15 MINUTES IMBALANCE SETTLEMENT PERIOD – MARKET IMPACTS OF LATE IMPLEMENTATION

Final report

June 15, 2018

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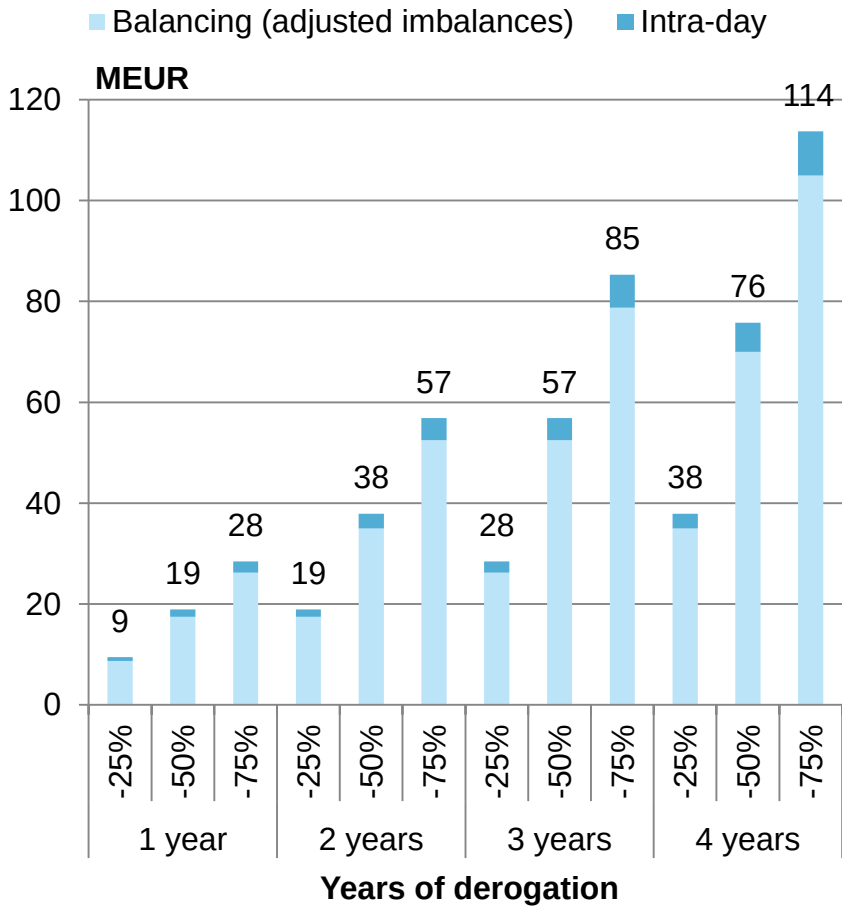
EXECUTIVE SUMMARY

Late implementation leads to increased balance management costs especially in the balancing market

- **Balancing market:** the cost impact is estimated to be 9-26 MEUR per year.
  - Up-regulation is more price sensitive with regards to regulation volumes. At the moment Finland has a positive imbalance on average and that has led to selling imbalance electricity to Sweden. This is expected to become more symmetrical the new Nordic balancing model.
  - More volatile prices due to reduced supply of cross-border balancing resources may lead to changes in market behaviour and the risk for extreme prices which is not captured by the quantitative analysis.
- **Intraday market:** the cost impact varies from 0.7 to 2.2 MEUR per year.
  - More volatile balancing and imbalance prices could increase trade volumes in the intraday market can leading to upward pressure on prices as well.
- **IT costs:** the impacts of late implementation on IT costs are remarkably lower that the market impacts.



INTRODUCTION

BACKGROUND TO THE STUDY

- Based on the EU Commission regulation (2017/2195) of 23 November 2017 establishing a guideline on electricity balancing (EBGL), by three years after the entry into force of the regulation (i.e. 18.12.2020), all TSOs shall apply the imbalance settlement period of 15 minutes (“15 min ISP”) in all scheduling areas while ensuring that all boundaries of market time unit shall coincide with boundaries of the imbalance settlement period.
- The relevant regulatory authorities of a synchronous area may grant an exemption from the 15 min ISP requirement upon a joint request of the TSOs in the concerned synchronous area or at their own initiative. In case of exemption, a cost-benefit analysis concerning the harmonisation of the imbalance settlement period within and between synchronous areas shall perform at least every three years.
- The relevant regulatory authority may grant the derogation until 1 January 2025 at the latest.
- In the Nordic countries, 15 min ISP is planned to be introduced first to the intraday markets and balancing markets.
- A number of market parties in Finland object the implementation of 15 min ISP by 2020 and request a derogation for several reasons. In order to grand a derogation, the criteria presented in the EBGL should be fulfilled.
- The Energy Authority is carrying out a study of the need and possibilities for the derogation. The study is expected to be finished by September 2018.
- Fingrid is not supporting the derogation unless other Nordic countries and especially Sweden is postponing the implementation of 15 min ISP. Fingrid considers the joint commitment and common timetable as particular important.

OBJECTIVES, SCOPE AND LIMITATIONS 1(2)

- The objective of the study is to analyse the impacts on the electricity market if Finland is not implementing 15 min ISP simultaneously with the other Nordic countries but later than the others.
  - The basic assumption is that Norway, Denmark and Sweden are implementing 15 min ISP by the end of 2020. Finland may consider derogation until 1 January 2025 at the latest.
  - Due to cross border transmission capacity especially simultaneous implementation with Sweden is seen important.
- The study analyses the costs of implementing 15 min ISP at the later time ("late implementation") than other Nordic countries.
- The costs and benefits of implementing 15 min ISP are out of the scope of this study.
  - The study considers only the costs and benefits of implementing 15 min ISP at the later time, not the costs and benefits of 15 min ISP per se.
- The study focuses of the impacts on the intraday and balancing markets only.
  - Other market impacts are out of the scope.

- The study considers the costs of the late implementation for the electricity market as a whole.
  - Impacts on different market parties are analysed if necessary.

