NORDIC DATA HUB INTEROPERABILITY

Assessment of the potential for reduction of access barriers in the Nordic electricity markets through the introduction of data hub interoperability

Study done by Implement Consulting Group on behalf of NordREG
3 February 2021

table of content

1 Summary

1.1 The Nordic wholesale market for electricity is an immense success – can a Nordic retail market achieve the same?

The Nordic[1] wholesale markets have been integrated over a long period of time and have created significant economic benefits. Several factors have contributed, including the establishment of a shared power exchange (NordPool) and investment in interconnectors enabling transport of power across borders. The wholesale market has been highly successful and enables real-time optimisation of electricity generation across all four countries in a fully market-based setup.

It seems relevant to ask if a closer integration of the Nordic retail markets for electricity might achieve similar results, extending the competition into the market for end consumers across the four countries and possibly delivering benefits for the end customers.

Several indicators support the relevance of the question: the market rules in each country have many similarities, which indicates that the establishment of a shared market may be feasible, and all countries will have data hubs in operation in a few years which may facilitate cross-border competition.

However, there are also significant differences between the wholesale and retail markets that speak against major benefits of closer integration of the Nordic retail markets. For example:

- Electricity generation has significant structural differences between the four countries, which creates a large potential for trading between lower-cost and higher-cost generators and price zones. In comparison, the retail markets have very homogeneous prices and products which limits the possible benefits from increasing competition
- The number of market participants in the wholesale market is moderate, and the cost for interacting with the market is very manageable. In comparison, the retail market has more than 20 million participants with comparably much smaller transactions than wholesalers

In conclusion, it is relevant to enquire into the desirability of a Nordic retail market, but it is not obvious that benefits will be larger than the implementation cost that will be needed to create a shared market, even though this was the case for the wholesale market.

The existing data hubs in Denmark and Norway have been highly successful in easing supplier switching for consumers, thereby lowering transaction costs and improving competition in national retail markets. The existing and upcoming data hubs have, however, not been designed to be interoperable. The present analysis is an investigation of the possibility to use interoperability between the Nordic data hubs as a tool for promoting Nordic retail competition and of the costs and benefits of doing so. To analyse this, we have investigated the following questions:

- How might data hub interoperability be designed to support inter-Nordic competition?
- Which economic benefits could Nordic retail competition create, and would it be attractive for suppliers to pursue them?
- What would be the net cost of implementing each of the suggested interoperability models?
- Can the economic benefits make up for the net cost of establishing data hub interoperability and create a positive business case for interoperability?
- Which other benefits could follow from interoperability, and which paths can be pursued?

[1] For simplicity, we use “Nordic” to refer to Norway, Sweden, Finland and Denmark, as Iceland is not part of the scope for the study.

1.2 Market harmonisation and interoperability models

The Nordic retail markets have developed in parallel tracks and are converging towards a largely common structure. The establishment of data hubs is a central element in the market design in all four countries (data hubs are operational in Denmark and Norway and are under construction in Sweden and Finland). Data hubs handle the exchange of meter data between the electricity distribution operator (DSO) and the electricity supplier which is necessary for billing the customer. Subsequently, they handle master data such as data identifying the meters and customers as well as master data maintenance, for example when a customer changes address or supplier. Notice that data hubs are only data processing. The market participants are responsible for providing and maintaining data and for ensuring data integrity.

Data hubs serve a double purpose in the market design:

- As an intermediate data handler, the data hub eliminates the contact between DSOs and suppliers, thus reducing the risk of DSOs giving preferential treatment to some suppliers over others
- As a single point of contact for DSOs and suppliers, the data hubs enable a standardised and automated, and therefore efficient, processing of large volumes of metering data

Despite the similarities between the Nordic retail markets, there are significant differences across the four markets from a supplier's point of view. Electricity suppliers operate a low-margin business with a large volume of transactions. For this reason, the automation of meter reading, billing and debt collection is a core element of an electricity retail business, representing a significant investment for the supplier. Therefore, for a supplier, markets will be similar if the same automated processes can be applied across the markets. On the other hand, structural similarities do not benefit the suppliers if these structures are not implemented in a harmonised way which allows the supplier to deploy the same systems and processes across markets.

Differences which may seem insignificant for the functioning of the market can mean that the processes and IT systems applied in one market cannot be applied in another. Such differences include choice of data protocols, meter reading frequencies, choice of the meter versus the customer as data entity identifying a transaction or the time window allowed for updating data in case of errors.

As market rules in the four countries are developed nationally, data and processes are not compatible, and a supplier will need to invest in establishing a new IT system and set of processes to enter the markets of other Nordic countries.

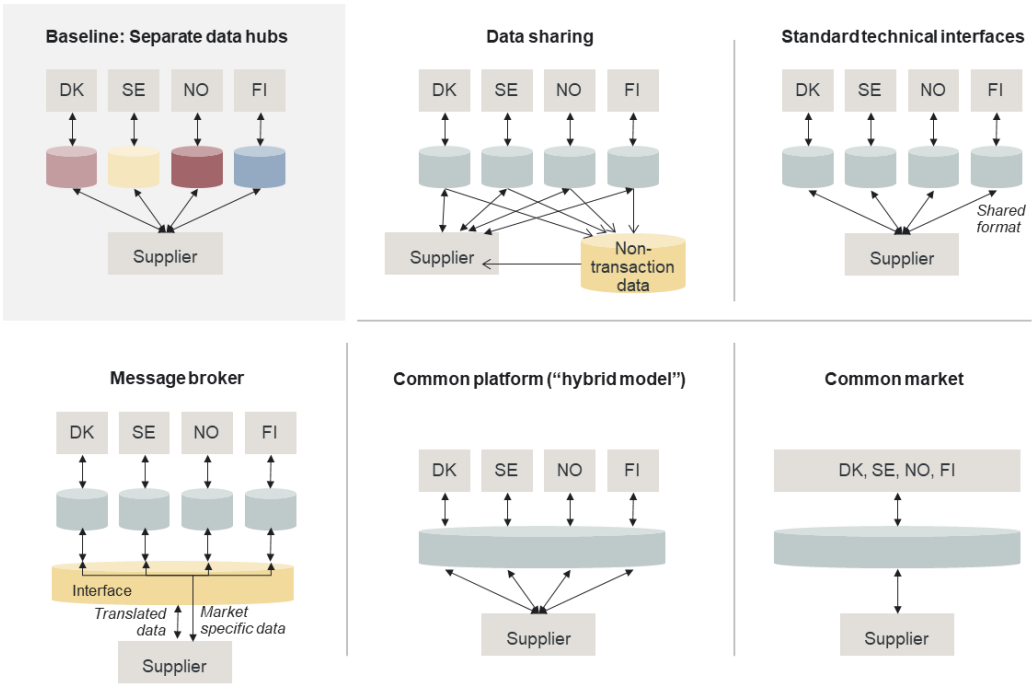
Interoperability between the Nordic data hubs can reduce the investment which a supplier established in one Nordic market must make to set up an operation in one of the other markets by facilitating data exchange with the data hub in the new market. We use the same definition used by the Nordic Council of Ministers: *Interoperability is forwarding of messages between data hubs, so that a retailer, for example, can initiate a supplier switch in the local hub, even if the metering point is in another country.* We have assessed five concrete models for achieving interoperability, ranging from simple data exhibition to deep integration of the Nordic data hubs.

- *Model 1. Data sharing* – a new common data access point with access to aggregated data from the four hubs (data export), but without data exchange or data processing for actual transaction support between national data hubs.
- *Model 2. Standard technical interfaces* – a harmonisation of underlying data formats (RSMs), potentially reducing the cost of adapting an existing IT system when entering a new market
- *Model 3. Message broker* – an interface translating messages related to data formats and market rules in one country to interact with the data hub in another country, enabling a

supplier to service customers in more than one Nordic country using the same IT system (with some modifications made necessary by national market rules)

- *Model 4. Common platform* – a hybrid model with one shared "core" data hub processing similar processes, supplemented with local hub organisations and processes. Electricity suppliers should experience the same level of integration as in the "message broker" model
- *Model 5. Common market* – harmonisation of market rules across the four countries and consolidation of data hubs into one entity, minimising IT-related costs of expanding across the Nordic borders

Figure 1: Overview of the layout of the interoperability models analysed



For each model, we have assessed the development, implementation and operational cost compared to the baseline over a ten-year life cycle.

1.3 Potential benefits of data hub interoperability

The potential benefits of data hub interoperability are to make it easier for national retail companies to establish operations in other Nordic countries, thereby increasing competition. A lack of competition has a number of adverse effects for consumers, notably:

- Over-normal profit margins leading to higher consumer prices
- Lack of investment in efficiency leading to higher consumer prices over time
- Lack of product innovation, causing a reduced choice of products available to the consumer
- Poor customer service

The benefits of data hub interoperability, therefore, are related to the reduction of adverse effects of insufficient competition.

We have investigated the four Nordic retail markets to identify any indicators of insufficient competition. The conclusion of these investigations is that *competition in the electricity retail markets is sufficient* when assessed by traditional economic indicators.

Profit margins do not seem to be “over-normal” in any of the Nordic countries. At a range from 10-15 EUR/MWh, the profit margins in all four Nordic markets are less than the European average of 16 EUR/MWh (2008-2018 average). Even if increased competition was able to further reduce margins, the benefit for households would be marginal: a 10% reduction of the profit margin would provide a saving of 1-2 EUR/month for Nordic households.

The number of suppliers is more than sufficient to ensure competition. Retail electricity is a commodity product, and a relatively small number of suppliers should be, in theory, sufficient to ensure competition. In other commodity markets as little as a handful of competitors can sometimes be adequate. The number of suppliers ranges from 45 (Denmark, 2020) to 130 (Sweden, 2020). In three of the four markets, the number of suppliers is increasing. Market concentration measured by the standard metric (the HHI index, see section 5.1.3) is the lowest in Europe for all of the Nordic markets. Hence, increased cross-border competition is not required to provide the consumers with a competitive selection of suppliers. Notice that all the national markets have at least two suppliers who are also established in other Nordic countries. This means that inter-Nordic competition is already present, however, at a low extent.

Switching rates are higher than the European average for all Nordic markets except Denmark. Despite not being a perfect indicator, a high switching rate shows that customers actively choose to switch to other suppliers. The moderate switching rate in Denmark may indicate that suppliers compete less actively than the European average. However, it may also result from the Danish households’ low electricity consumption, which means that the benefits of switching supplier are very limited for the average Danish household.

Perceived quality of service from electricity suppliers is on par with other services, indicating that there is sufficient competition to prevent poor customer service in general from electricity suppliers.

In conclusion, there are no clear indications that competition in the Nordic retail electricity markets is not working sufficiently well, which therefore limits the possible benefits of integrating the Nordic markets further.

For data hub interoperability to increase competition, it will have to create an incentive for electricity suppliers to expand their operations across the Nordic borders. To assess whether this is the case, we have looked at the market barriers perceived by the suppliers and the drivers for international expansion. We have assessed this from a structural point of view by assessing the barriers and drivers for expansion as well as from a perception perspective based on interviews with national and Nordic suppliers.

Data hub interoperability will reduce some entry barriers, while other entry barriers will remain unaffected. The entry barriers for an electricity supplier who is expanding from one Nordic market into another include:

- Investment related to IT systems and processes for customer billing and debt collection
- Investment related to building up knowledge about the new market, including competition, consumer behaviour and regulation
- Investment related to marketing and branding
- Investment related to establishing a local organisation

Only the first item on the list would be affected by data hub interoperability. This suggests that even with full interoperability there would still be significant entry barriers for the suppliers.

Our interviews with suppliers who are established in more than one Nordic country indicate that synergy in the supplier business is not a key driver for Nordic expansion. Rather, upstream synergies between electricity generation and trading seem to motivate inter-Nordic growth. Out

of approximately 400 electricity suppliers we have only identified one which has expanded its supply business to all four markets without relying on synergies through its generation assets.

The market analysis and analysis of incentives for expansion lead us to conclude that there are no sizeable socio-economic benefits related to data hub interoperability in the current market situation. Nor is there any immediate risk that the national markets will attain concentration levels which may be detrimental to competition and which may make inter-Nordic competition more relevant.

1.4 Cost of establishing data hub interoperability

We have analysed the net cost of data hub interoperability for each of the five suggested interoperability solutions through a bottom-up assessment of these cost elements:

- Developing the system
- Implementing the system
- Operating the system through a ten-year life cycle
- Avoided cost of operating existing systems, if relevant

The five interoperability solutions have very different impact on the cost base of the electricity suppliers in that:

- Some solutions can be implemented centrally and will not require changes in the systems used by the suppliers and DSOs. This is the case for the data sharing solution, the message broker and the common platform solution
- Other solutions will require system changes across all market participants. This is the case for the standard technical interface and the common market solutions. The reason for this requirement is that market processes and rules, which are coded into the IT systems of the market participants, are changed in these solutions and will require that market participants update their systems

The total number of DSOs and electricity suppliers in the four countries is approximately 850. Market harmonisation which imposes IT investments on all market participants is therefore a significant cost driver.

The net cost of the five solutions is summarised in Table 1 (negative values indicate a net benefit):

Table 1: Net cost of data hub interoperability

		Net system cost (mEUR, ten-year life cycle)		
Archetype	**Description**	**Data hubs**	**Suppliers and DSOs**	**Total**
Data sharing	Access to data from new Nordic front-end solution.	8	0	8
Standard technical interfaces	Harmonisation of the technical standards and protocols for data exchange.	3	33	38
Message broker	Implementation of functionality that enables the data hubs to interact.	47	-8	39
Common platform	Data hubs are consolidated into one new common platform.	77	-8	69
Common market	Market rules are largely harmonised and processed by shared data hub.	34	173	207

A best-case and worst-case scenario are calculated. The table indicates an average of the two scenarios for each proposed solution.

All proposed solutions have a net negative result. This indicates that there is a net cost of adapting and operating interoperable systems, even though some market participants will have isolated benefits of some of the solutions.

1.5 Conclusion and path forward

The benefit of data hub interoperability is to reduce entry barriers between the Nordic markets for electricity supply and thereby increase competition. Our analysis shows that there are no indications of insufficient competition in the Nordic electricity supply markets which implies that there are no sizeable socio-economic benefits of data hub interoperability. We cannot rule out that a more integrated Nordic retail market would spur benefits that cannot be foreseen today such as development of new and innovative business models which could improve consumer welfare. However, based on the standard metrics for evaluating the degree of competition, we argue that further integration will have limited positive effect on competition. Even without data hub interoperability, several suppliers are also already established in more than one Nordic country, which further reduces the demand for interoperability as a means to strengthen competition across the borders.

We have analysed five options for establishing interoperability which are very different in scope, ranging from a low investment option which will only affect entities who decide to make use of the functionality to a full market harmonisation which will have fundamental impact on processes and IT systems for all market participants.

Even though some of the proposed solutions create cost savings in some parts of the value chain, all solutions have a net cost.

By combining the two observations we conclude that data hub interoperability has net negative socio-economic impact in the current market situation and probably also will have so in a foreseeable future. The net negative result cannot be improved by optimisation of the interoperability solution. The root cause of the result is that there is no competition issue to solve and hence no potential benefit from interoperability.

One of the key findings of the analysis is that market integration which includes market rule harmonisation has a higher net cost than technical. This finding may at first seem counter intuitive. The reason is that harmonisation of market rules will impose a cost for updating processes and systems of all market participants and DSOs, even though only a few electricity suppliers will be participating in inter-Nordic competition.

Data hub interoperability – and more broadly, a synchronous evolution of the Nordic retail markets – may have other benefits which are beyond the scope of the current analysis, but should be explored:

New business models may benefit from interoperability. If a supplier were to develop entirely new value-adding services, for example combining electricity supply with balancing services, automation/smart home services or similar, interoperability might allow easier access to a larger market and make the investment in such product innovation more attractive. As these products and services are not developed and marketed today, this benefit is difficult to assess, let alone quantify. We would assume that the data sharing option would be a useful enabler for innovators working on intelligent services integrating electricity supply.

The **long-term** development of the Nordic markets could produce a situation with higher market concentration, which would make data hub interoperability more relevant. In this situation, the cost of introducing interoperability might even also be reduced as by definition much fewer

market participants would need to adapt systems and processes. Introducing interoperability in a long-term perspective and with a long planning horizon (e.g. from 2030-2040) would also reduce the implementation cost as it would allow data hubs and market participants to introduce the change with the natural life cycle (7-10 years) of their systems.

1.5.1 Recommendations

As the analysis has illustrated that an immediate harmonisation of market rules will lead to costly IT updates across the markets, we do not recommend initiatives promoting interoperability which aim to reduce market barriers for the current market participants. This does not mean that interoperability – and in a broader sense, the convergence of the Nordic electricity retail markets – is irrelevant. Rather, the scope and time perspective need to be different than that of increasing competition in the existing retail markets.

The four Nordic markets serve advanced and highly digitalised customers and have a high level of structural similarity. Despite the lack of immediate potential, convergence of the markets could yield long-term benefits as listed above.

