The idea behind the strengthening role of consumption is that, e.g., in scarcity situations, power-intensive industry would benefit from being able to transfer consumption to another moment in time. The active involvement of major consumers alone is not enough. In future, the goal is to include smaller-scale power consumption increasingly in demand-side management, households included. In the small and medium-sized entreprises sector, major flexibility potential in consumption is typically found in greenhouses and shopping centres. As regards household consumption, the greatest potential is currently related to the management of electric heating, but in the future, electric cars and their charging represent major flexibility potential.

The challenge is that currently the value of flexibility is not fully reflected in the market prices of electricity, which does not encourage participation in the electricity market. Outdated market structures and operating models may also restrict consumers' participation in the markets. It is essential that electricity consumers – large-scale industry, SMEs and households alike – are provided with opportunities to participate in the electricity market and thus fully benefit from the value of flexibility in electricity consumption.

4.1 Real-time information for major consumers

In Finland, major electricity consumers have been active participants in the electricity market in different time spans for a long time. In the balancing power market for example, bids come to a large extent from the consumption side even today. Measures aimed at developing an imbalance power model, described above in section **3.3**, also enable real-time demand side management to be utilised more effectively than before. A key requirement for using new opportunities is that the real-time price signal encourages flexibility and is at the operators' disposal right at the time when electricity is being used.

The imbalance power price tells the momentary value of electricity. In situations where there is shortage of resources required for balancing the power system, the price of imbalance power may rise to a substantially high level. Market operators are able to directly influence their imbalance power cost created by the price of imbalance power. The primary means is to remain within the balance. Major benefits can also be obtained in extreme situations from adjusting consumption such that the change supports the balancing of the power system.

A typical situation where the imbalance power price may rise to a high level is a malfunction at a major production facility. In these situations, a reduction in power consumption by industry may significantly help in maintaining the balance of the power system. As uncontrolled generation increases, there may also be more demand for rapid scaling-up of consumption in the future.

Knowing the value of electricity at the very moment of its consumption encourages investments in control measures and reacting to changing price signals, especially in scarcity situations. Fingrid supports a model in which the real-time price information of imbalance power is available to market operators. The pilots to be implemented are described in more detail in section **3.1**.

4.2 A customer-oriented operating model and regional retail market increase freedom of choice

A customer-oriented operating model means enabling comprehensive service for the customer. The model's benefit is that electricity-related flexible services are as easy to use as possible for the customer and that the overall electricity cost paid by them is minimised. Comprehensive service covers the sale of electricity, flexibility services, control of small-scale production and battery operation, and reconciling distribution tariffs with flexibility services to the customer's benefit. The need for reconciliation will be highlighted when power-based tariffs are introduced in the distribution network.

The current retail market model in place in Finland does not promote a comprehensive service approach. Currently, a major proportion of the electric heating load is controlled by the distribution system operator's (DSO) night-time electricity signal. The flexibility potential which is covered by slow, market-price independent control is partially lost; the arrangement does not incentivise customers to obtain flexible electricity contracts, and the overall electricity price for the customer increases. The control potential of electric heating amounts to 1,000–2,000 MW in total.

Faster and more dynamic steering of consumption according to market price by the electricity seller or other service provider optimises customers' electricity costs more effectively than time-based steering; and the more volatile and real-time the market is, the more this is true. The plan for shifting from the night-time control of electric heating to more dynamic, market-based control mechanisms is on the agenda of the smart grid working group appointed by the Ministry of Economic Affairs and Employment (MEAE). The transition should be smooth for the customer, and it should be implemented as soon as possible, taking into account practical issues, however, no later than in the early 2020s.

It is important that the retail market operating models are regionally compatible to enable larger retail market. A larger potential customer base creates better conditions for developing new services and technologies, the costs of which are typically high. Larger markets also create better conditions for aggregators. Large markets call for regional harmonisation of the retail market model and the related practices.

A seamless exchange of information is essential in market integration. In the Baltic Sea region, information exchange in the retail market and the availability of information will in future be based on centralised information exchange, i.e. datahubs. In Estonia and Denmark, data hubs were introduced some years ago, and Norway will launch a datahub in October 2017. In Finland and Sweden, the development work is ongoing. The datahub network, where information is transferred quickly and reliably, enables the integration of national retail markets. Regional joint market will require a joint information model and harmonised interface between datahubs. A harmonised interface opens up better opportunities for market operators to expand their operations regionally.

Fingrid supports the expansion of retail market into a regional retail market and better harmonisation of regional retail market models. An important goal would be to establish a broad-ranging working group to implement the joint regional retail market by 2025. The working group could start operations in 2017 with the aim of looking into the possibilities of harmonisation.