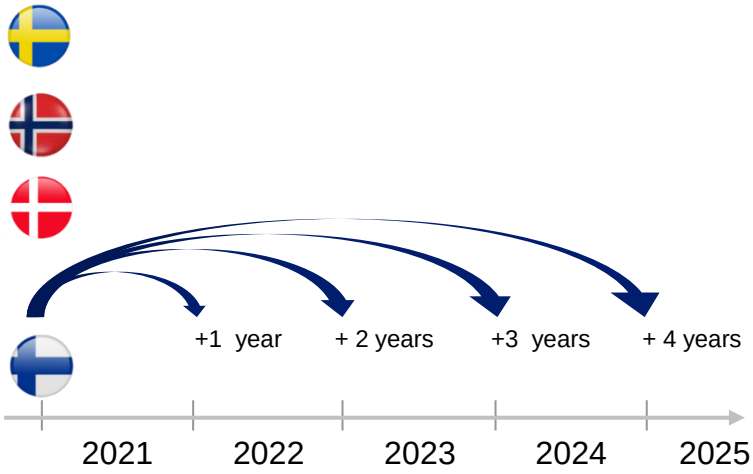
OBJECTIVES, SCOPE AND LIMITATIONS 2(2)

- In addition to electricity market impacts, a general comment on the IT costs and benefits is included.
  - Qualitative assessment.
- All the analyses are carried out from the Finnish electricity market perspective.
- The study applies both quantitative and qualitative research methods. Quantitative analysis is supplemented with the qualitative analysis when relevant market data is not available or the impacts are impossible to quantify reliably.
- The analysis is based on the public data, data provided by Fingrid and Pöyry's market view.
- The study contributes to the existing knowledge of the impacts of 15 min ISP from the Finnish perspective by covering a certain aspect of the electricity market impacts.
  - Many other impacts such as better use of interconnectors or impacts on Nordic cooperation and harmonisation have not been considered in this study.

APPROACH AND RESEARCH SCENARIO

- Baseline
  - It is taken for given that all the Nordic countries are implementing 15 min ISP; there is no need for a cost benefit analysis for that matter.
  - Implementation of 15 min ISP shortens the trading period of intraday markets and balancing markets to 15 minutes. Other market places such as day ahead markets may follow later.
  - Major changes in balancing model is due to by Q1/2021 regardless of 15 min ISP implementation schedule, e.g.
    - implementation of Area Control Error based balancing
    - single-price balancing model
    - 15 min imbalance settlement period between TSOs
  - Datahub begins operating before 15 min ISP.
- Research scenario
  - Norway, Sweden and Denmark are implementing 15 min ISP by 2020.
  - Depending on the derogation Finland implements 15 min ISP 1–4 years later than the other Nordic countries

- From 60 min to 15 min period
  - Imbalance settlement period (ISP)
  - Trading period in the intraday market
  - Trading period in the balancing market
- Day ahead markets may follow later



MARKET IMPACTS OF LATER IMPLEMENTATION

RESEARCH METHODOLOGY

The analysis is based on historical data from 2017 in the balancing and intraday markets

- The analysis is done for the balancing market and intraday market which will have 15-min products after the introduction of the 15-min imbalance settlement period.
  - Cross-border trade is expected to be impacted if Finland trades only in 60-min products whereas other Nordic countries will have 15-min and 60-min products.
  - Finnish market participants can trade only block products in the Nordic markets and the supply of bids from other Nordic countries can be less than in a situation where all countries have the same trading and imbalance settlement periods.
- The share of cross-border trade with other Nordic countries is calculated based on historical data from 2017 to be able to estimate what is the market impact of reduced cross-border trade.
  - The cost impact is estimated where the cross-border trading volumes have decreased by 25%, 50% or 75%.
  - In the balancing market the activated regulation volumes of Finnish balancing are compared to imbalance trade with Sweden, which represents activated volumes in other Nordic countries to balance imbalances in the Finnish system.
  - For intraday market, the ticker data from Nord Pool has been used to calculate volume of trades for each buy and sell area.
- The approach for estimating the impact on prices in the balancing and intraday markets has been described in the following pages.

COST IMPACT ON THE BALANCING MARKET – APPROACH

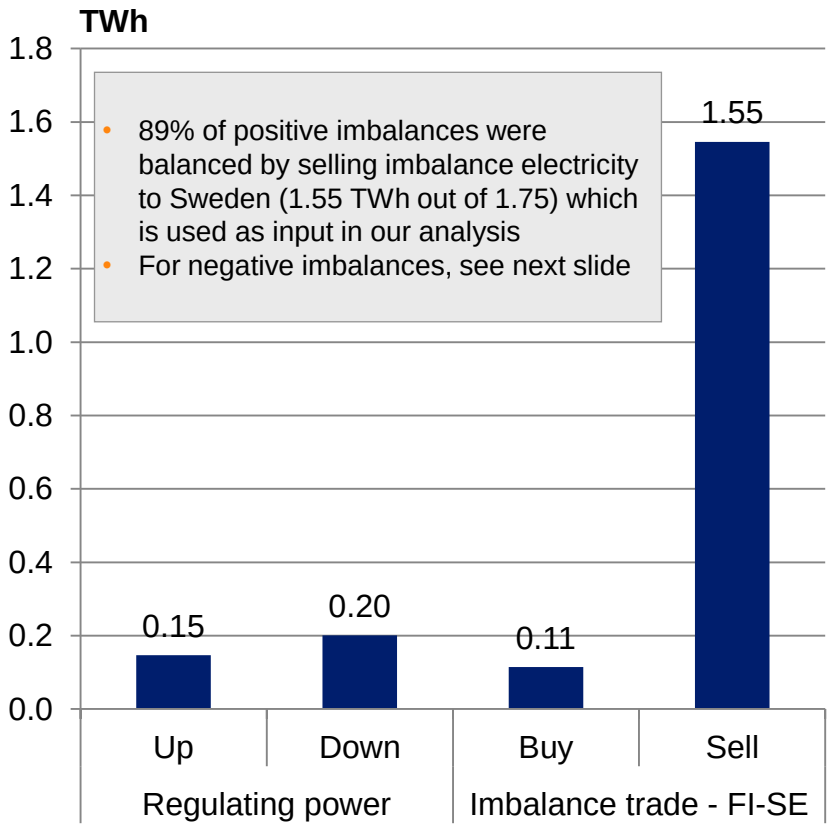
The cost impact is evaluated based on the price sensitivity of up- and down-regulation with regards to regulation volumes

Approach

- The price sensitivity of Finnish regulation prices with regards to regulation volumes is analysed through regression analysis based on historical data.