Exploitation of these benefit pools rely on close similarities between the four markets. This makes it relevant to ensure that the markets evolve in parallel, and preferably that they converge towards a higher level of harmonisation of market rules and actual implementation whenever these are updated. A further divergence of market rules will reduce the potential related to interoperability or other initiatives promoting future inter-Nordic competition.

To conserve and further explore the potential related to the interoperability or harmonisation of the four markets, we recommend the following:

Preserve the potential related to market similarities. Though there are no imminent benefits related to a common Nordic retail market for electricity, there may be a potential in the longer term. This is particularly relevant for the implementation of the Clean Energy for all Europeans Package which will create new markets. This potential can be preserved and strengthened if market rules converge or at least do not further diverge. Future updates of market rules, and most notably market rules which drive IT investment, such as data identity, data model, protocols, reading and billing frequencies etc., should be assessed with the perspective of preventing unnecessary divergence and preferably promoting harmonisation. It must be stressed that this is relevant to pursue when updates of market rules are necessary, but should not be initiated solely to harmonise markets, as this would drive unnecessary cost for the market participants.

Explore the potential related to new business models. NordREG could initiate a specific investigation of the potential for promoting business model innovation related to flexibility services, smart services, sector coupling and similar. Such an investigation should include market dialogue and could include an analysis of consequences of the Clean Energy for all Europeans Package for the use of meter data which could be made available by the data hubs.

By initiating an investigation of the potential for new services delivered across the Nordic electricity markets, NordREG could potentially achieve several aims:

- Assuming that the new business models require data access but not use of data to support automated transactions, data sharing may be a sufficient interoperability measure for promoting new business models. This is the least costly model we have identified, and it has no impact on those suppliers who decide not to apply it
- If interoperability proves useful for promoting innovation of new flexibility/smart services, a next step would be the establishment of an entity which would govern the development of such a solution. This would also ensure the existence of an organisation with a focus on

Nordic market rules and an incentive to work for harmonisation of these rules – something which is largely absent today.

- The market rules related to electricity supply are mature and represent a large sunk cost in terms of processes and IT systems as demonstrated in the analyses. As opposed to these established market rules, the rules which will implement markets for micro-flexibility, local distribution tariffs, prosumer incentives etc. are still being shaped. This creates a window of opportunity for promoting some level of Nordic harmonisation and thus promoting a common market for these new innovative services.

2 Background and objective

2.1 National data hubs are implemented or in progress across the Nordics but not designed to be interoperable

The Nordic countries have made and are still making substantial changes to their national electricity markets. A key element is the implementation of a supplier-centric model market model by which the electricity supplier is the consumer's single point of contact to the market. Another important and related element is the development of centralised data hubs. As of now, all Nordic countries have implemented – or are in the process of implementing – a centralised national data hub (operational in Finland from 2022[2] and in Sweden from 2022/23 or later[3]). A centralised data hub is a strong tool in supporting a dynamic retail market by streamlining, automating and simplifying data exchange processes between electricity suppliers, Distribution System Operators (DSOs) and Balance Responsible Parties (BRPs). Moreover, a centralised data hub is seen as a prerequisite of supporting a supplier-centric model and minimise the risk of preferential treatment of some suppliers over others (such as suppliers owned by the same group as the DSO). The data hubs process large volumes of consumption and other transactional-related data in a robust, transparent, and non-discriminatory way. To achieve this, nearly all processes are fully automated, and are mirrored by automated processes in the DSOs (meter data handling) and suppliers (meter data handling, billing, switching etc.). All data hubs are being implemented as national hubs without any link or interoperability with the other Nordic data hubs.

Despite a noticeable increase in the number of national electricity suppliers, there are very few suppliers currently operating on more than one Nordic market. This is in sharp contrast to the very well-functioning Nordic market for wholesale electricity, where electricity generators and traders are acting in a common Nordic market.

The lack of inter-Nordic competition in the retail market is in part due to a number of differences in market rules and regulation, which prevent domestic suppliers to reuse existing systems and processes when expanding to a new country. One of these so-called market barriers is the lack of interoperability between national data hubs, as e.g. a Norwegian supplier would need to establish a connection with the Danish data hub, including adapting to new software protocols, data formats, data models etc. to service Danish customers. A significant reduction of entry barriers for national electricity suppliers could increase competitive pressure across borders, and value creating business models would more easily be disseminated to other Nordic countries.

2.2 Might data hub interoperability reduce market barriers between the Nordic countries and improve competition?

NordREG has carried out a number of studies about the opportunities and barriers for closer end-market integration between the Nordic countries. An overall conclusion of these studies can be summarised:

- The overall structure of the markets is converging towards a supplier-centric model supported by a central data hub
- However, differences in a number of specific market rules and other regulations prohibit that a supplier in one country can supply customers in another Nordic country
- Though development of the overall, customer-centric model was coordinated between the four countries, the detailed implementation through market rules has been nationally focused

[2] https://www.fingrid.fi/en/electricity-market/information-exchange-services/datahub/

[3] https://www.svk.se/en/stakeholder-portal/Electricity-market/data-hub/

- A number of barriers to harmonisation is imposed by other regulation and legislation – for example tax legislation – implying that even a closely coordinated development of market rules would not have led to full harmonisation of market processes.

As data hubs are emerging in all the Nordic countries, but with different implementation choices, studies have suggested that a lack of interoperability between the hubs might impose yet another barrier for electricity suppliers who might consider starting operations in a neighbouring Nordic country. Or put differently: could a technological enabler such as improved interoperability between the Nordic data hubs allow a supplier who is already integrated with one data hub to exchange data with other data hubs automatically?

The purpose of this study is to investigate different technical ways that interoperability could be increased, what these models would cost and what benefits they could bring.

Costs would be actual IT and implementation costs for establishing the new system which makes the interoperability possible:

- The cost for the data hub owners developing, implementing and operating the system, and
- The cost for the market participants who would have to adapt their systems to be compatible with the changes.
- Some of the cost would be offset by cost savings for data hub owners through operational synergies and/or from cost savings for electricity suppliers when establishing in another country.

Benefits would come from increased competition resulting from lower market entry barriers. Benefit creation from data hub interoperability therefore depends on:

- Whether there is a potential for reducing consumer prices or improving quality and product innovation through strengthened competition and
- Whether data hub interoperability will create an incentive for Nordic electricity suppliers to invest in cross-border activities

The study is composed of these elements:

- An assessment of the possible economic value from increased competition in the Nordic retail markets
- An assessment of the total market barriers, the proportion of entry costs related to market rules and data hub interaction
- The influence of these barriers on the suppliers' strategic decision-making
- An assessment of the supplier IT cost driven by market rules
- An assessment of the investment and potential benefits related to a closer market integration from interoperability and/or market harmonisation and an assessment of the operating cost necessary for sustaining an interoperability solution.

The key data sources for the analysis are:

- Literature review on effectiveness of the Nordic electricity markets and potential common market benefits
- A survey of the Nordic electricity suppliers with 52 responses (see survey details in appendix)
- A review of data hub costs or forecasts in the four countries
- Extensive qualitative interviews with suppliers, IT vendors and all data hub operators.

Data collection for the study was performed from May to August 2020.

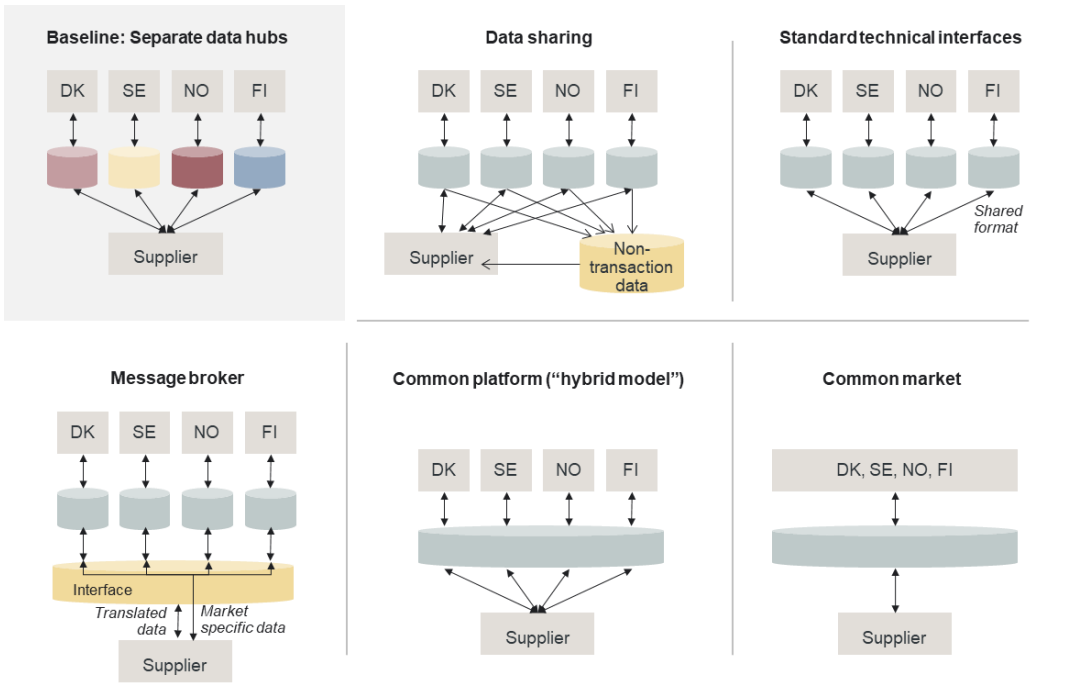
3 Interoperability models

There is no common definition of data hub interoperability. To cover the full picture of potential for the market participants as well as the full picture of the cost of creating interoperability, we have analysed a number of potential interoperability models:

- *Model 1 – Data sharing.* A common data access point with access to aggregated data from the four hubs (data export), but without data exchange or data processing for actual transaction support between national data hubs.
- *Model 2 – Standard technical interfaces.* Harmonisation of underlying data formats (RSMs), potentially reducing the cost of adapting IT systems used by an electricity supplier in one country to support operations in another Nordic country.
- *Model 3 – Message broker.* An interface translating messages related to data formats and market rules in one country to interact with the data hub in another country, enabling a supplier to service customers in more than one Nordic country using the same IT system (with some modifications made necessary by national market rules)
- *Model 4 – Common platform.* A hybrid model with one shared "core" data hub processing similar processes, supplemented with local hub organisations and processes. Electricity suppliers should experience the same level of integration as in the "message broker" model.
- *Model 5 – Common market.* Harmonisation of market rules across the four countries and consolidation of data hubs into one entity, minimising IT-related costs for electricity suppliers expanding across the Nordic borders.

Cost calculations are marginal and compared to a baseline where no interoperability is established. An overview of the models is shown in Figure 2.

Figure 2: Overview of the lay-out of the interoperability models analysed



For each model, we have assessed to what extent it could increase cross-border competition as well as the implementation and running costs of the IT systems.

Table 2 shows the key features of each archetype.

Table 2: Overview of interoperability archetypes analysed in the study

Archetype	Description	Process integration	Interfacing standards	Data models	Data hub platforms	Markets
Data sharing	Access to data from new Nordic front-end solution	No	National	National	4	4
Standard technical interfaces	Harmonisation of the technical standards and protocols for data exchange	No	Shared	National	4	4
Message broker	Implementation of functionality that enables data exchange across all data hubs	To some extent	National	National	4	4
Common platform	Data hubs are consolidated into one new common platform operating four sets of market rules	To some extent	National	National	1	4
Common market	Market rules are largely harmonised and processed by shared data hub	Full	Shared	Shared	1	1

3.1 Market rule harmonisation

The *standard technical interface, common platform, and common market* solutions rely on harmonisation of market rules. As described, market rules are implemented in highly automated processes. This means that for interoperability to provide a benefit to the supplier, market rules need to be harmonised in detail so that the same IT supported process can perform transactions in several markets. An approximate harmonisation of market rules will not eliminate the need for IT investments when expanding operations from one market to another.

Key market rules to be harmonised are described in Table 3.

Table 3: Market rules and derived processes which drive IT related market entry barriers

Process/ subject	Description	Comment
Generic business processes	Key processes include: • Change of supplier • End of delivery • Establishment of metering point • Processes for handling errors if any of the above processes was initiated by mistake • Moving • Change to the form of billing (e.g. change to yearly to hourly meter reading) • Stopping and re-establishing supply (e.g. in case of arrears) • Handling meters • Request for data (e.g. historical metered data, most current meter reading, aggregated data supplied by the data hub…) • Update and exchange of price lists and tariffs • Request for customers physical or billing address	In total approximately 40-50 business rules specifying data exchange between data hub and market participants at each relevant process step
Specific business processes	Each market has specific rules related to e.g. tax and incentive schemes. Examples include rules for prosumers, secondary meters, tax breaks for electric heating or car chargers, power plants' internal electricity consumption, etc.	

Process/ subject	Description	Comment
Master data	• Master data for customer • Master data for meter point	Differences in the definition and use of master data (for example basing a transaction on the customer in one market and meter point in another) can be a particular challenge for interoperability
Metering point definitions	• Relationships between related meter points (parent/child meters) • Meters not used for transaction purposes	
Data processing hierarchy	• Sequence/timing of handling of processes in a data hub (immediate execution, scheduled execution)	
Data correction rules	• Process and time window for updating data on behalf of a market participant • Rule defining which data can be updated	
Data formats	• Data exchange software code • Exact data format for each business process defined (data protocols)	Can to a large extent be overcome with message broker solution

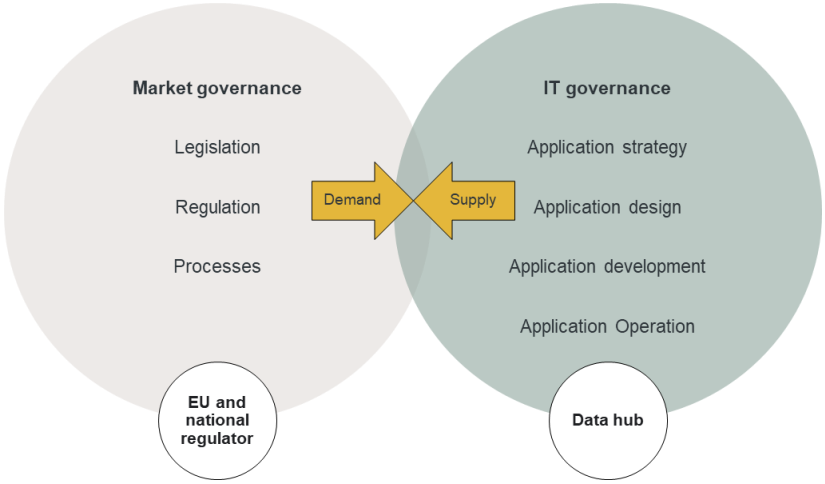
We notice that the benefits related to market entry barriers is related mostly to the suppliers' IT investments. This implies that the market rules which form the most frequent transactions (such as billed entity, reading and billing frequencies, supplier switching rules and time windows for data updates) are central to update. In all interoperability models, suppliers will have to include National exceptions. These will include, e.g. data for taxation and subsidies, and could include rules for handling supplier of last resort, handling of meter points without supplier or costumer attached, etc. Exceptions for low-frequency transactions cannot be eliminated, but do not form a significant entry barrier.

The table is based on *Forretningsprocesser for det danske elmarked (EDI guide – BRS),* Data Hub, 9 November 2020. At this level of aggregation, the table applies to all Nordic markets. As an indication of the level of detail in which the processes are specified, we notice that the document from the Danish data hub covers 306 pages of process and data definitions, supported by a 235-page specification of data protocols (*EDI-transaktioner for det danske elmarked*).

3.2 Governance and IT security

The interoperability models are impacted by the way the market is governed and how legislation, regulation and processes are conveyed into demand for IT services, which is delivered through an IT governance setup centred around a data hub application/platform as IT service provider. Figure 3 below illustrates the interplay between the market governance side (demand) and IT governance side (supply).

Figure 3: High-level market and IT governance



Each interoperability model calls for the establishment of cooperation and governance structures at Nordic level. We have suggested a governance model for each interoperability model in Table 4. Suggestions are indicative and the eventual design can differ from the suggested structures. However, the suggestions indicate the scope of the necessary coordination and governance body to be established.

Table 4: Suggested governance and coordination for each interoperability model

	Governance and organisation	Market rule coordination
Data sharing	• Coordinating body established by the four data hubs • The body will decide how to tender, implement and operate the needed IT solution • The body should establish a user forum as well.	• National legislators/regulators support data sharing, e.g. adaptation of data access rules. • Coordination through NordREG or similar
Standard technical interfaces	• Coordination task force of data hub owners	• National legislation to impose convergence of technical standards • Coordination task force of National regulators • Coordination through NordREG or similar
Message broker	• Permanent coordination board of the four data hub owners • Permanent coordination groups of the four data hub owners, e.g. performance management, technical support.	• National legislation to authorise data hubs to establish message broker • Coordination and performance monitoring through NordREG or similar reporting to the National regulators
Common platform	• Shared Nordic Data Hub organisation • Could be established as joint venture between data hub owners or as a separate entity through divestment of data hubs • General assembly with participation of the four owners	• National legislation to specify objective, means, restructuring of ownership, and reporting • Task force of National legislators and regulators identify and prioritise options for harmonisation • Road map for implementation in national legislations • Coordination through NordREG or purpose-built coordination board

	Governance and organisation	Market rule coordination
Common market	• *As above*	• National legislation to set target of highest possible level of harmonisation of market rules and allocate necessary resources • Establishment of a permanent, inter-Nordic task force of legislators and regulators mandated to harmonise • *Otherwise, as above*

In Table 5 below the IT governance model is detailed in a set of key processes and responsibility areas to be governed in each of the five different interoperability models, incl. how data is managed and how suppliers are supported in the transition from the situation today with no interoperability to different levels of interoperability in each model.