In Fingrid's view, effective retail market should be based on a customer-oriented model, in which the customer's electricity services are handled entirely by the electricity seller. The details of the customer-oriented operating model must be specified during 2017 and 2018.

4.3 Datahub improves information exchange and creates opportunities for new services

Along with the datahub, the electricity retail market will shift to a centralised, synchronised exchange of information. This means that market parties will only communicate with the datahub. This will enable nearly real-time processes when, for example, changing sellers, while at the same time providing electricity sellers with better conditions for serving their customers. Information concerning the customer and the point of consumption will be recorded in the datahub and will be available to all authorised parties. This will considerably improve the quality of the information, reduce the number of mistakes in the retail market processes and guarantee equal access to information to all market parties entitled to it.

The datahub will serve as a joint background system for the retail market, enabling companies in the sector to provide better services to their customers. The datahub will go live in 2019.

Standardised, open interfaces will be determined for the information submitted to and retrieved from the datahub, and these interfaces will be available to third parties and service providers for the purpose of developing services for customers. Data security will be comprehensively taken into account in the implementation of the datahub.

Fingrid's goal is to enable retail market business processes that are as smooth as possible, easy access to consumption information by market operators and customers, and the development of service applications for third parties.

4.4 Network service tariffs and taxation influence customers' incentive to participate in demand side management

In the coming years, DSOs will shift to a power-based tariff structure. The change is driven by the cost structure of network operations. A majority of the costs are fixed and not dependent on the amount of energy transferred. The increase in decentralised small-scale production adds to the need for change.

Currently, the network service tariffs are mainly energy-based, which does not provide customers with an incentive to be flexible in their electricity consumption. The electricity tax in its current form also does not encourage the use of electricity during those hours when it is the cheapest. Network service fees currently account for approximately a third of a household consumer's total electricity costs, and the electricity tax accounts for about a fifth.

In a power-based distribution network tariff, the fee would be based on the power drawn by the customer from the network. Power-based tariffs support the development of a DSM infrastructure by creating an incentive for customers to balance their consumption and store electricity on a small scale. In order to facilitate the optimisation of overall electricity costs, the tariff information should be readily available, e.g., in the datahub. Pricing that encourages flexibility is key when a customer considers acquiring DSM services.

In Fingrid's view, the introduction of power-based distribution network tariffs would help maintain power adequacy. Harmonisation of power-based tariffs and including tariffs in the datahub information must be looked into. Power-based tariffs will be discussed by MEAE's smart grid working group in 2017.

Changing the electricity tax into a dynamic tax that is dependent on the market price of electricity would strengthen the price signal and create better incentives to use electricity when there is plenty of supply and, on the other hand, to cut consumption when there is a scarcity of supply. Transitioning from a fixed electricity tax based on the amount of energy to a variable one based on electricity price may provide a quick way of encouraging flexibility in electricity consumption. The possibility of changing the structure of the electricity tax will be discussed by MEAE's smart grid working group in 2017.

Improving consumers' opportunities to benefit from flexible measures		
Goals	**Measures and schedules**	**Parties responsible**
Providing market operators with more up-to-date information on the value of electricity at any given moment	Continuing and expanding the pilot project launched in late 2016 on publishing the balancing power price in scarcity situations	Fingrid
Harmonising the operating principles of national retail markets to enable regional retail markets and linking national datahubs together in order to ensure the seamless exchange of information	Planning will begin in 2017 Linking national datahubs in the early 2020s Introduction of regional retail markets in the mid-2020s	Ministries of the Baltic Sea region, supervisory authorities and TSOs together with electricity sellers, DSOs and customer organisations
Introduction of a datahub in the Finnish retail markets	Completed by the end of 2019 Project subtasks: - legislative projects - competitive bidding, acquisition and implementation of the datahub system - data conversion with the sector - development projects of companies in the sector	Fingrid together with retail market operators and DSOs
Improving small-scale customers' participation in demand-side management	Clarifying operators' roles in demand side management in 2017 and 2018 Looking into the compatibility of electricity price, network tariffs and taxation in order to strengthen the incentives for demand-side management in 2017 and 2018	MEAE's smart grid working group MEAE's smart grid working group

5 New challenges require new solutions

Many of the valid electricity market regulations and operating models were drawn up at a time when the predictability of electricity generation was distinctly different in comparison to the future. Volatility in a green power system is greater, and the changes can already be seen. Future energy citizens may benefit from sharing resources with others or by adapting their own, time-independent demand to moments when there is plenty of electricity supply.