- The following scenarios have been used:
  - Scenario 1: The imbalance volumes for the system as a whole stay as they were in 2017.
    - the average imbalance position is roughly +170 MWh/h long, when combining Finnish regulation volumes and the imbalance trade with Sweden
  - Scenario 2: The imbalance volumes are adjusted so that they are 0 MWh/h on average with the same profile as in 2017, i.e. up-regulation and down-regulation volumes are equal over the year.
    - simulates the situation where market participants trade themselves into balance on average (this is one of the key objectives of the new Nordic ACE balancing model)

Regulation and imbalance trade volumes, 2017



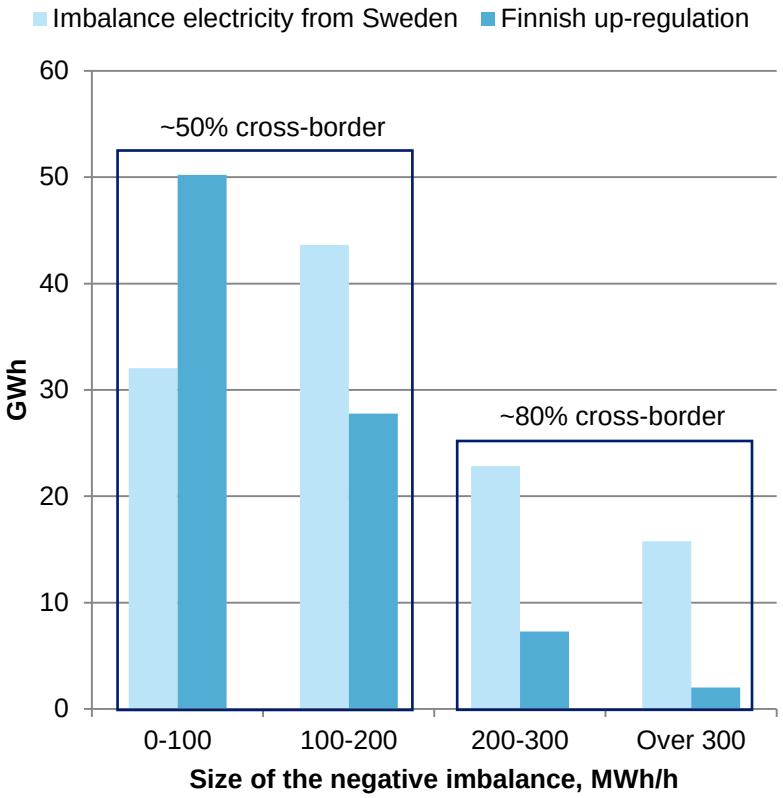
- 89% of positive imbalances were balanced by selling imbalance electricity to Sweden (1.55 TWh out of 1.75) which is used as input in our analysis
- For negative imbalances, see next slide

SHARE OF CROSS-BORDER UP-REGULATION

Negative imbalances are balanced by buying imbalance electricity from Sweden in increasing amounts as the size of the imbalances grow larger

- When calculating the share of cross-border balancing the impact of bottlenecks in the FI-SE interconnectors was removed by taking into account the available interconnector capacity in each hour.
- The share of cross-border balancing was found to be dependent on the size of the imbalance: the share is higher with larger imbalance volumes (see figure).
  - One possible reason for this is that there is a certain amount of relatively cheap Finnish up-regulation available and that the supply curve of cross-border up-regulation is relatively flat as it is provided primarily by reservoir hydro.
- Based on 2017 data, we have used the following assumptions depending on the size of the imbalance:
  - Over 200 MWh/h: 80% cross-border balancing
  - Under 200 MWh/h: 50% cross-border balancing
- In our analysis we have assumed that there is available interconnector capacity for cross-border up-regulation as the commissioning of Olkiluoto 3 is expected to reduce imports from Sweden to Finland.*

Cross-border and Finnish regulation volumes to cover negative imbalances, 2017



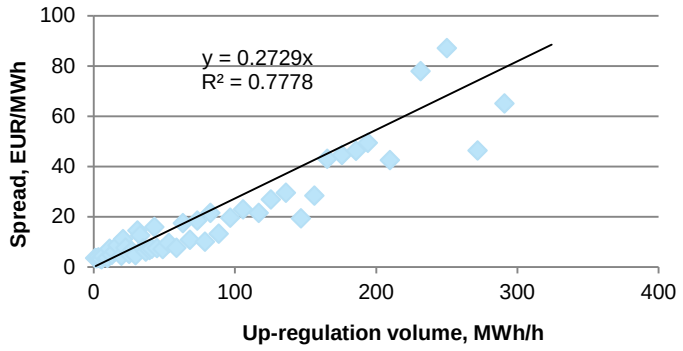
*Supported by findings in forthcoming Pöyry study which looks at e.g. supply of flexibility through interconnectors

PRICE SENSITIVITY OF UP-REGULATION

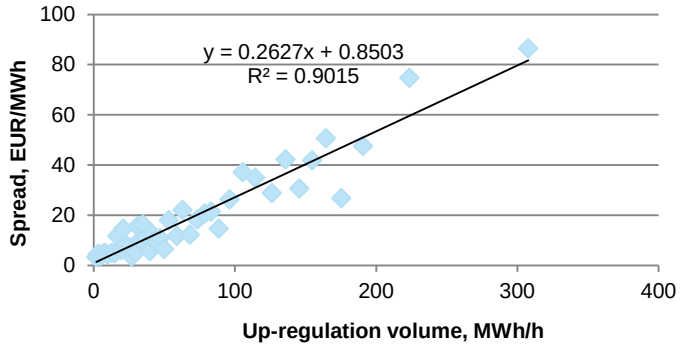
Based on the regression analysis 10 MWh of additional up-regulation costs roughly an additional +2.7 EUR/MWh

Spread and up-regulation volumes

2017



2016



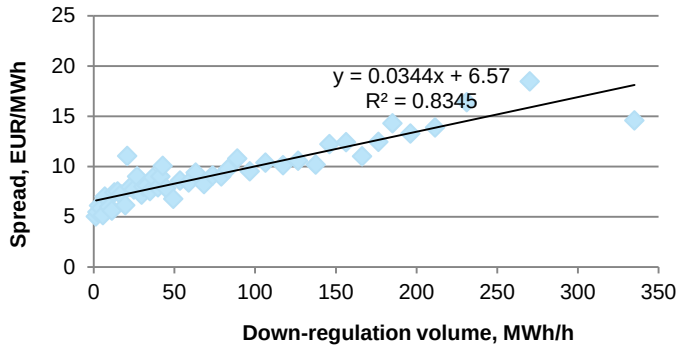
- Correlation between up-regulation prices and volumes has been estimated by calculating the hourly spread between day-ahead and up-regulation prices.
  - A clearer trend is observable when the data is averaged over discrete bins
  - Putting data in bins is a statistical technique to reduce the effect of minor observations by grouping the original data within a certain interval and using one representative value for the group, the bin
- The results based on years 2016 and 2017 indicate that an additional 10 MWh of flexibility is on average 2.7 EUR/MWh more expensive.
- Hours with spread higher than 400 EUR/MWh have been ignored as they were outliers in the data and reduce the linear regression fit quite significantly.
  - A combined 14 values were removed from the dataset from years 2016-2017