The mapping of responsibilities in the different models for future interoperability is based on the ITIL[4] framework for how IT processes are governed:

- *Application strategy:* Formulation of the strategic framework for data hub services are owned, financed, and delivered.
- *Application design:* Design of the tangible data hub services, standards, policies and service levels in order to be able to validate whether a service is delivered satisfactory.
- *Application development:* Implementation of functional changes in the data hub(s) based on business requirement backlog or requirements driven by changes in legislation.
- *Application operation:* Maintenance and operation of the data hub, incl. ongoing support of system users and management of incidents.

[4] Information Technology Infrastructure Library

Table 5: IT governance in the five interoperability models

Categories	Model 1 Data sharing	Model 2 Standard technical interfaces	Model 3 Message broker	Model 4 Common platform	Model 5 Common market
Application strategy					
System ownership	Data hubs: National ownership (as today) New solution: A new body will govern and own the new common data sharing solution.	National system ownership of data hubs.	National system ownership of data hubs.	Shared Nordic system ownership of data hub platform with national functional SME teams.	Shared Nordic system ownership of data hub platform.
Platform strategy	Data hubs: National strategy (as today) New solution: New body for data sharing solution to define strategy in dialogue with key stakeholders.	Data and functionality strategies defined on a national level. Technical data exchange strategies defined on a Nordic level through new coordination entity.	Defined on a national level combined with Nordic collaboration on message broker functionality through new coordination entity.	Defined on Nordic level with national flexibility to define functional strategies to support non-uniform market rules.	Defined on Nordic level.
Customer and demand management	Data hubs: National (as today) New solution: By new body or appointed party.	Two-fold planning with functional requirement planning on national level and technical requirement planning on a Nordic level.	National planning of capacity and development roadmaps, incl. understanding of and adaptation to new legislation.	Mix of national and shared planning as data hub will still need to support non-uniform market rules.	Nordic planning of capacity and development roadmaps, incl. understanding of and adaptation to new legislation.
Financial management	Data hubs: National (as today) New solution: By new body or appointed party.	National budget and controls with allocation to shared governance entity.	National budget and controls with allocation to shared interface solution.	Shared budget mixed with national application development budgets.	Nordic budget and controls.
Application design					
IT operational standards	Data hubs: National level (as today) New solution: Common (Nordic) service levels.	Nationally defined service levels based on existing contracts.	Nationally defined service levels based on existing contracts.	Common (Nordic) service levels.	Common (Nordic) service levels.
Security policies (privacy and data protection, physical security etc.)	Data hubs: National level (as today) New solution: Defined on Nordic level in new system owner setup.	Defined by national system owner.	Defined by national system owner.	Defined on Nordic level in new system owner setup.	Defined on Nordic level in new system owner setup.
Supplier management	Data hubs: National level (as today) New solution: Managed on Nordic level.	Managed on national level.	Managed on national level. Message broker supplier managed on Nordic level.	Managed on Nordic level with national vendors/resolver groups to handle non-uniform market rules.	Managed on Nordic level.
Contingency planning	Data hubs: National level (as today) New solution: Defined on Nordic level.	Defined on national level.	Defined on national level.	Defined on Nordic level.	Defined on Nordic level.
Data and information strategy	Data hubs: National level (as today) New solution: Defined on a national level in combination with common strategy on how to govern data in shared data solution.	Defined on a national level.	Defined on a national level combined with Nordic governance on specifications of 'translations' between markets.	Defined on a national level as data models and market rules are still not fully unified.	Common data practises and rules need to be defined on a Nordic level.

Application development					
Functional changes	Data hubs: National (as today) New solution: Decided on Nordic level.	Decided on national level. Changes to data exchange specs. decided on Nordic level.	Decided on national level combined with shared decision-making related to message broker functionality.	Decided on Nordic level.	Decided on Nordic level.
Implementation of changes	Data hubs: National (as today) New solution: Executed on Nordic level.	Executed on national level.	Executed on national level.	Executed on Nordic level.	Executed on Nordic level.
Operation					
Registration of incidents (Level 1)	Data hubs: National level (as today) New solution: Managed on Nordic level in shared ITSM tool.	Managed on national level in local ITSM[5] tool.	Managed on national level in local ITSM tool.	Managed on Nordic level in shared ITSM tool.	Managed on Nordic level in shared ITSM tool.
Incident resolution (Level 2 and 3)	Data hubs: National level (as today) New solution: Resolution on Nordic level.	Resolution on national level with Nordic resolver groups related to technical standards.	Resolution on national level with Nordic resolver groups related message broker application.	Resolution on Nordic level with national resolver groups with expertise in national data models.	Resolution on Nordic level only.
User support and management	Data hubs: National level (as today) New solution: Users are managed in Nordic helpdesk with local language support desk.	Users managed in national data hub.	Users managed in national data hub. National user support trained to support message broker.	Users managed in Nordic data hub, likely with local support desk.	Users managed in Nordic data hub, likely with local support desk.
Master data management	Data hubs: National level (as today) New solution: Common data rules and practises are governed on a Nordic level.	Governed on a national level.	Governed on a national level with reference groups related message broker translations.	Governed on a Nordic level with national subject matter expertise on data models.	Common data rules and practises are governed on a Nordic level.

All interoperability models will change the cyber security situation regarding metering data handled by the data hubs. The current national data hub is today exposed to a growing number of threats:

1) Targeted activities like nation-state and other politically motivated hacking (such as DDoS) or financially motivated cybercrime (such as CEO-fraud or internal embezzlement).
2) Non-targeted activities from the internet in general like ransomware or phishing

Targeted threats are based on the target being valuable and desirable to damage or extort money from. Therefore, larger platforms are more attractive targets. The larger customer base, larger public exposure and larger economic impact of a disruption makes a data sharing platform, a common data hub platform or a common data hub more attractive targets than a single national hub. Note that the national data hubs are no different from today in models 1-3, hence only the new data sharing platform in model 1 and the common systems of model 4 and 5 are increased risks.

Non-targeted attacks follow with number of devices and employees. As the non-targeted (opportunistic) attacks randomly exploit single devices and persons, this will scale with number of devices connected to the internet (the servers for data hub) and number of employees with

[5] IT Service Management

devices and access to the internet (the persons employed to operate the data hub infrastructure). With less servers/employees the risk of non-targeted attacks will decrease.

Table 6: Cyber Security

Categories	**Model 1** Data sharing	**Model 2** Standard technical interfaces	**Model 3** Message broker	**Model 4** Common platform	**Model 5** Common market
Cyber risks					
Risk of targeted attack (based on attractiveness)	Data hubs: Unchanged for national data hubs New solution: Increased	Unchanged	Unchanged	Increased	Increased
Risk of untargeted attack (based on number of devices)	Unchanged	Unchanged	Unchanged	Decreased	Decreased
Resulting risk	Slightly increased	Unchanged	Unchanged	Unchanged	Unchanged

For model 1 there is a slightly increased risk, but only for the new data sharing platform, being an attractive target and adding more servers and employees. For models 2 and 3 there is virtually no difference in terms of cybersecurity compared to current. Finally, for model 4 and 5 there is a greater attractiveness for attacks on the central platforms, but on opportunistic attacks there is a corresponding reduced risk as there are fewer elements, variations and employees compared to the current.

The change in over-all cyber security risk by introduction of interoperability is insignificant in all the models compared to current, National operation. Cyber security issues should not be a determining factor for the choice to introduce interoperability or for the selection of interoperability models.

However, a concrete implementation study must do a proper risk assessment of the suggested technical architecture and system operations in greater details to ensure that the design mitigates the slightly increased risk.

4 Data hubs and interoperability models

Each of the Nordic data hubs is built or is being built to serve its national market. The data hubs process meter and transaction data in an almost fully automated way based on each country's specific market rules. The market rules provide very specific roles and algorithms for processing time-based or event-based information such as metered consumption; supplier switching; establishing, moving, or closing a point of consumption; and shutting off supply in case of arrears. The market rules also specify data formats, requirements for data exchange, etc.

The highly automated processes in the data hub are mirrored by equally automated and rule-based processes in the suppliers and meter-reading entities (DSOs). In this way, each national market defines a set of highly automated transaction rules linked by the data hub. The data hub is at the same time an enabler for automation and an effective entity for ensuring a neutral treatment of all suppliers, as it removes nearly all touchpoints between suppliers and DSOs.

Because market rules are specific to each country, data and data formats are different from one data hub to another. For this reason, a supplier who is established in one country cannot supply customers in one of the other Nordic countries using the existing process and IT setup.

Data hub interoperability designates any setup that will enable a supplier connected to one data hub to exchange data with the other data hubs – and in this way facilitate cross-border activity and competition. Interoperability can be established at different levels such as:

- Providing access to data from all Nordic data hubs from one access point without processing data which directly supports transactions (such as the suppliers' billing and debt collection process)
- Exchanging transaction supporting data with all Nordic data hubs through one access point but in the format specified by each national set of market rules
- Translating some transaction supporting data between different sets of market rules so that an IT setup for one market can process transactions such as billing and debt collection in another country (with modifications)
- Harmonising market rules across countries so that the Nordic markets will act as a common market and suppliers will exchange data in one single format and in one single point.

With a full harmonisation of market rules, the market entry barrier related to IT costs of going into a new market would be minimised.[6] With little or no harmonisation of market rules, interoperability might reduce entry barriers related to IT investments but to a much smaller extent.

4.1 Conceptual archetypes of interoperability analysed in the study

To describe the full potential and the scope of change, we have analysed five conceptual archetypes of data hub interoperability:

Data sharing – a shallow integration providing access to information from all data hubs from a shared access point and in a single data format but with no processing of transaction supporting data. This would enable suppliers to access data about potential prospects (respecting the data privacy and protection rules that exist for the national data hubs today). This might reduce costs of identifying and selling to customers across the Nordic market but would not reduce market barriers related to servicing the customers.

[6] In practice, some national differences are likely to remain such as rules for energy taxation, accounting, VAT and similar, just as bills and other customer touchpoints will need to be adapted to local languages.

Standard technical interfaces – a technical integration that would allow suppliers to exchange data with all data hubs using the same messaging and communication protocol, potentially reducing the investment related to maintaining multiple data hub interfaces as well as investment in establishing operations in a new market. Data structures and models would be unaffected and would need to be handled by the supplier according to the market rules in each market.

Message broker – a process integration with functionality that translates messages and transactions from one set of rules to another across countries, where possible. Some data is assessed to be of such proximity that it can be translated, for example information that designates the same identity (e.g. “meter”) but is formatted differently. Other information cannot be translated (e.g. a transaction may relate to “meter” in one market and “customer” in the other). The message broker will allow suppliers to reuse part of their IT and process setup across countries, while extending the system to handle transactions that cannot be translated.

Common platform – a partial consolidation of data hub operations enabled by establishment of one common application platform with integrated message broker functionality to support interoperability of country-specific processes and data structures. The common platform will still have to manage four different data models and four different sets of business requirement specifications as the market rules across the four countries have not been harmonised. Therefore, a common platform will need different application specialists with key insights into the local market rules. As with the “message broker” solution, suppliers can operate across Nordic borders using a core IT and process setup with local adaptation. Therefore, the suppliers will experience the same benefits as with the “message broker”. Despite the significant investment in establishing a common application platform, the consolidation of data hub platforms will unlock operational benefits in the data hub development and operations in terms of shared IT application and IT infrastructure maintenance services.

Common market – harmonisation of market rules across the four countries will open the path for developing a single new data hub based on one set of processes and one unified data model. This would bring about a significant change and investment cost for suppliers and DSOs in the market as they would need to reconfigure their IT systems and business processes to align with the new data hub. However, this model would also eliminate most of the IT-related entry barriers for entry into a new Nordic market and at the same time reduce data hub costs significantly.

4.2 Costs and efficiencies related to interoperability

The conceptual interoperability models allow us to analyse cost and potential cost savings.

The establishment of interoperability requires investment and running costs at several levels, depending on the types of interactivity established. Firstly, the IT solution needs to be developed and implemented. Secondly, suppliers and DSOs may have to modify or replace their IT systems as a result of changes to their interaction with the data hub. The cost related to establishing and operating each of the interoperability solutions is modelled in chapter 6.

The primary benefit of interoperability is the reduction of market entry barriers, potentially resulting in increased competition, as described in the next chapter. However, some of the interoperability solutions may also enable cost savings at the data hub level and for suppliers that already have inter-Nordic presence.

The most noticeable distinctions between the different models are:

Market rule harmonisation: Some of the models rely on harmonisation of market rules across the four markets, while others compensate for differences in the market rules. While market rule harmonisation is a prerequisite for establishing a single market for electricity supply, it also drives significant IT costs: When rules are harmonised, suppliers as well as DSOs will have to

update or replace their IT systems, which are purposely built to support the existing market rules. While rule harmonisation is beneficial to suppliers who consider cross-border expansion, the cost of replacement or re-implementation of IT systems would also be imposed on suppliers remaining local and on DSOs, who will not benefit from the establishment of a common market. For this reason, market harmonisation also *redistributes cost and benefits* at the expense of local suppliers and DSOs.

The “data sharing”, “standard technical interface” and “message broker” models work with national market rules, while the “common platform” and “common market” models require partial or full harmonisation of market rules.

Data hub consolidation: The “common platform” and “common market” models will enable a consolidation of data hubs. This distinguishes them from the other models in that the cost of developing interoperability is compensated by benefits during the data hubs’ life cycle.

The key features of the models with regard to market barriers and costs for the market participants are described in Table 7.

Table 7: Cost-effect of interoperability depending on suppliers' position

						Effect on market barrier for supplier expanding cross-border		
Inter-operability model	**Description**	**Mar-kets**	**Effect on suppliers already established in more than one Nordic market**	**Effect on suppliers that remain local**	**Effect on suppliers expanding cross-border**	**Search of market/ prospect infor-mation**	**Need for new IT system**	**Other barriers e.g. brand, language, organisati on**
Data sharing	Access to data from all data hubs from one access point, allowing fast access to relevant information	4	Opportunity for slight reduction of data analysis	None (insignificant cost is passed through to end customer)	Opportunity for slight reduction of data analysis	Reduced	Not affected	Not affected
Standard technical interface	A harmonisation of the technical data exchange interface between market and data hub across all countries; data defined by local market rules; only data format is harmonised	4	Some long-term IT benefit	None (minor cost is passed through to end customer)	Some IT savings when making the market entry	Not affected	Reduced CAPEX and OPEX: existing IT system can be modified	Not affected
Message broker	Transaction supporting data are translated from one national format to another to allow suppliers to exchange data in same format with all data hubs; only some data are translated while other data are market-specific	4	Significant long-term IT benefit	None (minor cost is passed through to end customer)	Significant IT savings when making the market entry	Not affected	Significant reduction of CAPEX and OPEX	Not affected
Common platform	Data hubs are consolidated into one new common platform, allowing a scaled shared operational setup across the Nordics with relation to management of the platform	4	Significant long-term IT benefit	None (minor cost is passed-through to end customer)	Significant IT savings	Reduced	Significant reduction of CAPEX and OPEX	Not affected
Common market	Market rules are largely harmonised and processed by shared data hub	1	Major short-term cost Major long-term savings	Major cost – need for IT re-implemen-tation	Major short-term cost for re-imple-menting current system Major cost reduction of market entry	Eliminated	Eliminated	Not affected

5 Potential value of data hub interoperability

The Nordic retail markets for electricity are far from harmonised. Unlike, for example, the wholesale market for electricity, where generation capacity across the Nordic countries is activated in a common market, there is very limited cross-border activity in the retail market. This is also the case for the rest of the EU. Out of the about 385 suppliers in the Nordics, only 10-15 operate their retail business in more than one Nordic country.[7]

In this section, we explore to what extent there would be socioeconomic benefits from creating a more common Nordic electricity market, and to what extent we can expect improved interoperability between the Nordic data hubs to lead to a more common market. The first step (The value of creating a common Nordic electricity market 5.1) in the analysis is to consider to what extent a fully integrated Nordic retail electricity market would bring market benefits. The second step (section 5.2) is to consider to what extent the different interoperability models will bring us closer to a fully integrated Nordic market.

5.1 The value of creating a common Nordic electricity market

A common Nordic market for retail electricity can be understood as a market with harmonised market rules such that a retail supplier established in one Nordic country has no regulatory or technical barriers to access and service a customer in another Nordic country. The idea behind achieving such a common market is that competition in the entire Nordic area would be increased, as efficient electricity suppliers would more easily be able to expand to other Nordic countries.