The market entry of DSM potential requires reforms in which the structural factors affecting participation willingness are examined, starting from the steering effects targeted in the future. The solutions should also promote the effective use of small-scale customers' own production as part of the power system.

Flexible solutions in supply and demand alone are not sufficient to balance volatility in the power system, which means that, eventually, a solution to the storage question must be found. In terms of short-term storage, expectations regarding the development of battery technology are high. In future, the batteries of electric cars may also be an important short-term storage solution as regards the power system. Commercially profitable long-term storage has proved to be challenging.

5.1 Open data enables new services and innovations

For the markets to function effectively, all market participants must have access to correct and real-time information. The demands concerning access to real-time information will increase when the market situation changes at a faster pace than before and trading moves closer to real time.

As far as we know, Fingrid is the first TSO to have opened an open interface through which market participants and other parties may freely make use of close to real-time information on the state of the power system. The interface was opened with the aim of improving the functioning and effectiveness of the market. The information is freely accessible to all operators. The machine-readable data can be used, for example, in user-friendly applications offered to small-scale customers, in data visualisation and in the internal processes of market participants. Trading in the electricity markets can be further automated when information affecting the electricity market becomes more readily available than it currently is.

The open interfaces of the datahub allow the development of more unique energy services and facilitate the creation of new business models. In future, it is also important to make the measurement data of other energy forms, such as district heating, available to operators, since it would enable more comprehensive energy management of buildings.

5.2 Decentralised resources help balance the power system

In future, an increasing number of resources participating in the electricity markets, in flexibility and in maintaining the national power balance will be connected to the distribution networks. Customer activation will influence distribution networks and the use of the national power system. Fingrid's goal is for decentralised resources to participate as extensively as possible in the balancing of the electricity market.

In the future, decentralised, flexible resources will be steered quickly according to the situation. At the same time, the need for information exchange between operators will increase. This means that the information exchange required by real-time trading needs to be developed in the energy sector. It must be possible to exchange information and steer decentralised resources in a way that guarantees data security.

The option of offering decentralised energy resources to the electricity market must also be possible. Electric cars, for example, represent a flexible resource from the point of view of the power system. Making use of the flexibility potential requires a smart charging infrastructure. If smart charging were not implemented, the increase in electric traffic would create challenges for the entire power system if charging strongly increases the instantaneous power consumption and local transmission need.

Although the impacts of electric traffic on the power system will not increase until electric traffic becomes more common, defining the charging infrastructure criteria at an early stage is important. In Fingrid's view, the charging activities of both public and private electric traffic should mainly be based on smart charging, which takes into account the price signals of the electricity market. This enables cost-effective charging activities for electric traffic. The cyber security of the charging activities must also be thoroughly guaranteed.

MEAE's smart grid working group will survey the extent to which electricity market participants and system operators need real-time information exchange, especially is terms of decentralised resources. Based on this survey, a vision for information exchange will be formulated. The group will propose possible further measures during 2017–2018.

5.3 Aggregation enables the effective use of decentralised resources

Traditionally, only the balance responsible party for the site, the electricity seller or the site owner have been able to participate in the reserve market. At the beginning of 2017, Fingrid enabled the independent aggregator model in the Frequency Containment Reserve for Disturbances (FCR-D). Independent aggregator refers to an operator outside the supply chain with no contractual relationship to the balance responsible party for the aggregated resources. Fingrid has also carried out a pilot project concerning the participation of an independent aggregator in the Frequency Containment Reserve for Normal Operation (FCR-N). The project results will be presented at Fingrid's stake-holder events during spring 2017.

At the end of 2017, Fingrid will launch a pilot on the operating model of an independent aggregator in the balancing power market. The goal is that by combining offers, more operators would have the opportunity to gain financial benefits from participating in maintaining the power balance of the power system. This increases supply in the real-time market. The aim of the pilots is to gain practical experiences from the handling of bids, trade records and balance errors, and from information exchange between the different parties. Based on the experiences gained from the pilots, Fingrid will assess the conditions for the general introduction of the independent aggregator model in the reserve and balancing power markets. The principles of aggregator activities are also handled by MEAE's smart grid working group. Fingrid additionally participates in working groups made up of both Nordic and Baltic Sea region TSOs that are looking into the matter.

Fingrid promotes a model where the customer is free to choose its flexibility services provider and, as a general rule, does not need permission from the electricity seller or balance responsible party. The model supported by Fingrid does not include administrative compensation between competitive operators, for example between an independent aggregator and the balance responsible party.

5.4 Electricity storage solutions needed

Electricity storage will bring more flexibility to the power system and improve transmission reliability. Surveys show that electricity storage reduces the overall costs of power systems; this should be taken into account when considering the network tariffs to be applied to electricity storage facilities, taxation practices and other market rules. Storage facilities are neither production nor consumption, which is why they should be treated separately in the power system.