PRICE SENSITIVITY OF DOWN-REGULATION

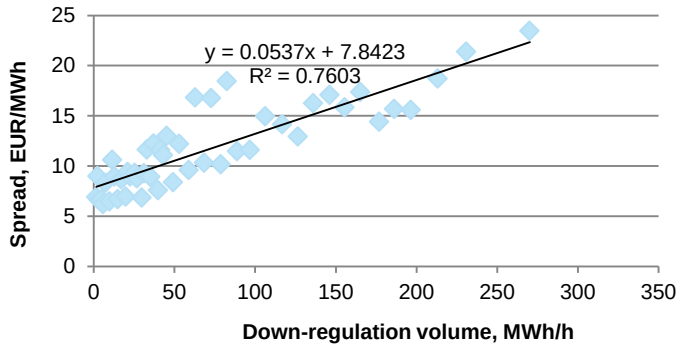
Based on the regression analysis 10 MWh of additional down-regulation increases the spread to the day-ahead price by roughly 0.4 EUR/MWh

Price spread and down-regulation volumes

2017



2016



- Correlation between down-regulation prices and volumes has been estimated by calculating the spread between day-ahead and down-regulation prices.
  - The data is averaged over discrete bins as for up-regulation
- The results based on years 2016 and 2017 indicate that an additional 10 MWh of down-regulation increases the spread to the day-ahead price by roughly 0.4 EUR/MWh on average.
  - The price spread is much less sensitive to regulation volumes than with up-regulation
- Hours with spread higher than 90 EUR/MWh have been ignored as they were outliers in the data.
  - A combined 23 values were removed from the dataset from years 2016-2017

RESULTS – 2017 IMBALANCE VOLUMES (SCENARIO 1)

The cost impact is estimated to be 7–22 MEUR/a when using the imbalance volumes from 2017 as basis for calculation

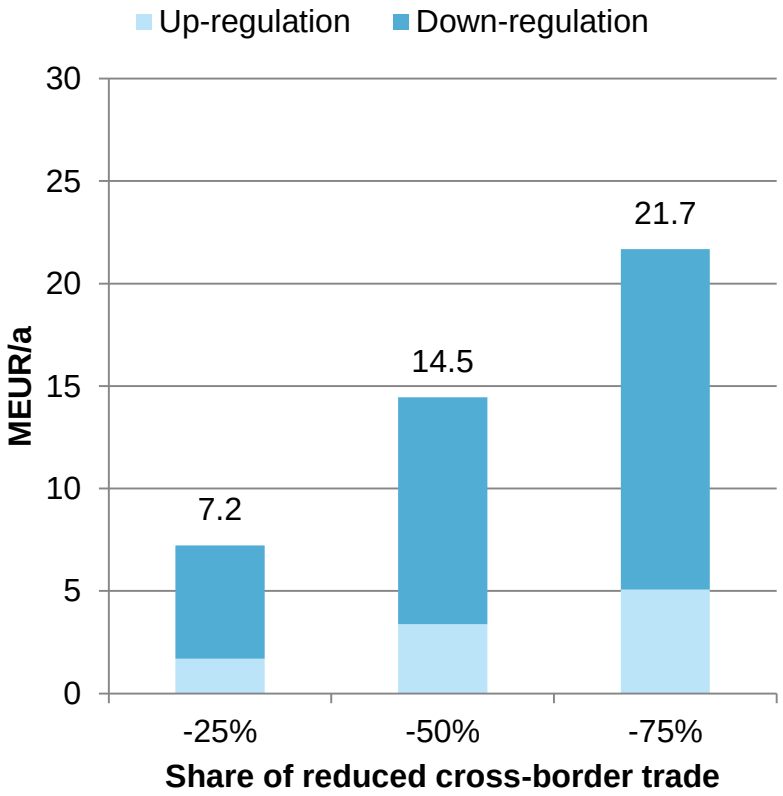
- Even though down-regulation is less price sensitive to regulation volumes, the large volume of imbalance trade to Sweden to settle long positions means that the increase in procurement costs from lower down-regulation prices forms a larger share of the overall impact.

- If Finnish market participants are systematically long as a whole, they have to sell back their excess energy as down-regulation which results in higher effective procurement costs (see example below).

Example

- Supplier procures 10 MWh from the day-ahead market at the price of 40 €/MWh
- Customers consume only 9 MWh during the hour
- The supplier has to sell back the excess electricity through the imbalance settlement for a price of 30 €/MWh, which is defined by the down-regulation price
- The supplier's overall procurement costs are now – (10x40) - (1x30) = 370 €, i.e. 41 €/MWh
- A lower down-regulation price results in higher procurement costs per MWh for customers

Cost impact on the balancing market with 2017 imbalance volumes, MEUR/a

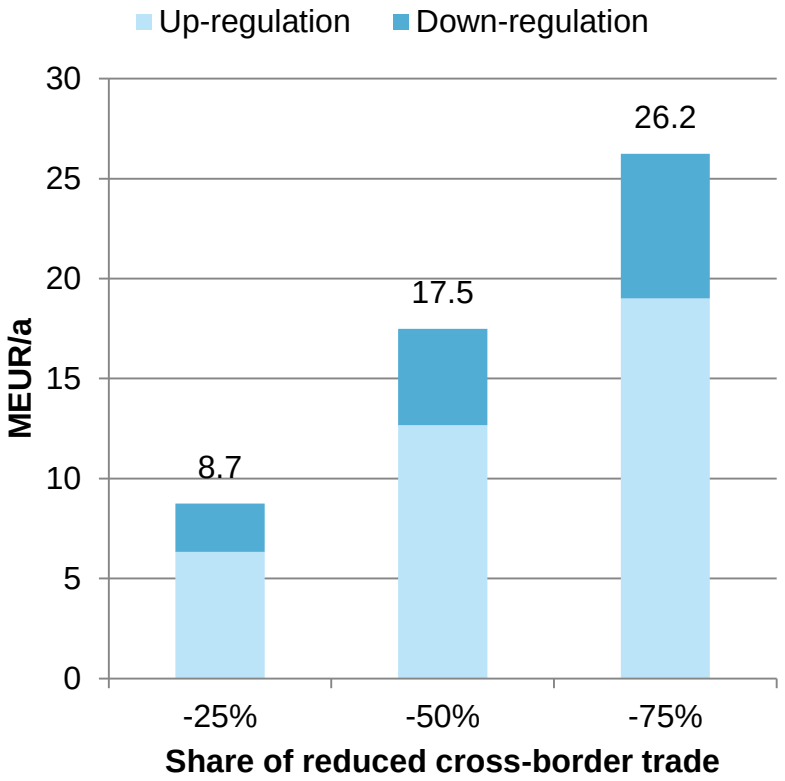


RESULTS – ADJUSTED IMBALANCE VOLUMES (SCENARIO 2)

The cost impact is estimated to be 9–26 MEUR/a when adjusting the imbalance volumes as symmetric