Such increased competitive pressure on existing market players from new market entrants will in theory bring several types of market benefits, including:

1) *Price competition*. Reduced prices and thereby elimination of “over-normal” profit margins through increased price competition. If profit margins are initially “too high” because of a lack of competition, this effect can in theory be significant
2) *Cost competition*. Competition can lead to lower costs and higher-quality services through, for example, innovation and business development. This could lead to further reductions in price and higher quality. Cost competition also includes the possibility for consolidation in the sector potentially leading to economies of scale benefits.

In addition, benefits will also accrue to existing market players that are currently already present in more than one Nordic country, as these companies would be able to simplify and reduce existing IT systems and processes which are currently required to support different market rules and systems. We analyse such benefits in chapter 6 as a reduction in costs.

[7] Estimate based on data from Implement questionnaire.

In order for a common Nordic retail market to deliver benefits to market participants through the drivers mentioned above, it needs to improve the competitive situation on the existing markets. To illustrate whether this is likely to be the case, we have analysed a number of criteria and indicators of the current competitive situation. We conclude that there are no indications of insufficient competition in the Nordic retail markets. The indicators are the following:

1) Profit margins
2) Impact on household budgets
3) The number of suppliers available to customers
4) Consumer switching behaviour
5) The customers' perception of quality of service

The following sections summarise the findings related to each indicator.

5.1.1 Profit margins are lower than EU average

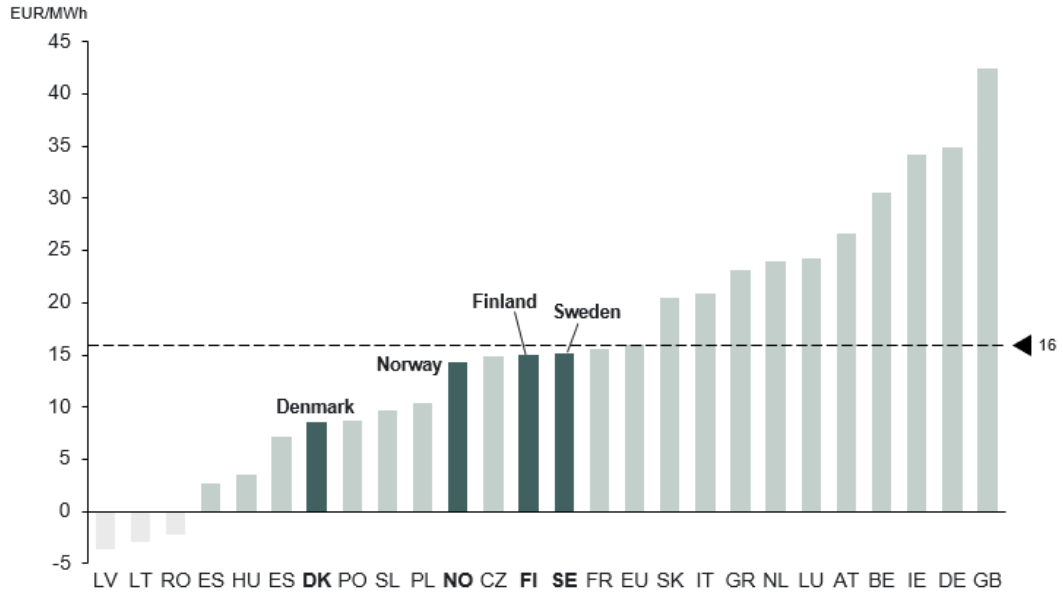
Electricity retail is generally a low margin business. On average, it is estimated that the so-called electricity markup[8] (also known as the gross profit margin) in the Nordic countries between 2012 and 2018 has been around 8,6–15 EUR/MWh (see Figure 4), which translates to about 27 EUR per household in Denmark and 227 EUR per household in Norway per year due to higher consumption per household in Norway. Out of the gross margin retail companies have to cover costs of running their business, such as cost of sales and marketing, sourcing and procuring power, servicing and billing customers, collecting debts, operating IT systems and ensuring data flows and processes.

In the period 2012–2018, the mark-up in the Nordic countries has been somewhat lower than the EU average and even significantly lower in Denmark (8,6 EUR/MWh against the EU average of 16 EUR/MWh, which also includes countries with negative margins). It should be noted that the gross profit margin in Denmark in 2018 increased to 20 EUR/MWh.[9]

[8] The markup is defined as the difference between the retail price the customer is paying and the wholesale electricity price.

[9] The gross profit margins should be interpreted with caution as they are not based on companies' actual results but instead estimated costs. Consequently, these margins are likely to vary significantly over time and within countries.

Figure 4: Gross profit margins/electricity markup 2012-2018

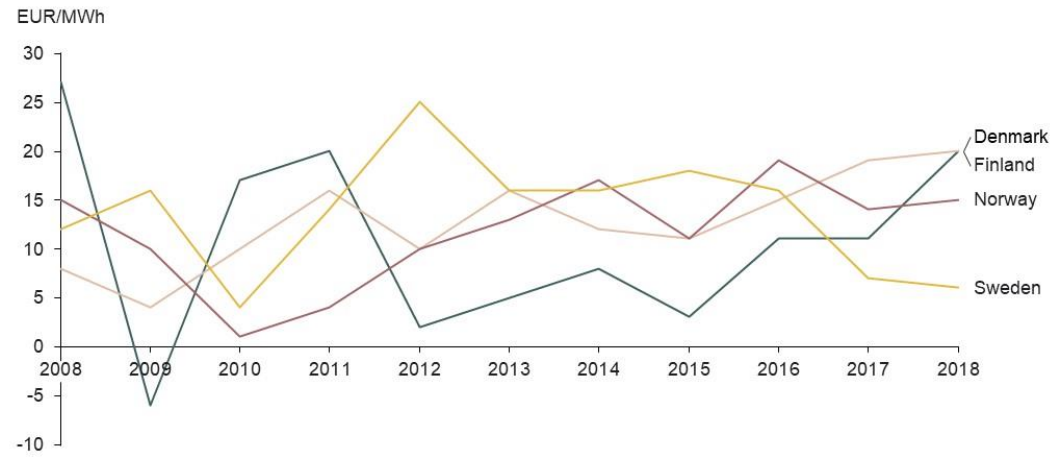


Source: Calculations based on ACER Estimated Electricity Markup 2008–2018 (prices in €/MWh).

As a result, we conclude that there are no obvious "over-natural" profit margins in the Nordic markets, which could be reduced by increased competition. Though it cannot be ruled out that efficiency gains could be achieved, margins are already significantly lower than in most other EU countries.

Moreover, the variation in gross profit margins within a country has a similar magnitude to the variation in profit margins between countries. Consequently, it is not clear that profit margins in one Nordic country are structurally higher than in the other countries, and therefore, they have the potential to be reduced by increasing foreign competition. A similar picture emerges when comparing profit margins over time (see Figure 5).

Figure 5: Development in gross profit margins over time

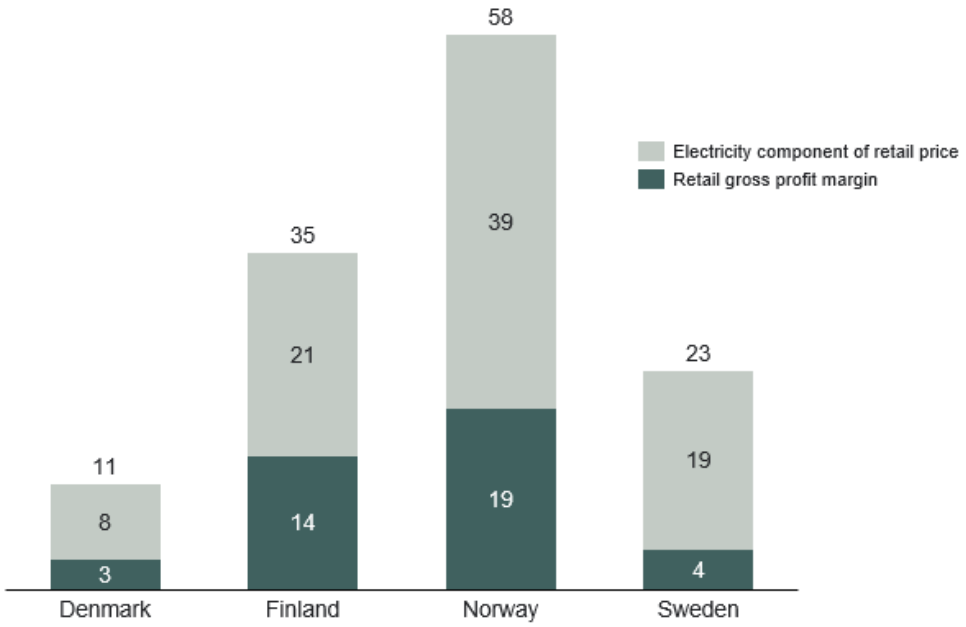


Note: Gross profit margin in defined as the difference between the retail electricity price (excluding grid tariffs, taxes and VAT) and the wholesale electricity price
Source: ACER Estimated Electricity Mark-up 2008–2018.

5.1.2 Most consumers are indifferent to the potential savings

Even if profit margins could be reduced, this would not affect household budgets by a lot. Even in a purely hypothetical case assuming that suppliers could completely remove 100% of their costs and sell directly at the wholesale price, households in Denmark and Sweden would save between 3 and 4 EUR per month, and households in Finland and Norway would save between 14–19 EUR per month (see Figure 3). If suppliers instead reduced profit margins by a hypothetical 10% due to increased competition, monthly savings for a household would range from less than 1 to 2 EUR per month.

Figure 6: Retail margin constitutes a low share of overall electricity bill (EUR / month)



Note: The electricity component of the retail price is excluding grid tariffs (TSO and DSO), electricity tax and VAT

Source: Calculations based on ACER Estimated Electricity Mark-up 2008–2018 (prices in €/MWh) and NordREG 2016 status report retail markets 2016. Average retail price and mark-up is based on 2017 data, and electricity consumption based on 2015 data.

5.1.3 Electricity is a homogenous product, and several companies can supply

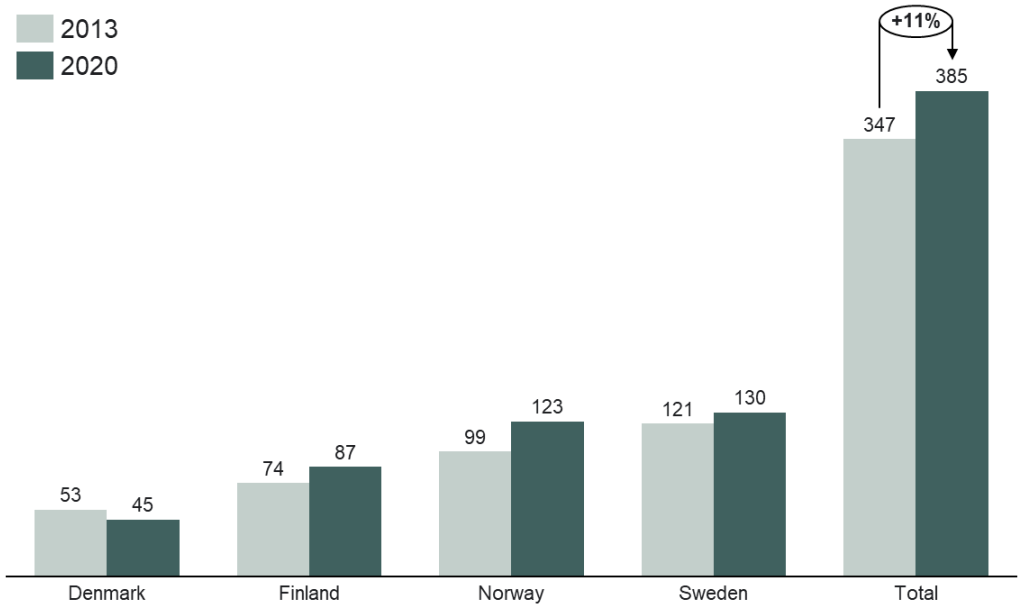
Retail electricity is a very homogenous product with relatively limited ways of offering differentiation and quality of service. Because of the underlying physics, the electricity consumed by a customer is completely identical no matter which supplier is selected, which primarily makes retail electricity a financial service where customers can choose different price and risk profiles given the underlying price fluctuations in the wholesale market.

After the liberalisation of electricity supply, suppliers have made significant efforts to differentiate on other parameters than price – for example added services, premium customer service (such as 24/7 access to call centres), sustainable electricity sourcing, bundled services and brand differentiation. The experience of most suppliers is that electricity remains a low-interest commodity with limited options for differentiation. Parameters other than price are mostly viewed defensively – poor customer service and negative press coverage, for example, may cause existing customers to switch, while superior service does not attract new customers.

In sectors where products are homogenous (such as retail electricity), the degree of price competition is typically high. Products are easier to compare and evaluate for consumers and more difficult to differentiate in terms of quality and added value services for producers. Consequently, producers compete on price instead of quality and added value. This implies that in such markets, even a limited number of competitors will ensure sufficient price competition; in some instances, only two competing alternatives can be enough.

In the Nordic countries, the number of electricity suppliers is quite high and has been growing. In 2020, there are approximately 385 suppliers in the Nordics, which is an increase of about 11% since 2013. The number of suppliers varies from about 45 in Denmark and 76 in Finland to 123 in Norway and 130 in Sweden (see Figure 7).

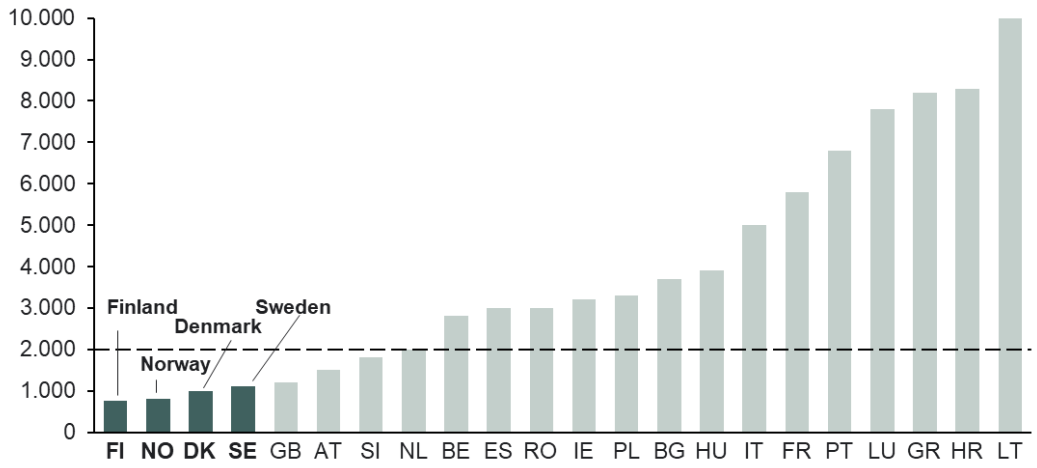
Figure 7: Number of retail suppliers has increased since 2013



Source: VaasaETT (2014) quoting National Regulators and Implement based on Fingrid data hub, www.strømguiden.no, Elpriskollen and response from Danish regulator

Market concentration in the Nordic countries is the lowest out of all EU countries. One common way of measuring the degree of competition is by using the so-called Herfindahl-Hirschman Index (HHI), where a low score is a measure of low concentration – and vice versa. According to this indicator, the Nordic countries have the lowest market concentration, suggesting the highest competitive pressure in the EU (see Figure 8).

Figure 8: HH-Index for the household market in electricity in 2018



Note: No data available for Finland.
Source: CEER (2019), Monitoring Report on the Performance of European Retail Markets in 2018.

Based on these indicators (commoditised service, high number of suppliers and low market concentration) it is not obvious that a strengthening of cross-border competition would be able to drive any significant market benefits.

5.1.4 Switching rates show variation within countries

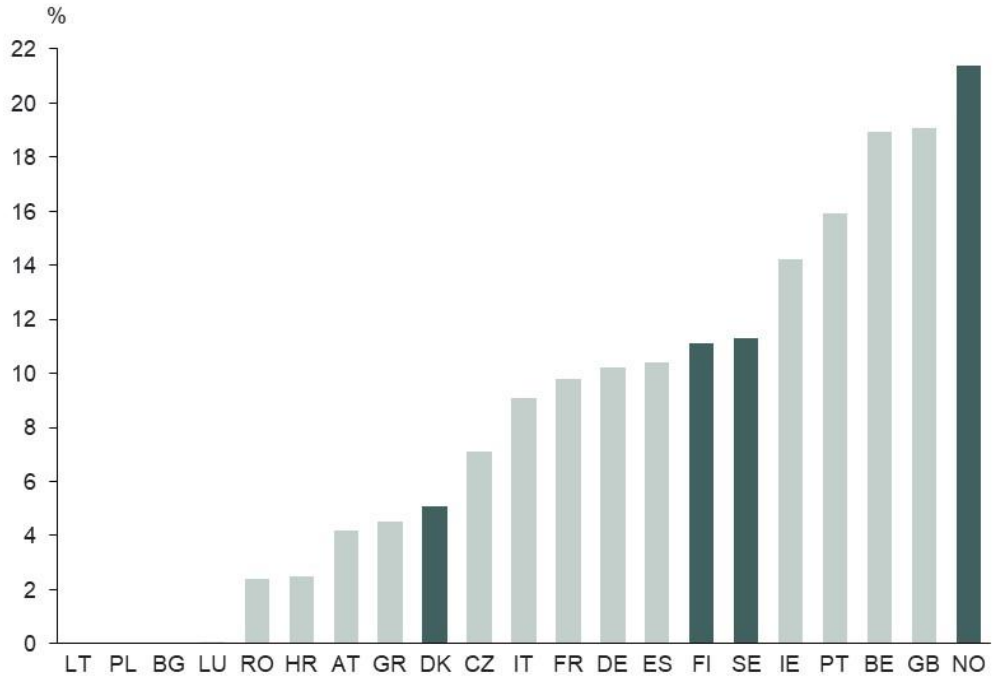
Another indicator of the degree of competition in a market is the so-called switching rate that measures how often a customer switches supplier. The idea behind the indicator is that if the switching rate is high, consumers are more "footloose", and suppliers will be facing a more intense degree of competition, as they struggle to maintain their customer base.