When shifting to a carbon-neutral power system, it is necessary to find a longer term solution for storing electricity to be able to handle customers' electrical energy requirements for the entire year. This is why research into storage technologies must be promoted and pilot facilities built jointly by research institutions and market operators.

5.5 Energy communities allow increased electricity generation by customers

Energy communities are voluntary alliances that generate, for example, renewable energy and want to use the generated energy for the benefit of the community members. Energy communities thus increase customers' alternatives in terms of producing energy. They may also have electricity storage facilities or other technology at their disposal. At the same time, they may serve as balancing resources for the power system.

So far, 'energy community' is not an established concept. This is why practices that local and decentralised energy communities follow must be defined. Energy communities must have measuring and data transfer services at their disposal. One option is to enter the basic information and energy information of the energy community's points of use in the datahub, where they can be accessed by the energy community's service providers. In this case, DSOs should offer measuring and data transfer services to energy communities, too.

MEAE's smart grid working group is expected to draw up a proposal enabling the operations of energy communities. Fingrid's goal is, for its part, to enable the establishment of energy communities. We consider it important that electricity market rules are fair for all operators.

Promoting the market entry of new technologies and using them in the balance management of the power system		
Goals	**Measures and schedules**	**Parties responsible**
Promoting the participation of decentralised resources in the balancing of the power system	Defining the criteria for the connections of decentralised resources such that participation in the balancing of the power system is easy, 2017–2018	Fingrid together with market operators
Promoting electric cars' opportunities to participate in the balancing of the power system	Defining the criteria for electric cars' smart charging such that electric traffic resources have the possibility to participate in the balancing of the power system, from 2017 onwards	Legislative proposals by the Ministry of Transport and Communications/Ministry of the Environment Fingrid together with charging services suppliers promotes the effective integration of electric traffic into the power system.
Developing real-time exchange of information to better meet the needs of market operators	Surveying information exchange needs and agreeing on further plans, 2017–2018	Fingrid as a part of MEAE's smart grid working group
Enabling the operation of independent aggregators	Implementing a balancing power market pilot, 2017–2018 Nordic TSOs' Third Party Aggregator project, 2017 Baltic TSOs' demand-side management working group, 2017	Fingrid together with pilot parties Nordic TSOs Baltic TSOs and Fingrid
Clarifying the rules of operation of energy communities	Establishing the principles for energy communities during 2017	MEAE's smart grid working group

In conclusion

The energy and electricity systems are going through a major transformation, which will lead them to a green, carbon-neutral system of the future. The transformation was sparked by climate change and it aims to mitigate and combat climate change.

The power system transformation has challenged the operations and market rules of the power market. This is also reflected in the modified legislative targets. In the EU's previous legislation package on the internal energy market at the end of the first decade of the 2000s, the main objective was the harmonisation and integration of the European markets. The goal of the European Commission's 'Clean energy for all Europeans' package published at the end of 2016 is to combat climate change in accordance with the policies of the Paris climate agreement and to adapt the market for electricity generated with variable, renewable energy.

At Fingrid, we rely on market-based solutions: we put electricity consumers – whether large or small – at centre stage, promote market rules that let pricing steer power generation, consumption and storage, and add market flexibility in order to secure the sufficiency of electricity in different situations. The operating system made up of the market and power system needs to be backed-up by solid infrastructure. Fingrid is systematically developing its transmission grid and connections to neighbouring countries, as the decision to build a third DC connection between Finland and Sweden indicates, as does the publicly announced plan to increase connections between northern and southern Finland in the form of the new Forest Line.

We are co-operating with several parties on developing market rules that are compatible with the future power system. European co-operation through ENTSO-E is closely connected to the implementation of network codes. All eight network codes have now been approved; they are legally binding regulations that now require implementation, which requires a lot of work. This roadmap also includes some of these market rule issues. Nordic co-operation, which at one point was thought to be dwindling, has gained new momentum: network codes require, for example, common methods by transmission capacity calculation region. We are putting great effort into drawing up these methods together with Nordic and Baltic TSOs.

In bringing about one of the key issues in market development – demand side management – we have had the opportunity to work closely with Finnish stakeholders. Fingrid's development of the balancing and reserve market rules and the use of pilots for testing new practices have served as channels for developing the short-term markets. Smart grid efforts as a whole play an important role in enabling demand side management.

The journey to a green power system continues, and we want to take this trip together with our stakeholders. This is why we are improving, through this roadmap and information published on our website, your visibility into power market development projects and their progress.

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