- When the imbalance volumes are adjusted, the impact of more expensive up-regulation is larger as it is more price sensitive to regulation volumes.
- This effect is dampened somewhat by the fact that a smaller share of up-regulation is assumed to come from cross-border resources compared to 89% for down-regulation.
  - The adjusted negative imbalances are over the threshold of 200 MWh/h 12% of the time when the share of cross-border balancing is assumed to be 80% (compared to 50% for smaller imbalances)
- The impact on overall cost is also dampened due to smaller overall imbalance volumes, which are now roughly 0.6 TWh/a each for both directions (1.2 TWh/a in total).
  - In the previous case they were in 2.0 TWh/a in total of which positive imbalances accounted for 87%

Cost impact on the balancing market with adjusted imbalance volumes, MEUR/a

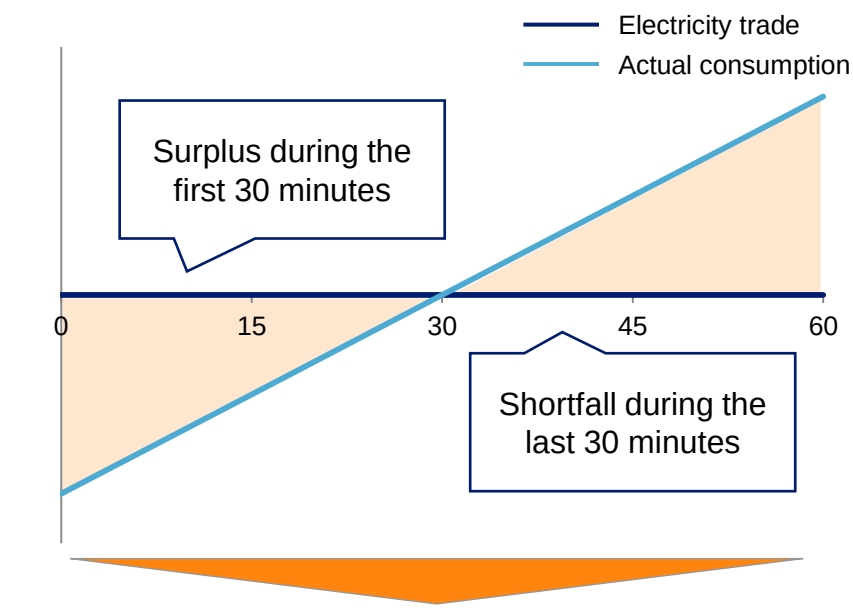


IMPACT OF DISCREPANCY BETWEEN MARKET PERIODS

Market participants are not incentivised to support system balance within 15 min periods as imbalances are netted over 60 minutes

- In our scenario we have assumed that the new Nordic ACE balancing model is in use in 2021; under this model the imbalance settlement between Nordic TSOs, including Fingrid, will be done in 15 min.
- This leads to a situation where Finnish market parties continue to balance their portfolios over a 60 min period whereas balancing and imbalance settlement between Fingrid and the other Nordic TSOs is done in 15 min periods.
  - This discrepancy is not presented at the moment and hence not captured by the data analysis
- There is no price signal to incentivise market participants to support system balance within the 15 min periods as market participants are not exposed directly to 15 min prices through the balancing market (as there will be no 15 min products in Finland) or imbalance settlement.
- Possible ways for TSO to handle balancing within 15 min period:
  - Procure more aFRR reserves
  - Procure 15 min products from other Nordic TSOs through bilateral agreements
  - Create a custom 15 min product for the Finnish market

Illustrative example



- The TSO procures down-regulation during the first 30 min and up-regulation during the last 30 min.
- The market participants are in balance over 60 min and the balancing costs cannot be allocated in the imbalance settlement based on the ‘polluter pays’ principle.

COST IMPACT ON THE INTRADAY MARKET – APPROACH

The cost impact is evaluated in two ways: 1) based on average price spread and 2) based on the highest realised trade price for each hour

Approach

- Cost impact is estimated in situations where trading volumes from Sweden, Norway and Denmark have decreased by 25% / 50% / 75% compared to current situation
  - SE, NO and DK represent 41% of the overall procured volume of 1 TWh during 2017
  - When the impact of bottlenecks is removed, the share is 51%, i.e. 25% increase
- To analyse the impact on procurement costs, the replacing volume is assumed to be bought from Finland based on:
  1. The average price spread between Finnish and electricity imported procured from; and
  2. The highest realised trade price for each hour where the buy or sell area has been Finland

Example – 50% of SE/NO/DK trade replaced

Buy area	Sell area	Price, €/MWh	Volume, MWh
FI	SE1	20	20
FI	SE1	20	20
FI	FI	25	20

- In approach 1 the impact is: 20 MWh x 2.4 €/MWh = 48 €
  - Avg. price spread FI-SE 2.4 €/MWh (see below)
- In approach 2 the impact is: 20 MWh x 5 €/MWh = 100 €
  - 20 MWh is replaced with the highest trade price 25 €/MWh

Average prices and trading volumes (2017)

Sell area:	FI	SE	NO	DK	Baltic	Cont. Europe
Avg. price, EUR/MWh	33.4	31.0	30.6	30.9	33.5	30.5
Spread vs. FI, EUR/MWh	0	-2.4	-2.8	-2.5	+0.1	-2.9
Volume (GWh)	364	241	30	145	139	101
Share of volume	36%	24%	3%	14%	14%	10%