Electricity services have typically been seen as a market with relatively low switching rates, which to some extent covers both quite active consumers and a share of highly inactive consumers. The average EU switching rate for households for electricity is about 10,4%, implying that within a year, 10,4% of household customers have switched to another supplier. While not being substantial, it is, however, somewhat above the switching rate of the average EU service sector of 9,4%.[10]

Within the Nordic countries, there is quite a difference between household consumers' switching behaviour. While Norway has the highest switching rate of about 21%, Finland and Sweden have an average rate of about 11% and Denmark has a low rate of 5% (see Figure 6). This difference is likely explained by the fact that Norwegian households have a significantly higher consumption than especially Danish households and thus a higher saving potential from switching to a less costly supplier. It should also be noted that a low switching rate does not imply that competition is poor. Indeed, it can also be a result of consumers not having a clear monetary incentive to switch.

[10] CEER (2019), Monitoring Report on the Performance of European Retail Markets in 2018

Figure 9: External switching rates for electricity household customers by metering points in 2018



Source: CEER (2019), Monitoring Report on the Performance of European Retail Markets in 2018

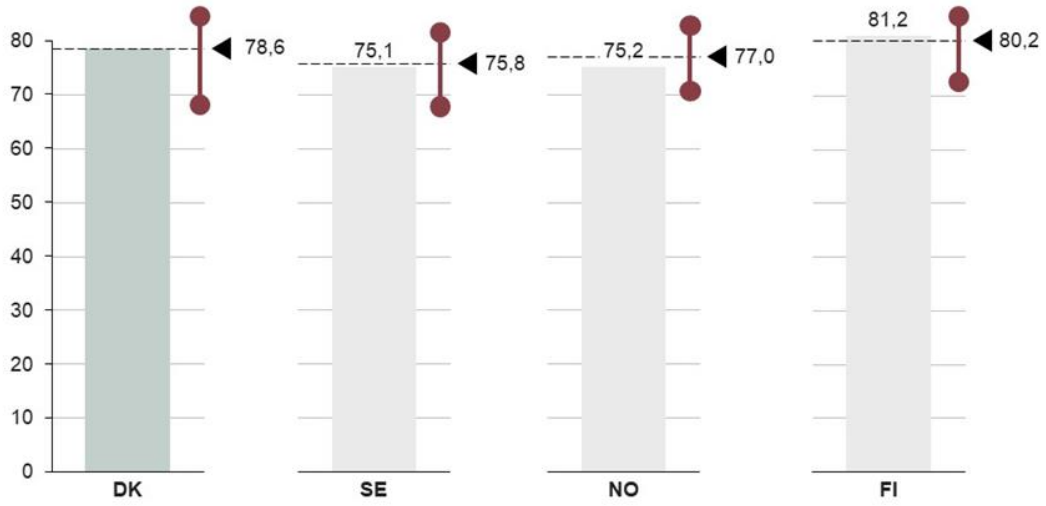
5.1.5 Market performance and quality of services are similar to the average service market

If quality provided by a sector to its consumers is low this could be a sign of inefficient competition. In sectors with effective competition, producers would have a clear incentive to produce the highest quality possible – and maybe less so in sectors with more limited competition.

Measured by the so-called Market Performance Indicator (MPI),[11] consumers evaluate electricity services to be in line with the average service sector in each Nordic country. In Finland, the MPI is above average, while in Norway and Sweden it is below average (see Figure 10). While not being conclusive, this suggests that there is no obvious potential to improve the quality of electricity service provision in the Nordic countries.

[11] The MPI is a combined indicator that considers consumer preference measures such as comparability, trust, problems and detriment, expectations, and choice.

Figure 10: Market performance indicator in each country

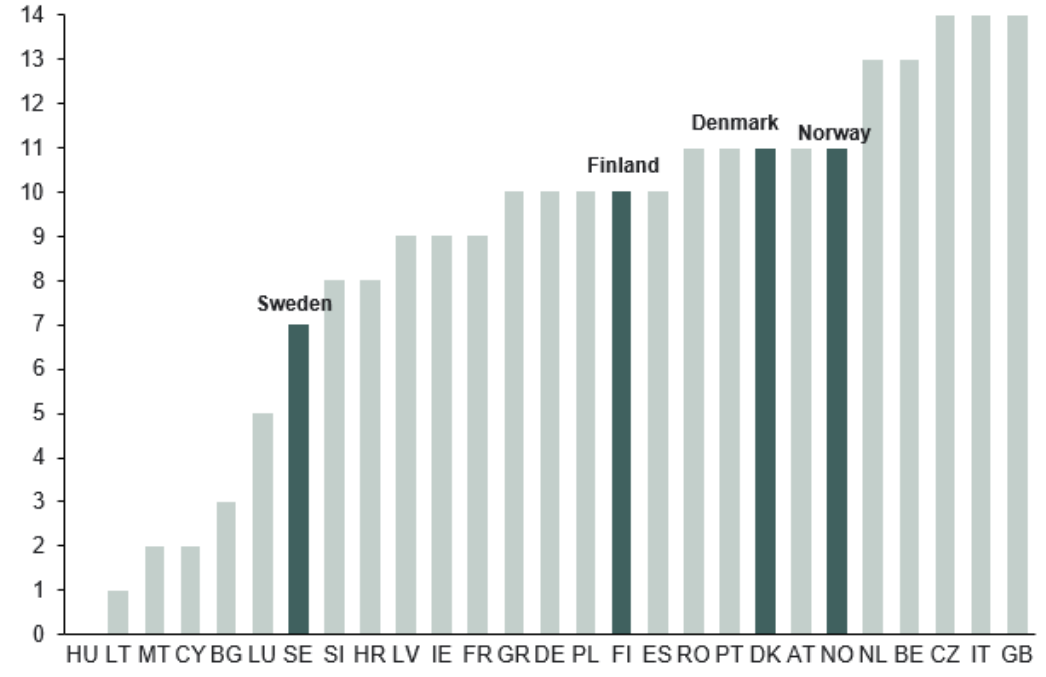


Note: The height of the column depicts the overall MPI-score for retail electricity in each country. The dotted line depicts the score for the average service sector in each country. The red dots show the highest ranked service and the lowest ranked service.

Source: CEER (2019), Monitoring Report on the Performance of European Retail Markets in 2018

Moreover, it also appears that Nordic electricity consumers have a significant degree of variation in the available choice of services. In Finland, Denmark and Norway, suppliers offer 10–11 different types of product variations, while in Sweden it is 7 variations (see Figure 11). This suggests that there is no obvious potential to improve variation and choice for consumers.

Figure 11: Number of available types of offers, 2018



Source: CEER (2019), Monitoring Report on the Performance of European Retail Markets in 2018.

5.2 Will increased interoperability lead to more inter-Nordic competition?

In the previous section, we concluded that increased inter-Nordic competition would likely not create significant benefits.

In this section, we explore to what extent increased data hub interoperability would in fact be able to drive an increase in inter-Nordic competition. We will describe market barriers related to data hub usage in the context of the strategic decision of an energy company established in one Nordic market to expand into other markets. The section describes:

1) The relative effect of interoperability on market entry barriers, based on previous studies
2) The relative importance of the electricity supply business in the growth strategy of an energy company
3) The relative importance of data hub interconnectivity in the growth strategy of the electricity supply business (whether a stand-alone energy supplier or a business unit in an integrated energy company).
   The section is based on interviews, answers from our survey and on structural analysis.

5.2.1 Data hub interoperability will only address a limited number of the barriers for market entrance

In their study *Market Entrant Processes, Hurdles and Ideas for Change in the Nordic Energy Market - the View of the Market*, 2014, VaasaETT identified 60 entry barriers to the Nordic electricity markets, of which 26 were considered to be major obstacles for market entry and therefore increased competition. Some of these barriers have been reduced or eradicated by development of market rules since the report was published.

In Table 8 we have assessed which of the remaining major obstacles are addressed by data hub interoperability.

Table 8: Number of major obstacles to market entry that are addressed with data hub interoperability.

Obstacle	Reduced or eradicated by other initiatives	Reduced with data hub inter-operability without market harmonisation	Reduced with data hub inter-operability and market rule harmonisation	Unaffected	Comments
Size of individual markets is seen as too small for larger entrants		(PARTIALLY)			
Separate BRP agreements in each Nordic market for own BRP suppliers					Harmonisation of market rules may remove obstacle but is not linked to data hub interoperability
Need to have different IT systems in each Nordic market		(PARTIALLY)			Data broker model may reduce but not eliminate need for IT investment for market entry
Market for ESCO services immature, moves slowly / protectionism					
Balancing processes and costs not consistent (NBS may solve except for DK)					
Risk from hedging (case for all competitors) - increases with size					

Table 8: Number of major obstacles to market entry that are addressed with data hub interoperability.

Obstacle	Reduced or eradicated by other initiatives	Reduced with data hub inter-operability without market harmonisation	Reduced with data hub inter-operability and market rule harmonisation	Unaffected	Comments
Absence of supplier-centric approach					
Absence of near-identical processes between Nordic markets		(PARTIALLY)			
Data quality issues (poor or late data)					
Difficulty identifying when a customer's contract will end (not Norway)					
Customer information required to initiate switch is often difficult to obtain					
Process of attaining customer information reveals intentions of competitors					
Some DSOs may forewarn their associate suppliers of imminent switch					
Customer unawareness, apathy and inactivity					
Current APIs for meter data are not considered sufficient for ESCO use	(In some countries)				
Absence of easy access to near real-time consumption data					
Cost and difficulty of brand and offering awareness					
Brand bundling (DSO, supplier)					
Limited savings potential in face of price matching					
Lack of combined billing or combined billing only by bundled incumbents					
Moving home favours incumbents					
Inhibition of legality or visibility of innovative tariffs[12]		?	?	?	
Different data formats in each Nordic market		(PARTIALLY)	(PARTIALLY)		Issue likely reduced but not eliminated with interoperability
Inferior customer lifetime value for entrant suppliers					
Easier to keep customers than to win them / incumbent margins transfer					
Current absence of smart meters in Denmark and Norway					
TOTAL ISSUES RESOLVED	**10**	**4 partially 1 potential**	**3 fully 1 partially 1 potential**	**11–12 unaffected**	

Source: VaasaETT, 2014, Implement research.

[12] Depending on implementation, interoperability may promote and create visibility of innovative tariffs across markets or may slow implementation as consensus across a shared platform must be achieved to allow new tariff structures.

The efforts to introduce supplier-centric models and establish data hubs in the Nordic markets are successful in eliminating a number of identified market barriers in the VaasaETT study.

Data hub interoperability has the potential to reduce or eliminate a few of the remaining barriers. We notice that technical interoperability without market rule harmonisation does not fully address any of the remaining barriers, and only addresses a limited number of barriers. Interoperability based on market rule harmonisation has a larger potential for reducing access barriers but also drives higher IT costs for the suppliers and DSOs. Whether a technical or rule-based interoperability is implemented, a number of obstacles still constitute major access barriers.

5.2.2 Market barriers and synergy are decisive for the cross-border expansion

If interoperability is to promote cross-border competition, it will have to incentivise suppliers in one Nordic country to invest in establishing operations in another. To assess whether this would be the case, this section describes the full set of entry barriers which meets an electricity supplier when expanding from one Nordic country to another. As nearly all large electricity suppliers are part of a vertically integrated energy company, we also describe the typical drivers for inter-Nordic expansion from the perspective of an integrated company.

The over-all logic for cross-border expansion is that synergy must exceed the investment needed for overcoming market barriers. If this is not the case, a company will invest in domestic growth, or in alternative activities.

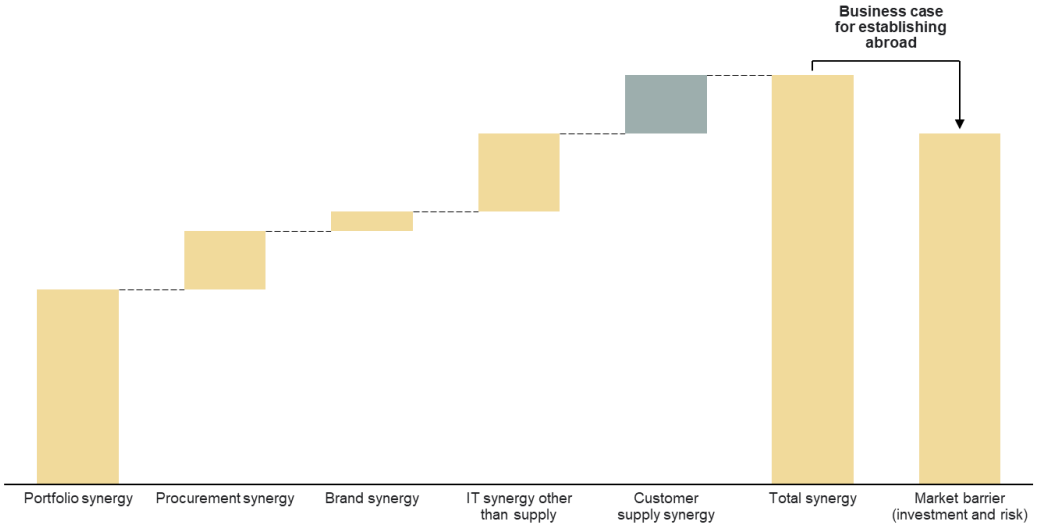
To understand how interoperability affects a company's decision to expand, we describe the synergy and market barriers from the company perspective with respect to:

- To which extent does synergy in the supply business unit drive expansion decisions in a vertically integrated energy company?
- To which extent could data hub interoperability reduce market barriers for an electricity supplier?

For the vertically integrated energy company, portfolio optimisation is a key driver for consolidation. Traditionally, integrated companies have off-set their upstream risk against downstream risk. The electricity supply business has provided a hedge against fluctuating electricity prices, so that in periods with low wholesale prices, increased earnings in the supply business would make up for lost income in the generation business, and vice versa. Integration of the Nordic wholesale markets has made it possible to optimise portfolios in real-time, maximising the value of a company's assets through active trading and has increased the value of the balancing potential of vertical integration.

In Figure 12, we illustrate a view of the business case as it will look from the perspective of an integrated company, with the idea of illustrating that synergy in the electricity supply part of the business is only one component in the decision to expand.

Figure 12: Illustrative breakdown of the case for cross-border expansion. The "customer supply synergy" is broken down in the following section



Source: Implement analysis

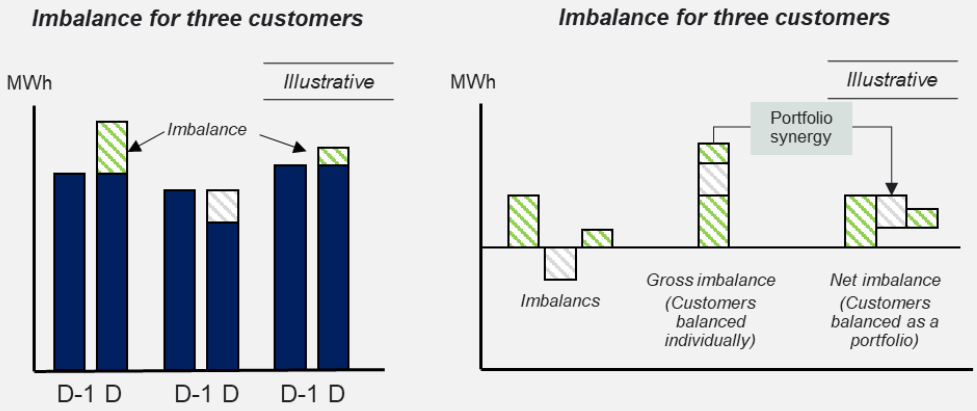
Text box: Portfolio synergy as a driver for consolidation

Portfolio synergy is a major driver for consolidation in vertically integrated energy companies for two reasons:

The “natural hedge” effect implies that upstream price fluctuations are compensated by downstream positions, so that losses in the upstream activities caused by a price drop are compensated by increased earnings and vice versa. The “natural hedge” is without transaction cost and market premium and therefore more efficient than hedging an energy position in the financial market. As there is little operational synergy between business units in the various parts of the energy value chain (such as between oil production, electricity generation and energy retail), the “natural hedge” is the key reason why energy companies are vertically integrated.