Source: Nord Pool, Pöyry analysis

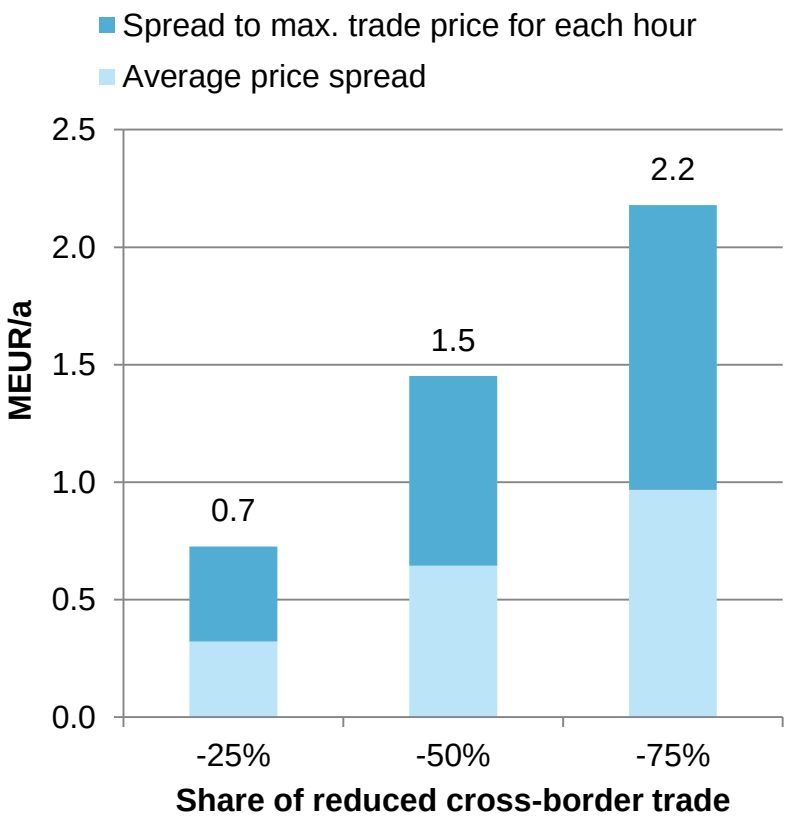
Buy area: Finland

COST IMPACT ON THE INTRADAY MARKET – RESULTS

Based on the assumptions used in the analysis the cost impact in different scenarios varies from 0.7 to 2.2 MEUR/a

- Based on the highest trade price for each hour, the impact is 0.7-2.2 MEUR/a.
  - Share of cross-border trade from other Nordic countries assumed to be roughly 50% as Olkiluoto 3 commissioning will reduce the bottlenecks
  - Average price spreads between Finland and other Nordic countries contributes 0.3-1.0 MEUR/a of this impact
- Replacing the removed volumes with volumes that are priced according to the highest realised trade price for each does not take into account that the next MWh procured could be more expensive.
- On the other hand, sometimes the highest realised trade can happen at a different time during the trading period than the trades for the removed volumes. At that time, there could be cheaper domestic electricity available compared to the highest trade price.

Cost impact on intraday markets (based on 2017 figures)



SUMMARY AND CONCLUSIONS 1(2)

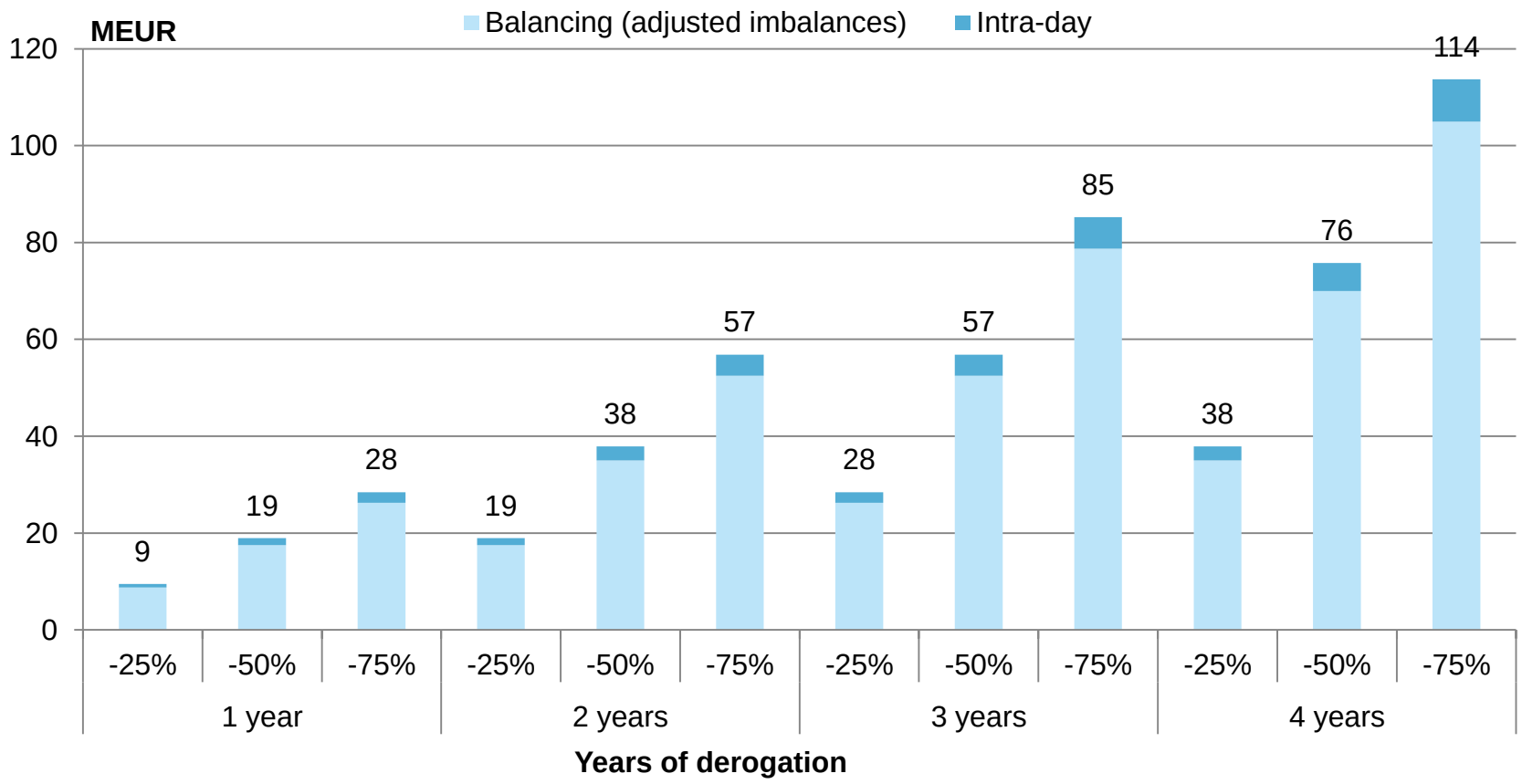
Reduced cross-border trade due to late implementation of 15 min ISP is estimated to have a considerable larger impact on balancing market costs than intraday market costs because of significant imbalance trade with Sweden

- **Balancing market:** The cost impact is estimated to be 6-21 MEUR/a based on 2017 imbalance volume data and the imbalance trade with Sweden
  - Up-regulation is more price sensitive with regards to regulation volumes. At the moment the Finnish system has a positive imbalance on average and most of that is regulated through selling imbalance electricity to Sweden. This is expected to change with the introduction of the new Nordic balancing model based on Area Control Errors (ACE).
  - More volatile prices due to reduced supply of cross-border balancing resources may lead to changes in market behaviour and the risk for extreme prices which is not captured by the quantitative analysis.
  - Exposing market participants to more volatile prices could lead to development of trading practices, better forecasting or formation of larger balance portfolios.

- **Intraday market:** The cost impact in different scenarios is estimated to be 0.7-2.2 MEUR/a based on 2017 trading volumes and prices.
  - By using the highest trade price for each hour as the reference price for the replaced volume the impact more than doubles compared to average price spreads between Finland and other Nordic countries.
  - Making the balancing, and as a result imbalance, prices more volatile trade volumes in the intraday market can increase leading to upward pressure on prices as well.

SUMMARY AND CONCLUSIONS 2(2)

Multiplying the combined annual impact of reduced cross-border trade on balancing and intraday markets provides an indicative estimation on cumulative costs for the late implementation



LIMITATIONS AND COMMENTS

Risk for extreme prices and more volatile prices leading to changes in market behaviour is not captured by the quantitative analysis

- The analysis does not take into account change in market behaviour of market parties.
  - Especially in the first case where the imbalance volumes are assumed to remain unchanged, it is unlikely that market participants would not adjust their trading strategies if the spread between the day-ahead and down-regulation price increases.
  - In both cases exposing market participants to more volatile prices could lead to development of trading practices, better forecasting or formation of larger balance portfolios, especially in a single-portfolio imbalance settlement model. This could have a second-order impact on intraday trade volumes and prices.
  - On the other hand, more volatile prices can also lead to increased supply of balancing power from Finnish resources, e.g. by incentivising investments in demand-side response, and making the regulation prices less price sensitive to regulation volumes.

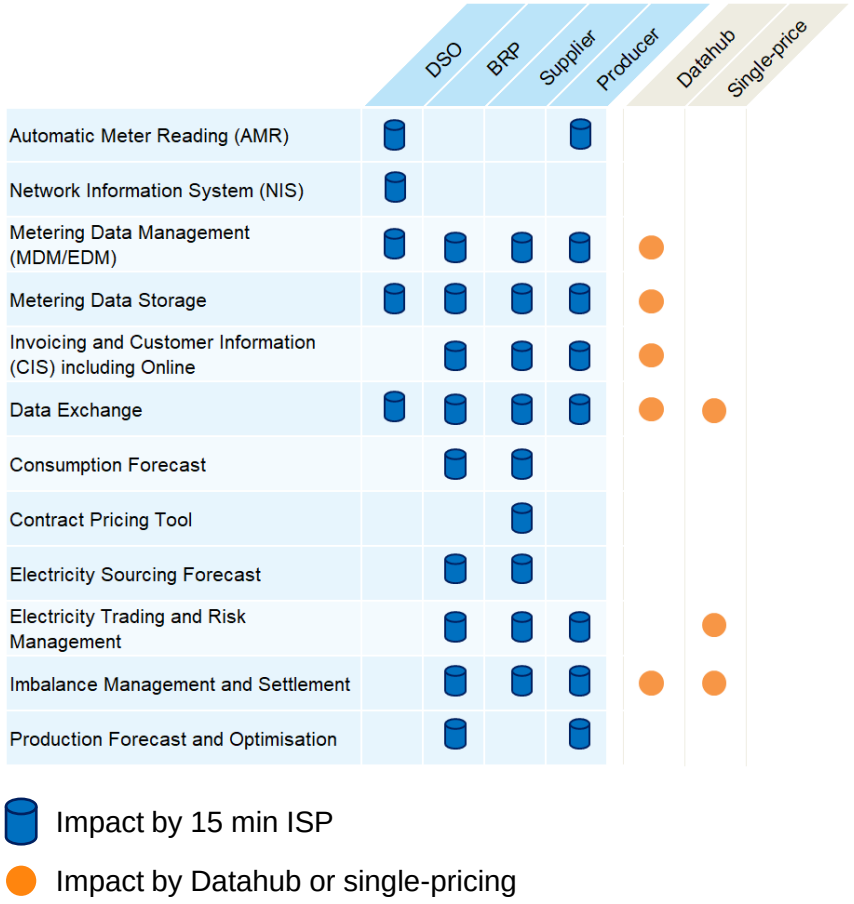
- The fitted linear regression model does not capture extreme situations.
  - Reducing the cross-border supply of balancing resources can lead to high price spikes for up-regulation or very low negative prices for down-regulation.
  - This might increase the imbalance price risk especially for market parties with imbalances that are large relative to their total volume, e.g. temperature-dependent demand or wind production.
  - This could also increase the imbalance price risk for large outages.

COMMENT ON IT COSTS

15 MIN ISP REQUIRES UPDATES IN MANY IT SYSTEMS

System updates are also caused by the introduction of Datahub and single-price imbalance settlement.

- Implementation of 15 min ISP requires investments in IT systems or services from the market parties.
  - New IT systems and software supporting 15 min ISP and/or updates and modifications of the existing systems and software.
  - Increase of data processing, exchange and storage capacity.
- Investment needs are market party specific.
  - Depends on the current state of the IT systems and on-going or planned IT projects.
- Investment costs are not directly related to the simultaneous Nordic implementation unless the market party is operating also in other Nordic countries with the same IT systems.
- Also eSett (ISR), Fingrid (TSO), Fingrid Datahub Oy and power exchanges shall invest in new features but these are out of the scope of this study.
  - The focus of the analysis is on the investment needs of DSOs, BRPs, energy suppliers and producers.



COSTS AND BENEFITS OF LATE IMPLEMENTATION

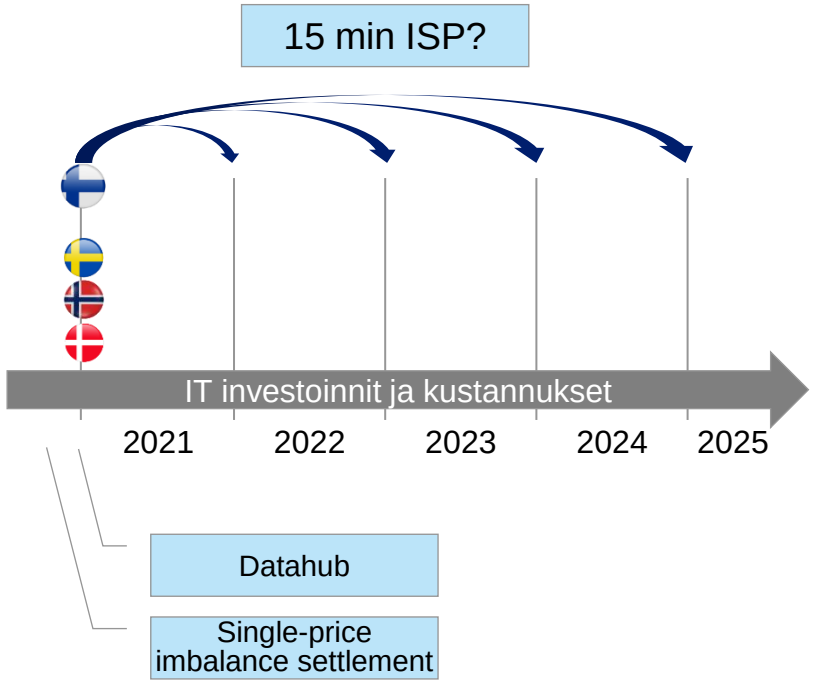
Are the benefits of late implementation greater that the implementation synergies that might be lost?