The “balancing synergy” is the effect of having different customers with different consumption profiles. These customers will partly absorb changes in consumption so that the net balancing cost for the total portfolio becomes smaller than the potential balancing cost of the individual positions.

The graphic is a simplified illustration of the balancing synergy, showing synergy for downstream positions (customers or groups of customers). The synergy can be further increased if the portfolio combines upstream and downstream positions.



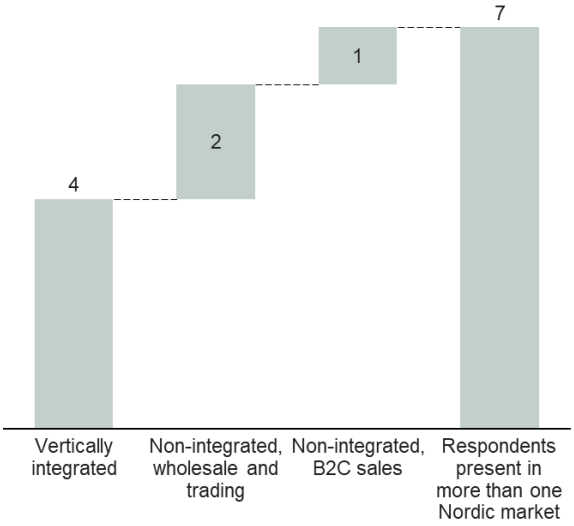
The balancing synergy has significant volume benefits.

Both types of synergy are strong drivers for consolidation. A reduction of market access barriers at the supplier level may not address the major drivers for cross-border expansion of Nordic energy companies nor the entry of non-Nordic competitors.

The balancing synergy is also a significant component of the success of energy trading houses such as Centrica and Danish Commodities. The trading houses optimise a portfolio of own large end customers and generation and supply positions for other customers. As for the vertically integrated energy company, the growth motor (including the motor for cross-border expansion) is to a large extent the size and diversity of the portfolio and to a much smaller extent the operational economy of scale.

In the survey, 6 out of 7 supply companies with presence in more than one Nordic country belong to vertically integrated groups or are trading-based companies with large B2B end customers (see Figure 13). This illustrates that synergy from vertical integration and portfolio synergy are stronger drivers for cross-border expansion than economy of scale in the supply operation.

Figure 13: Number of respondents present in more than one Nordic country that belong to a vertically integrated entity.

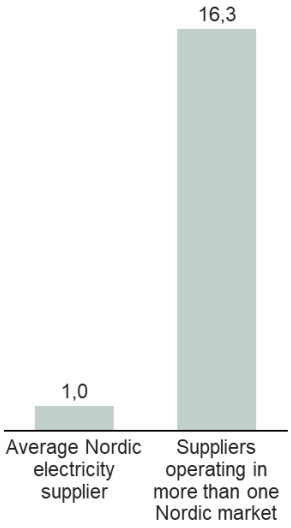


Source: Implement survey for NordREG, 2020.

Respondents from vertically integrated companies in our qualitative interviews confirm that electricity supply activities are sometimes taken over as part of a larger expansion but with no immediate plan for harvesting synergy in the supply business by integrating similar activities across borders. This supports the argument that synergy at the supply level has not been a key driver for expansion.

Currently, inter-Nordic operation has mostly attracted the very large players (see also Figure 14).

Figure 14: Average size of local and inter-Nordic respondents by total amount of electricity supplied (TWh/y)



Source: Implement survey for NordREG, 2020.

This may have several reasons other than the need for a large portfolio to drive synergy, e.g. the need for financial strength and for analytical and leadership capacity to drive expansion.

Even though cross-Nordic expansion is often driven by upstream synergy, data hub interoperability may still increase cross-border competition by:

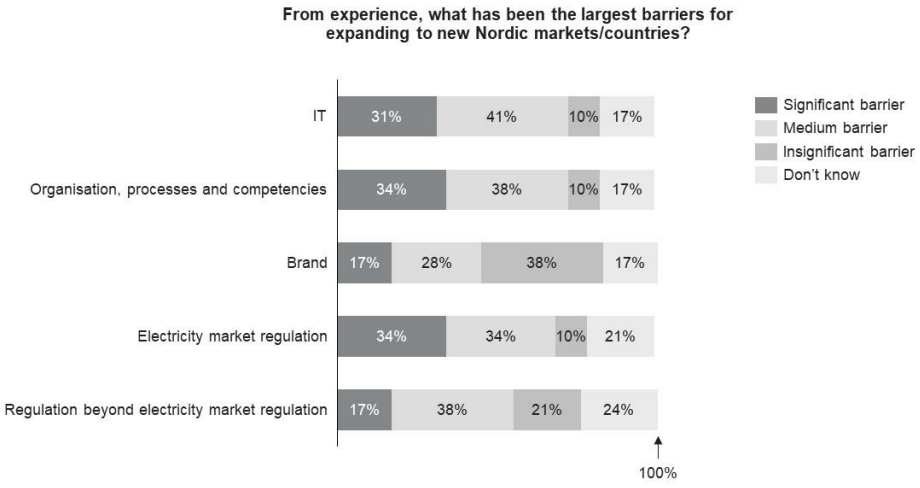
- Making it more appealing for supplier-only entities to expand across borders by reducing entry barriers.
- Strengthening the case for vertically integrated companies to expand across borders by reducing the sub-set of entry barriers related to the supply business.

In the following, we will look at the entry barriers specifically linked to electricity supply and how interoperability might affect them.

For small to mid-sized suppliers, acquisition of customers in their current market will be more attractive than international expansion, as there are no entry barriers and the cost of customer acquisition can be comparable (whether through organic or non-organic growth). For large suppliers, it may be necessary to expand outside their own borders to gain sufficient scale if their market share in the current market is large.

In Figure 15, we illustrate the main barriers experienced by the market entrants. Of the five perceived barriers, only the barrier related to IT costs is significantly affected by data hub interoperability. The barriers related to building an organisation, developing processes and competencies to serve the new market and variations in regulation of electricity markets are seen as equally significant market barriers and are not reduced by the introduction of interoperability.

Figure 15: Market barriers for existing supplier entering a new Nordic market



Source: Implement survey for NordREG, 2020.

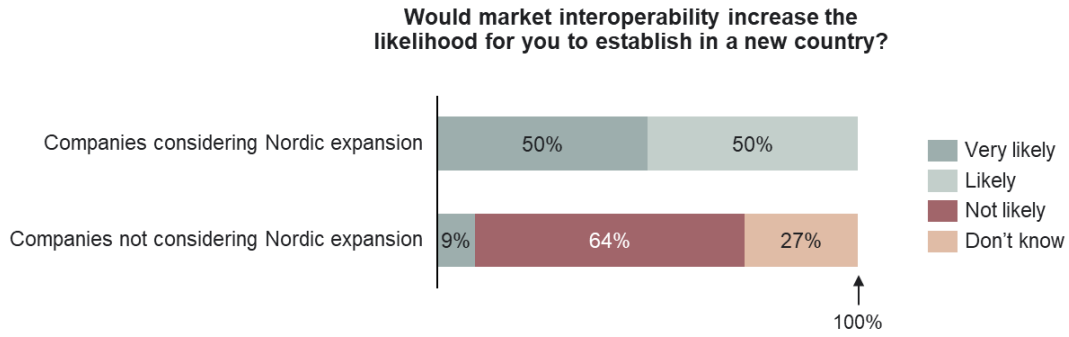
The results are aligned with indications from our interviews with suppliers who have experience establishing supply businesses in several Nordic countries. They mention the following market barriers as the most significant:

- establishing a local organisation
- attracting experienced senior staff
- establishing a local brand (if not retaining existing brand from non-organic growth)
- understanding local market dynamics
- establishing a strategy for profitable growth in the market

It has to be noticed that these results are the perception of established suppliers. Though these entry barriers will be relevant for all suppliers, it is possible to imagine that highly digitalised new entrants would rank the barriers differently and improve the case for interoperability.

Though most of the respondents rank non-IT-related entry barriers as being as significant or nearly as significant as IT-related barriers, the respondents also assess that data hub interoperability would increase the likelihood of cross-border expansion, as shown in Figure 16.

Figure 16: The respondents' assessment of how increased data hub interoperability would influence the likelihood that they would establish business in another Nordic country



Source: Implement survey for NordREG, 2020.

The answers indicate that interoperability might help companies which are already considering expansion to make the investment decision, while it is unlikely to trigger locally focused suppliers to expand. In the survey we tried to explore the difference between a technical integration (such as a shared interface format) and a full market integration (such as common market rules and processes). The survey respondents do however not distinguish the effect of the two. In the qualitative interviews, however, several respondents clearly distinguished between technical integration and a common market, with an emphasis on the need for common market rules to reduce market entry barriers.

In the comments to the question about the effect of interoperability, the respondents note:

- "We see that overall market models such as centralised data exchange, supplier-centric model and metering scheme = hourly/quarterly data for all customers should be fully harmonised. It is of great importance that the national development initiatives are strongly promoted. Also, the more detailed regulations/set of processes should be harmonised more (also implementing EU regulations in the same [way] in the Nordic countries). Increasing the harmonisation and interoperability of the Nordic data hubs is one of the highly recommended measures to move in the right direction."
- "Key for us is that the regulations and data hub solutions are as similar as possible in all countries."
- "Political climate and business models must be ready for interoperability."

These comments suggest a perceived need to consider harmonisation of market rules as an underlying condition for reducing access barriers, at least for some respondents.

5.2.3 Electricity suppliers' readiness to expand across Nordic borders

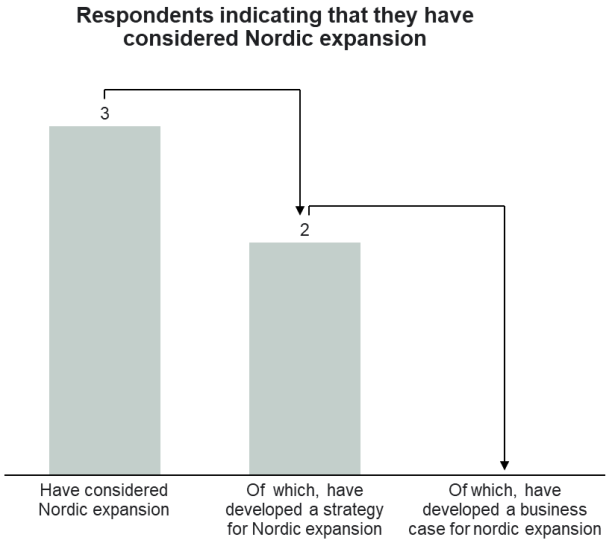
Interoperability will only trigger cross-border expansion for companies with an intention to expand when market barriers are reduced. The respondents have been asked 1) if they have considered Nordic expansion and 2) if they have developed a strategy or business case for

expansion. We distinguish between companies “considering” and “developing a strategy for” expansion, as we expect that the commitment from the latter category is stronger than from the first.

In Figure 17, we show the distribution of answers in the survey. Only a few respondents indicate an intention to expand cross border. However, two out of the three respondents who consider expansion have also developed strategies, which indicates that the intention is concrete. None of the respondents have developed business plans for the expansion, which may indicate that they have not made any specific analyses to quantify synergy and entry barriers.

It is possible that more companies would investigate the potential for inter-Nordic expansion if entry barriers were lower. However, we observe that most companies are not exploring the possibility of expansion, and therefore are not even aware which market barriers might be prohibitive. Lowering the entry barriers for these companies is unlikely to trigger an investment decision.

Figure 17: Respondents who have considered Nordic expansion



Source: Implement survey for NordREG, 2020.

The respondents *not* considering expansion often refer to their size or mandate (such as being municipally or cooperatively owned) in their comments:

- We are only focused on our local area
- We are in the middle of a merger, so at the moment we are focusing on that.
- From business/strategy, we are not on scope at the moment. The group is focusing to current markets.
- Our strength is to be local even though we have customers on a national basis.
- We are a small organisation with a local focus.
- We are too small.
- [Company] is a municipality-owned energy/utility and optical fibre infrastructure group. Our operation is mainly focused on the local market, in the municipality of [town]. We are not big enough for a Nordic expansion. We started up electricity sales (again) in April 2015 to be able to keep customer contact with as many of our electricity grid customers as possible. (In the electricity sales-centred model perspective). We have grown from zero to 8,300 customers so far and will work hard to grow to at least 20,000 customers by 2024.

- 90% of our customers are from the local region. We are owned by the municipality. The Swedish market share is less than 1%, so increasing that market share is more attractive than going abroad.
- We are a municipality company on a local market.
- It´s not part of our mission.
- We are a municipality-owned company
- As of now it is not a part of our strategy.

15 respondents specifically indicated that they are not considering Nordic expansion.

The three respondents commenting on why they may consider Nordic expansion refer to economies of scale as well as the ability to service inter-Nordic customers as a driver for expansion:

- As one of the largest electricity suppliers in [country], it is natural to consider your geographic footprint.
- We have customers and attend tenders with groups present in two or more Nordic countries.
- We want to increase our customer base.

The survey results indicate that Nordic expansion is seen as relevant by some suppliers, while a majority of suppliers seem to focus locally or nationally.

6 Cost of establishing data hub interoperability

The implementation of Nordic data hubs and the simultaneous implementation of a supplier-centric market model has already required significant investment:

- The cost of establishing the data hubs as the single central IT platform for information exchange in a market
- The cost of separating IT systems and processes between DSOs and suppliers
- The cost of adapting or, in most cases, replacing the IT systems supporting meter data collection, meter data exchange and customer billing as meters age or demands for higher time resolutions are implemented

Introduction of further changes to the way the data hubs interact with DSOs and suppliers will drive further cost both at data hub level and at the level of DSOs and electricity suppliers who will have to adapt their systems to the change.

Therefore, to analyse the cost of introducing data hub interoperability, we have investigated the accumulated cost at data hub, supplier and DSO levels. Of the solutions analysed, the establishment of a common market will have the highest impact on entry barriers. However, this is also the solution which imposes the highest investment in new IT on market participants and has a net cost of EUR 200-300 million despite some net operational savings at data hub level. Shallow integration, which will only partially eliminate IT-related access barriers, can be implemented with far less investment and does not impose significant cost on suppliers who will not expand outside the National market.

6.1 Cost components analysed in the study

The analysis considers these cost elements:

- *Project-related cost.* One-time IT-related investments necessary for electricity suppliers and DSOs for implementing the change as well as investment and potential savings for the necessary changes in data hubs
- *Operational costs.* Recurring cost related to operations, management and maintenance of IT systems

Notice that the cost is not distributed in the same way for all solutions. Some changes will only affect those market participants who decide to implement for example common technical standards for data exchange, while other solutions impose investment on all market participants. In the same way, some benefits in terms of cost savings only apply for suppliers with presence in multiple Nordic countries and/or the data hub operators.

IT-related costs include necessary pre-studies, stakeholder engagement and project cost for developing and implementing the new technology.

IT cost is a proxy for the total cost which will also include cost for developing new regulation, cost of governance, data management, user support and IT processes to support shared IT interfaces and common rules. This cost is assessed to be minor compared to the IT and data hub-related cost and is ignored in the analysis.

IT cost elements are based on estimates related to the five conceptual archetypes introduced above. Estimates are presented in ranges from a best-case scenario to a worst-case scenario of each conceptual archetype.

Main sources for cost estimations are:

- Survey of electricity suppliers' current IT-related costs and IT usage
- Interviews with DSOs, suppliers and all data hubs

- Interviews with IT vendors established in the Nordic markets
- Analysis of data hub cost and investment cases
- Analyses of the cost effect of changing market rules as experienced by data hub and market participants
- Benchmark data from previous large and complex IT programmes in the sector

6.2 Assumptions related to the cost analysis

For the different archetypes, we assume that a functioning data hub is implemented in the national market. Therefore, the scenarios will only be valid after the completion of the Swedish and Finnish data hubs. Where establishment of one data sharing platform is suggested, or consolidation onto a common data hub platform is suggested, we have made no investigations into which country or corporate legal entity should actually build, own and operate this platform. We further assume that the IT platforms are fully separated between suppliers and DSOs, meaning that suppliers only incur cost related to changes in billing and customer support-related systems while DSOs only incur cost related to meter reading systems.

The number of suppliers and DSOs in the four countries is a cost driver for any changes which involve market rule change and is shown in Table 9. Based on our questionnaire to suppliers, we have assumed that 16 suppliers, equivalent to 5% of the total number, already have inter-Nordic operations and hence serve retail customers in more than one Nordic country.

Table 9: Number of entities potentially affected by changes in communication with data hubs

	Suppliers	DSOs
DK – domestic market only	45	43
FI – domestic market only	87	77
SE – domestic market only	130	170
NO – domestic market only	123	130
The Nordics – presence in two or more Nordic markets	16	0

Source: Nordic regulators and data hubs

The total cost will be less if there has been market consolidation at the point of implementation. At the moment, there is a small trend towards consolidation of DSOs in all the markets, while there is a significant growth trend in the number of suppliers, which makes it fair to assume that there will be the same number of entities (retail suppliers and DSOs) in the future scenarios as there are entities today. The assumptions for the analysis should be revisited if a significant consolidation or further growth in the number of entities takes place.

The cost projections consider a ten-year cash flow (investment, operating cost and economies) for all affected market participants. All cost is calculated as marginal cost compared to a baseline without interoperability. Uncertainty related to the cost estimates is significant. For this reason, all cost estimates are indicated as ranges. For simplicity, cost is not discounted, and no cost of capital is applied.

The net cost assessment is modelled on a concrete implementation process. We allocate implementation cost to each specific element of the interoperability model. Cost is assessed from experience-based time estimates for development and maintenance of each component.

Other modelling choices are:

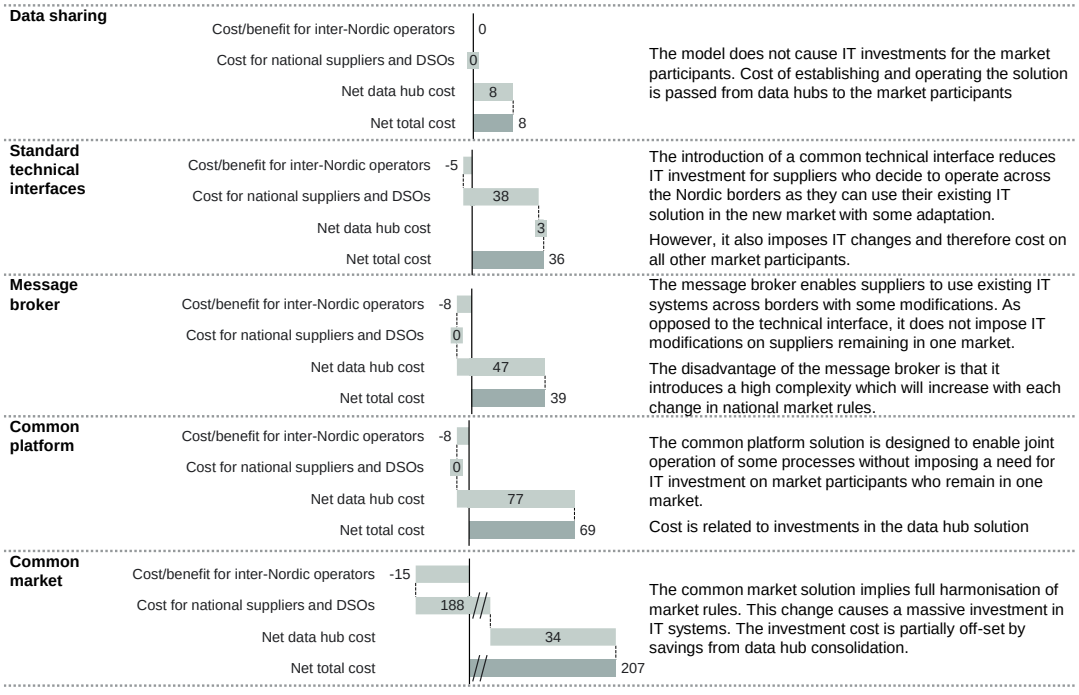
- Except for changes necessary for establishing interoperability, functionality and technology platforms remain the same as today. Cost estimates are based on already realised projects wherever possible.
- IT cost of DSOs and suppliers is modelled as a cost per market participant and scaled to the full population of market participants as opposed to extrapolation of the full IT cost base. We chose this approach to acknowledge that each connected party will have to implement changes in their own IT systems.
- We have assumed that platform projects will be executed country by country to reduce the implementation risk. From a cost point of view, it may be less costly to introduce a new IT solution with a "big bang" implementation approach changing all interfaces in all markets at once. However, we find the associated risk unacceptable and have therefore considered each of the markets to be handled individually in the migration projects.

6.3 The effect of data hub interoperability on market IT cost

The cost analyses show a significant difference between models with shallow integration (IT layers with no harmonisation of market rules) and deep integration (relying on partial or full harmonisation of market rules). Also, this distinction has a very strong impact on the distribution of cost among the market participants. While shallow integration passes some surplus data hub cost to the end customers, deep integration also introduces IT changes for DSOs and for those suppliers who remain nationally focused.

Figure 18 shows an overview of the net cost and cost distribution of the archetypical models. Net cost includes direct benefits related to IT cost in the form of savings for the market participants and data hubs. Potential economic benefits for the end customers are not included.

Figure 18: Overview of total cost and cost distribution of the models. Costs are mEUR. The graphic shows the average of best-case and worst-case simulation.



The overall distribution of net costs – costs and savings – is detailed in Table 10. The cost estimations are presented in a best-case ("BC") and worst-case ("WC") scenario. Negative

numbers (-) represent a cost saving, while positive numbers represent an addition to the existing cost.

Table 10: Overall distribution of costs in all five conceptual archetype models. The table shows net cost; negative numbers indicate a net benefit for the group of market participants (mEUR the first 10 years)

	MODEL 1 Data sharing		MODEL 2 Std. technical interfaces		MODEL 3 Message broker		MODEL 4 Common platform		MODEL 5 Common market	
mEUR 10 years	**BC**	**WC**	**BC**	**WC**	**BC**	**WC**	**BC**	**WC**	**BC**	**WC**
Total net cost	**6**	**9**	**15**	**57**	**14**	**64**	**40**	**99**	**112**	**302**
Data hub	6	9	2	3	23	71	48	106	- 0,3	69
Domestic suppliers	0	0	9	14	0	0	0	0	89	160
Inter-Nordic suppliers	0	0	- 7	- 2	- 9	- 7	- 9	- 7	- 20	- 9
DSO	0	0	10	42	0	0	0	0	44	83

Annex 1 gives a detailed description of the net cost relating to each model. Annex 2 describes the underlying assumptions for each type of market participant and data hub.

7 Conclusion

We have analysed the potential benefits of increasing inter-Nordic competition by introduction of interoperability of Nordic data hubs at the electricity supply level and the net cost of establishing the processes and systems to achieve this.

Our main findings are:

1. There are no immediate benefits from increased inter-Nordic competition. The reasons are that there is no apparent lack of competition in each of the four retail markets, and that there is already inter-Nordic competition from several suppliers operating in more than one Nordic retail market.
2. There are different models which can achieve various levels of interoperability, and which can reduce entry barriers for Nordic electricity suppliers seeking to establish operations in another Nordic country. All the solutions which we have identified have a net cost.
3. The most significant reduction of entry barriers is achieved when market rules are harmonised. This can happen in two stages – a purely technical harmonisation of IT protocols, or a harmonisation which also addresses the meter reading process such as metering frequencies, clearing windows etc.
4. Though solutions which include market harmonisation are best at reducing entry barriers, they also have the highest net cost. This is because changes to market rules impose significant cost on all market participants for IT and process updates, though only few will benefit from the harmonisation. Costs of updating IT systems to accommodate new market rules are also imposed on DSOs though these experience no benefits from inter-Nordic competition

It follows that the socioeconomic case for establishing data hub interoperability is negative, and that interoperability should not be pursued as a means for increasing competition between Nordic electricity suppliers.

Increased interoperability and market harmonisation may potentially create benefits in the long term. However, these benefits are not part of the scope for the current study and remain speculative until further analysed. We have identified two options for long-term value creation:

Preserve the potential related to market similarities: In the long run (2030 and beyond), the national supplier markets may see stronger concentration which could make inter-Nordic competition more relevant. It is also possible that the national data hubs may see advantages of developing joint solutions (such as joint sourcing and procurement, joint technology selection or partnerships). To preserve and strengthen these options, it is essential to secure a parallel and preferably converging development of Nordic market rules. A divergent development will reduce the potential.

Explore the potential related to new business models: Interoperability might increase the potential for promoting business model innovation related to flexibility services, smart services, sector coupling, and similar. Such an investigation should include market dialogue and could include an analysis of consequences of the Clean Energy for all Europeans Package for the use of meter data which could be made available by the data hubs.

We recommend that NordREG assesses the long-term value of market similarities and of interoperability which could promote flexibility-related business models; that NordREG continues to promote parallel or harmonised development of Nordic electricity markets; and that NordREG promotes a common Nordic implementation of EU regulation related to flexibility and “smart” services. This could potentially strengthen the development of innovative products and business models across the Nordic electricity supply markets.

As mentioned previously we must stress that this should be pursued as part of any necessary update of National market rules such as the implementation of the Clean Energy for all Europeans. The cost of implementing new market rules across the Nordic DSOs and suppliers is much higher than the potential benefits. Therefore, market harmonisation, including any interoperability model which requires changes to the National metering and billing related market rules, should not be pursued with the sole purpose of achieving a higher level of harmonisation.

7.1 Key findings for the conclusion

There is no indication of a significant economic benefit from further harmonising the Nordic retail markets. We have assessed several options for achieving interoperability which have all proved to create limited value. Based on a number of different indicators, the retail markets in all the Nordic countries have a sufficient level of competition and perform better than most EU countries. This is indicated by a high number of suppliers, an absence of over-normal gross margins and a sufficient quality of service. Retail electricity is also a highly commoditised/-standardised product, which means that only a few market participants are needed to ensure effective competitive pressure. It is therefore not obvious that additional competitive pressure from companies in other Nordic countries would be able to bring any significant additional benefits.

The current market structure is characterised by several small local players that have emerged from local integrated energy companies and by very modest levels of consolidation. This, together with quite low consumer switching rates in some countries, could indicate market inefficiency and a potential benefit of Nordic market integration. However, this could equally well be explained by very low possible savings for consumers and already low profit margins for suppliers. It is unlikely that inter-Nordic competition will yield significant benefits as long as the national suppliers have not further taken advantage of the potential for consolidation in each national market. It should be noted that benefits from further market harmonisation can also emerge through channels which are difficult to foresee. An example could be innovative, valuable business models that would only be viable in a common Nordic market. So, while we do not see indicators suggesting significant benefits from further harmonisation, a potential for such benefits could exist.

Data hub interoperability will only remove a few of the market entry barriers experienced by the suppliers. The expansion into a new geography is a significant investment for the electricity supplier. The suppliers interviewed for this study refer to cost of establishing IT systems, cost of understanding the new market, cost of establishing a brand, cost of customer acquisition and cost of establishing a local organisation as the most significant cost elements. Of these, only the IT investment is influenced by data hub interoperability, and we find that this constitutes a minor share of total costs of entering a new market. Suppliers might potentially operate out of one country, which would eliminate the need for a local organisation. However, this is not indicated as an option in any of our interviews and would not eliminate the need for establishing a brand, establishing market intelligence, establishing knowledge about regulator and tax issues, and establishing contractual relationships with National DSOs.

Nordic expansion is often driven by other benefits than economies of scale in the supplier business unit. Out of about a dozen energy companies with inter-Nordic presence, nearly all are vertically integrated. Only one respondent in our survey who is present in more than one Nordic market is not part of a vertically integrated group or a trading and wholesale group. There are several drivers for consolidation across borders, most notably the option for optimising a larger energy portfolio. In this type of expansion, the take-over of the supply business is considered as a side effect of acquisition of the upstream assets. This implies that a reduction of entry barriers for electricity suppliers will have a limited effect on the strategic decision to expand.

Few suppliers seemingly would consider Nordic expansion. For data hub interaction to be effective, it would have to trigger suppliers to invest in cross-border expansion. Only three respondents in the survey are formulated about cross-border expansion, and only two of these have made the step of developing an actual strategy for expansion. None of the participants in the survey have made a business case evaluating Nordic expansion. From the qualitative interviews as well as the survey commentary, the majority of suppliers remark that "if they intended to expand, it would be more evident to expand nationally". Most of the large suppliers already have a presence in more than one Nordic country.

The different interoperability models we have analysed have different potential impacts on overall costs in the system.[13] Some models will only affect data hub owners directly through centralised IT investments, developing, implementing and testing the interoperability processes and software, while other models also impact suppliers and DSOs directly as they will have to carry the cost of implementing changes in their own systems. Given the large number of suppliers in the Nordic countries (a little below 500), even a moderate cost per supplier will amount to a large total cost. In some of the models, there will also be a potential for cost savings through two different sources: 1) suppliers who are already present in multiple Nordic countries could rely on fewer and/or more simple systems and processes and 2) cost synergies achieved through partial or full consolidation of Nordic data hubs.

7.1.1 Assessment of the models analysed in the study

The key conclusions for each of the interoperability models we have analysed are the following:

The *data sharing model* is a relatively low-cost model that improves information access for suppliers and other parties such as ESCOs, flexibility providers etc. There will be no net costs for existing market participants except marginally higher tariffs for data hub use (passed to end users). Overall, we conclude that this model would only have limited effect on retail electricity market functioning, but there could be benefits in other related markets such as improving the data foundation for identifying electricity savings potential or support for future business models based on flexibility and delivery of "smart" services.

The *standard technical interface model* is a relatively limited investment for data hub owners but will also incur costs for all existing market participants. The model will provide some – but limited – cost savings to suppliers already operating in more than one Nordic country and will make it slightly cheaper for an existing domestic supplier to establish operations in another country. Overall, we conclude that the cost of implementation substantially outweighs the benefits.

The *message broker* can potentially significantly streamline data processes and create synergies in IT costs for suppliers operating in more than one country. Costs are only carried by data hub owners and can thus provide an attractive alternative for suppliers already having or looking to establish presence in other countries. It is, however, a very complex setup with a huge risk when data related to different and potentially changing national market rules and regulations needs to be converted into four different rule sets and data formats. Overall, we conclude that the model introduces a high level of complexity and risk without providing benefits to customers given the competitiveness of the current markets.

The *common platform* will in addition introduce the possibility for achieving cost synergies for the data hub owners. Again, we find negative net benefits and potentially an even larger degree of complexity in implementation from a technical, organisational and political perspective. The

[13] The scope for our analysis has not been to make a detailed cost assessment and/or specific business case for implementing detailed interoperability models. Instead, it has been to provide an approximate picture of cost categories and estimated sizes and of cost distribution among market participants.

same conclusion as above applies: the model introduces net cost and increased complexity without providing benefits to the customers.

The *common market* is the most wide-ranging interoperability model, as it stipulates one Nordic data hub supported by one set of common Nordic market rules. It is therefore not just a technical solution but presupposes a large degree of harmonisation of rules and regulations. In a situation where rules and regulations in the Nordics are harmonised, it would be natural to consider a common Nordic data hub as this would be able to achieve significant operational cost synergies. It is also our finding that harmonised rules and regulations would be a much stronger driver for an integrated Nordic retail market than any data hub interoperability model.

However, the model will have a high net cost and introduce significant complexity and implementation risk which should be seen in the context of the relatively limited benefits achievable from an integrated Nordic market.

ANNEX 1: IT COST BREAK-DOWN

The annex describes the technical design, cost drivers and net cost build-up for each interoperability model.

7.1.2 Model 1 – Data sharing

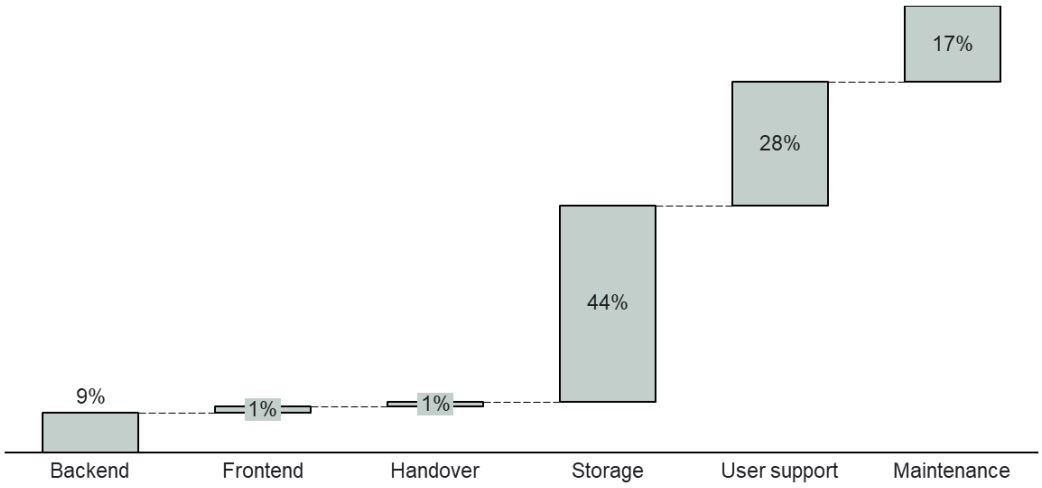
Model 1 is the establishment of an open data access solution, which will provide access to all approved and relevant third parties. This could provide the basis of third parties creating new services for consumers/prosumers. Examples could be advanced energy reporting, energy monitoring, energy management or optimisation purposes. The solution would enable innovative app developers, research institutions as well as all current market participants who could benefit from direct access to consumer data (granted pre-approval from end customers) as part of delivering add-on services. From the markets this will be seen as a value creating, optional enhancement to the current national markets. With one common interface for ~13 million users, this could make the Nordic energy market more attractive to global digital players and to international electricity suppliers. Notice that the model does not specifically address market entry barriers *between* the Nordic markets, but also *into* the Nordic markets.

Implementation of the model: A new common data sharing solution will be built in addition to the existing data hubs without having to modify the individual data hubs nor any need for suppliers or DSOs to modify their existing IT systems as only new ways of accessing the already existing data will be provided. The implementation phase (design, tender, development) is assumed to take 2 years. There will be one single entity appointed to undertake this additional new project and following operations. There will be integration work in the existing data hubs and the maintenance of integrations will be added to the tasks of current data hubs.