Costs of the late implementation

- Loss of synergies (i.e. economies of scale) with other IT investments taking place at the same time
  - Datahub
  - Single-price imbalance settlement
- Avoidance of duplicated IT systems and processes
  - Companies operating markets with 15 min ISP

Benefits of late implementation

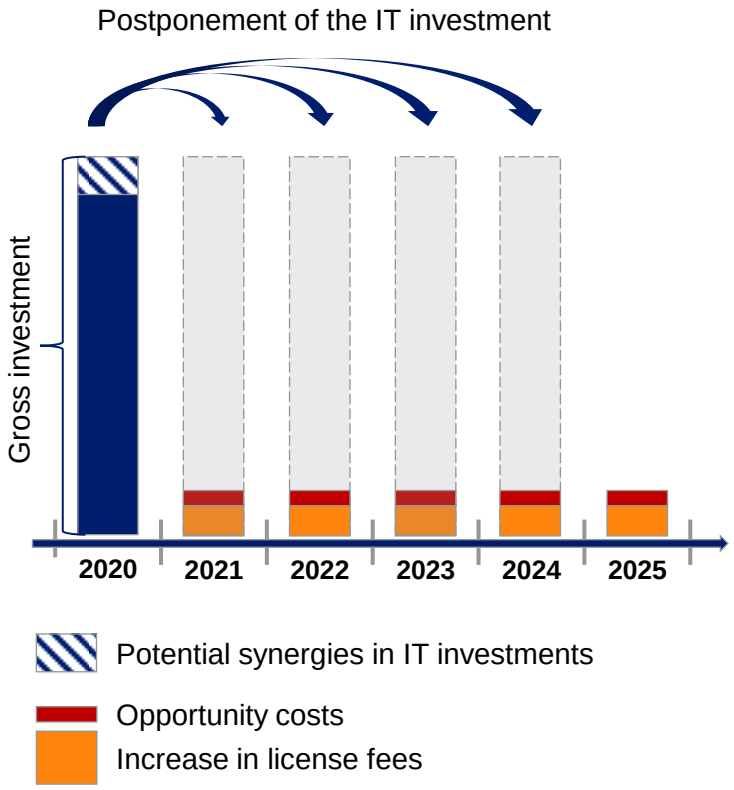
- Postponement of investment costs
  - Opportunity costs (return for investments)
- Lower costs of premature investments
- Decrease in IT system related operating costs
  - License and service fees
- Possible resource bottlenecks of IT providers can be avoided



THE IMPORTANCE OF IT INVESTMENTS IN DECIDING THE IMPLEMENTATION SCHEDULE

The market impacts of late implementation are greater than those of IT

- Cost benefit analysis of Copenhagen Economics* shows accumulated IT/data related benefits of EUR 7 million for Finland from late implementation (2025) of 15 min ISP.
  - Baseline year is 2021 and only incremental costs are considered.
  - Cost calculation include DSOs' and BRP/BSP's IT and data costs as well as the costs for trading systems and TSO IT costs.
  - Synergies with other simultaneous IT implementation projects, however, have not been considered.
- The loss of implementation synergies are offset by the decrease in IT costs.
  - Opportunity costs of the investment
    - E.g. in case of network business typically 4 % per annum
  - Operating expenditures
    - IT investments usually include new licenses. License fees including maintenance and support are typically 20–25 % of the investment cost.
- The impacts of late implementation on IT are remarkably lower that the impacts on balancing power and intraday markets (cf. p. 22).

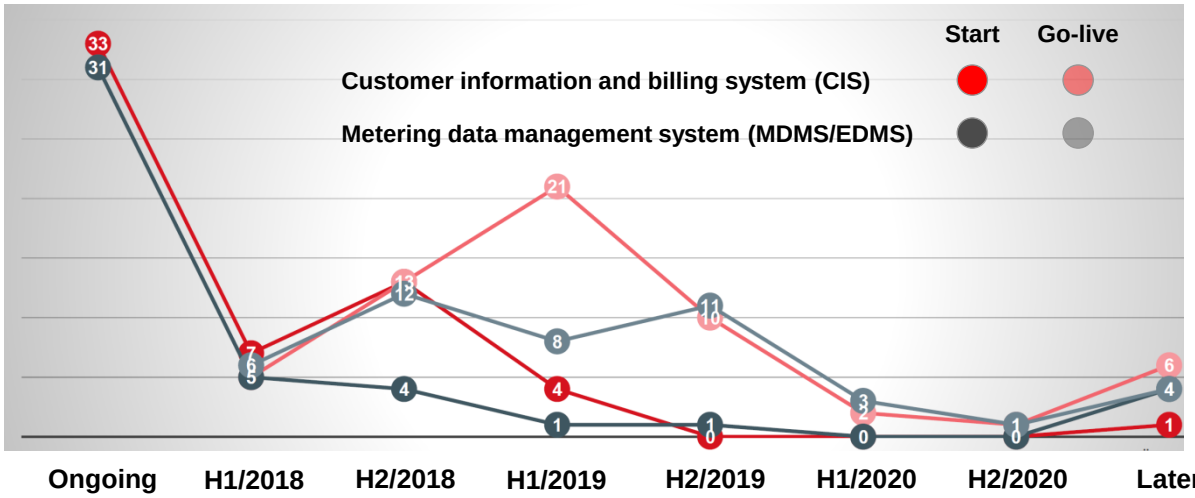


***) Copenhagen Economics. Nordic power markets: A Cost Benefit Analysis, 30 October 2017.**

IN CASE OF LATE IMPLEMENTATION ARE UPFRONT IT INVESTMENTS JUSTIFIED?

Implementation synergies are decreasing over the time due to ongoing Datahub related IT projects

- Synergies in IT implementation projects can be greater than the additional costs if
  - the postponement of 15 min ISP is not particular long (e.g. 6–12 months)
  - the new license or service fees are not charged by IT suppliers until the go-live of 15 min ISP
  - the simultaneous IT system updates can be managed as one implementation project
- Finnish DSOs and electricity suppliers are replacing or updating their current metering data management and customer information systems to prepare for Datahub. However, the number of new projects is decreasing rapidly. Hence, the potential for synergies is lowering over time.
- A quantitative assessment of the net benefits would require data from market parties.



Source: Fingrid Datahub Oy, 2018

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