Cost elements: The implementation project will consist of the following elements (years 1 to 2): Design and tendering, development work of a backend that extracts and transforms data from the national data hubs into one common data model, development work building a frontend/API through which data users can access data. Finally, the solution and organisation must be prepared for going in production mode delivering reports and data insights.

The future operational cost elements (year 3 to 10): Ongoing storage consumption, frontend licenses, support to the users of the data sharing solution and maintaining the data sharing solution application.

Figure 19: High-level cost breakdown – model 1[14]



Benefit elements: There are no separate IT related benefits for this model pertaining to the data hubs, suppliers or DSOs.

Risk and model considerations: The core use case will touch upon new ways of providing third party access to data and govern ownership of energy data. Consequently, EU GDPR regulation, local data protection regulation, local consumer rights and local market regulation must be analysed in detail in a feasibility study for this model.

The model relies on data access to four highly complex data hubs with four individual data structures. Governance and maintenance of the solution is demanding, as changes in one hub will require modification of the solution. Complexity of the solution may increase over time with compounding of modifications.

7.1.3 Model 2 – Standard technical interfaces

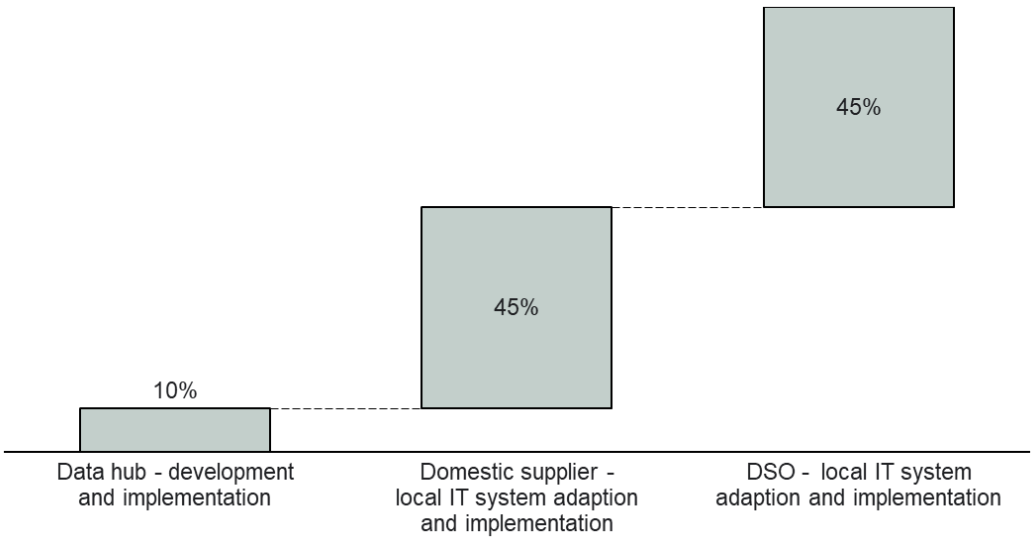
In model 2 the technical interfaces for data communication between market players and data hub are harmonised across all countries in order to arrive at a common set of standards for exchanging data and messages within all Nordic data hubs. These new standard technical interfaces will unlock synergies and potential cost savings for suppliers active in more than one country, as these suppliers will be able to reuse the data hub interface components across markets and simplify their IT portfolio, which will bring down a proportion of their operational IT costs of connecting to the data hubs. To minimise cost and complexity for the market participants the technical standardisation of interfaces must be kept at a level that will not require any harmonisation of local market rules, data models nor processes.

Implementation: Following a detailed feasibility study and decision, the new common set of technical interfaces and rules for data communication are established. The implementation will be executed over the next planned major releases of the local data hubs market by market. As the implementation is not interdependent between markets, this can be executed over a period of 3 years or more to allow for standards to be implemented during normal upgrades. As part of the implementation, the change processes across the four markets will need aligning.

[14] Benefits (~savings) are not displayed in the figure

Cost elements: The cost driver in model 2 is partly process of making new technical standard feasible in each data hub, which entails defining and agreeing on the new set of standards incl. dialogue with market. Furthermore, the standards new to implemented in each data hub. Looking at the suppliers and DSOs they need to make adaption and implementation in their local IT system to comply with the new standards. Currently there are some differences in the technical standards and protocols for data exchange between the Nordic markets, but the core principles of data communication are alike.

Figure 20: High-level cost breakdown – model 2[15]



Benefit elements: The largest benefit will be for the supplier active in more than one market, these will see a reduction in IT costs of maintaining IT systems, as core elements of their systems can be reused and replicated across markets. For all other market participants, there might be the benefit over time, that market for IT systems will expand across borders and therefore suppliers will see more, better and cheaper IT solutions to support their business. The data hubs will align their change processes towards the markets, which is a clear benefit if further technology and/or market integration is anticipated at a later point in time. The analysis does not include potential benefits from increased competition among IT vendors, as we see no clear indicators of lack of competition[16]; nor are potential benefits from shared data hub change coordination quantified.

Risk and model considerations: Technically, this is a low risk, low impact approach to standardising technical implementations across the four markets. This could be executed as a first step towards closer technology and/or market integration. The main risk element is related to the political and regulatory process of establishing a shared standard, which may not have priority in all of the four countries, TSOs and data hubs and which may lack a natural institutional owner and driver.

[15] Benefits (~savings) are not displayed in the figure

[16] One indicator of sufficient competition among IT vendors in the Nordic markets is low concentration. The survey respondents list about 15-20 vendors supplying IT systems to Nordic electricity suppliers.

7.1.4 Model 3 – Message broker

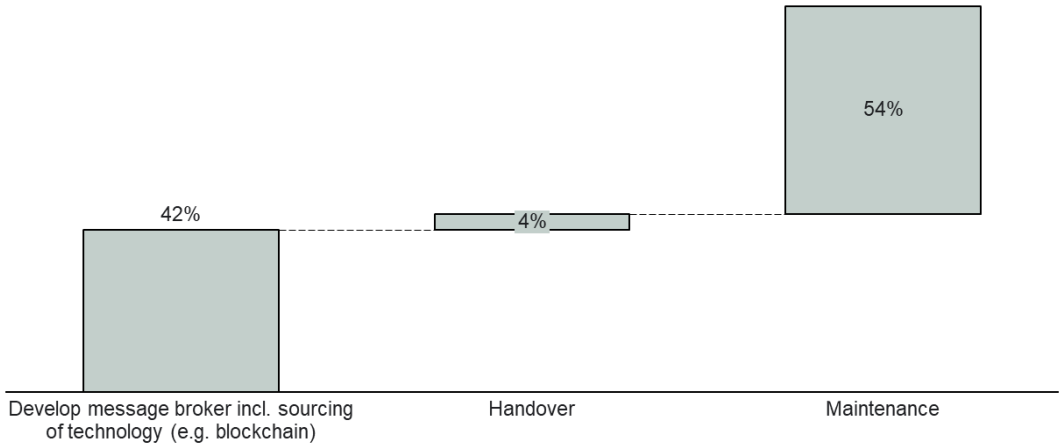
Model 3 entails implementation of functionality that enables the data hubs to convey messages and interact with one another without changing any interfaces between the data hubs in each country and suppliers and DSOs in the market. Suppliers and DSO will be able to continue using their existing IT systems, data models and interface to their local data hub.

The ambition is that the message broker will be able to translate the core processes and transactions needed for a supplier and a DSO to operate their billing and customer processes. Expectedly there will be grey areas with processes that are not fit for being translated from one set of market rules to another set of market rules. This may be cases of regulation far from the core processes of meter data exchange such as energy tax rules, liabilities, etc; cases where data formats cannot be translated from one process to another without risk of errors (for example substitution of customer ID with meter ID), or cases where variations in market rules will require specific processing for each market, such as variations in time limits for data uploads, timelines for notices to customers, etc. These exceptions would necessitate parallel processing of some per-country specific information.

Implementation of model: First part of the implementation (9-18 months) will be to execute an assessment of how many processes, and to which extend these processes can be translated between the different market models through a message broker. When the foundation is laid the design of translation schemas, data modelling and development work with relation to building a central message broker component can be carried out in a governance setup with close collaboration between data hubs and market participants to ensure testing against the market. The duration of the design and build process is estimated to 6-18 months. When the component is handed over to operations, the component is managed and maintained by the data hubs.

Cost elements: The effort of design, developing, testing and implementation of the message broker is significant cost driver in the model. The message broker technology and platform itself drives fairly low fraction of the cost, whereas the work that goes into the modelling and translation of processes between the countries is estimated to require a significant amount of internal and external hours (e.g. data modelling and market specialists). The application maintenance and operational work, incl. minor enhancements that goes into operating the message broker is also a significant cost element. It requires a high level of coordination between each data hub with relation to development road maps, change and release management as small changes in one local data hub can lead to considerable and critical incidents across several processes and with high impact for market players.

Figure 21: High-level cost breakdown – model 3[17]



Benefit elements: Given that message broker implementation is successful and enables transactions between the different markets through the local data hubs, the suppliers that are active in or expanding into more than one market will be able to benefit a great deal as they potentially would be able to use only one of their IT systems to support multiple markets. Already established players retire one of their IT systems over time and gain an operational saving of not having to operate more than one IT system and not having to make re-investments in more than one IT system. New entrants avoid the cost of acquiring and maintaining a new, market specific system. It is however anticipated that these inter-Nordic suppliers would have to extend and enhance their current IT systems.

Risk and model considerations: The potential of this model is high and so are the risks from data hub and market perspective. The message broker is simulating a common market enhanced by technology, but it requires deep process specialist and technical specialist knowledge to manage the translation logic and make sure that all schemas are translating as they should. Given the complexity of the processes, the volume of data and number of suppliers and DSO that take part in the ecosystem, there is a great risk in this model as even small local changes which are not implemented properly in the message broker can lead to major breakdowns and loss of data integrity. Governance of the model is critical, and no institution exists today with appropriate authority over data hub cooperation to ensure proper decision-making, stakeholder engagement and resources to ensure the safe operation of a market critical solution. Having said this, the model also holds a great opportunity to create more collaboration between the markets and ignite the dialogue around creating a shared catalogue of processes.

7.1.5 Model 4 – Common platform

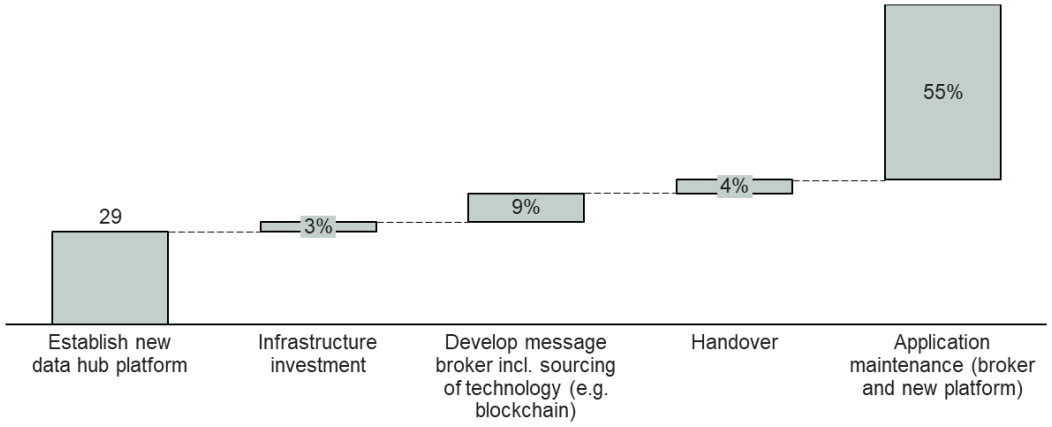
Model 4 is an evolutionary extension to model 3. In addition to establishing a message broker and new 'simulated' Nordic market language, a new common data hub application platform is developed to host the business and data model in each of the four data hubs as the market is still not harmonised. The major rationale for this model is the potential in the current IT platform cost for the four independent national data hubs to be consolidated into one single common IT platform, which could be operated at a significant lower running cost budget than the sum of the existing four individual IT platforms.

[17] Benefits (~savings) are not displayed in the figure

Implementation of model: It would make sense from an IT perspective to carry out the sourcing and development (12-24 months implementation perspective) of the new common platform, incl. transitioning and implementing each market/data model into the new platform before implementing the message broker functionality (6-18 months implementation perspective). The reason for this implementation being that the consolidation of platforms could lead to a reduction of the complexity of building the message brokers as an extension to each data hub.

Cost elements: In addition, the cost elements in model 3 related to establishment of the message broker, this model entails a significant investment into establishing the new common platform, which needs to be designed and built to be able to contain each of four data hub data and business models. Further, investments into infrastructure need to be made. The type of infrastructure investments will depend on whether this will be a pure cloud model or on-premise[18] platform. Model 4 estimations are based on an on-premise infrastructure.

Figure 22: High-level cost breakdown – model 4[19]



Benefit elements: As in model 3, the inter-Nordic suppliers are potentially to benefit greatly from the implementation of a message broker. On top of this model 4 could make it possible to unlock lasting cost savings of only having to operate one data hub platform and not four. As market rules remain unharmonised it will still be necessary to have specialised individual application support teams with deep knowledge about local regulation and processes, and who are able to support the data modelling work, when translating transactions from one data model to another

Risk and model considerations: The same risks and considerations mentioned in model 3 must be considered here. In addition to this model 4 could be an important step in creating a common market as the establishment and management of a shared technical platform – including the proper governance - would require an intensive dialogue, collaboration and actual close coordination between the four countries. A fundamental risk to this model is whether regulation in the Nordic markets will actually converge or diverge in the future. If a future convergence is expected, the risk of model 4 will decrease and vice versa if the Nordic markets are expected to develop along different routes the risk of model 4 might be prohibitive to selecting this model.

[18] Infrastructure (servers, software etc.) physically based in own datacenter

[19] Benefits (~savings) are not displayed in the figure

7.1.6 Model 5 – Common market

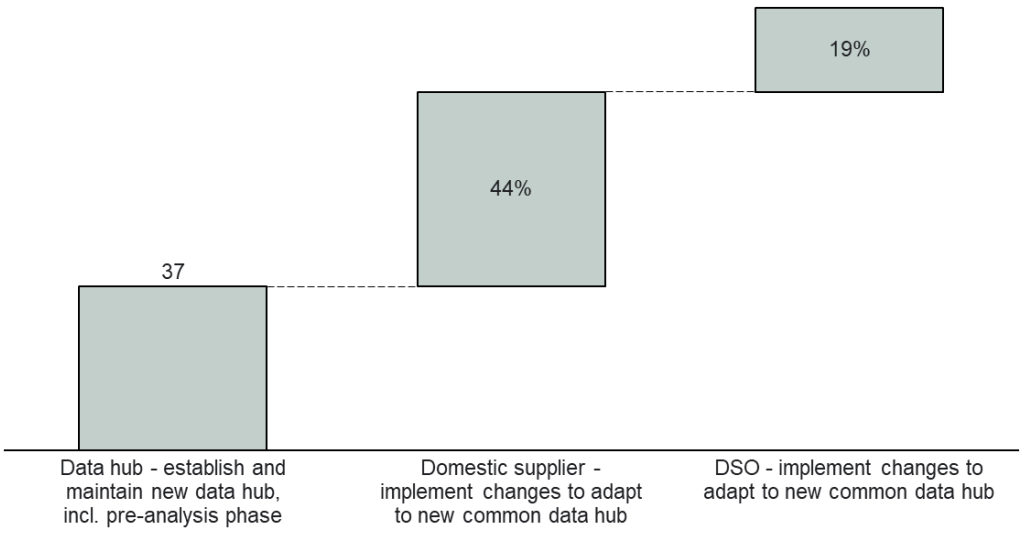
The common market solution implies full harmonisation of market rules and processes. Suppliers will be supported by one single data hub application serving the whole Nordic market based on common technical standards and consequently same interface.

Implementation of model: A prerequisite for implementing model 5 is the establishment of a common pan-Nordic regulatory framework, including time and effort needed to change and harmonise the regulation, on which a common market can be based. As an important first step after such regulatory harmonisation there will be a pre-analysis phase to translate the new common pan-Nordic regulatory framework into a common set of processes (6-12 months). This will be combined with a market dialogue phase to create the support and business and process foundation for building a common data hub (6-12 months). When the foundation is laid, the IT project starts with design and development of the new data hub application and handover to IT operations once the application has been tested and approved for production (12-24 months).

Cost elements: The largest cost driver in model 5 is the changes and adaptions that the suppliers and DSO' will need to make as a consequence of introducing a new data hub application. However, it must be factored in that the previous implementation of data hubs in all countries have already addressed some of the key cost drivers of introducing a data hub into the electricity retail market such as introduction of a supplier centric model and the physical separation of DSO and supplier IT systems to support the supplier centric market model. The significant historic cost incurred for both suppliers and DSOs of cleaning up and migrating data is therefore expected to be less expensive the second time.

Establishing the data hub application is a huge and complex IT project. The fact that the project (program) needs to be governed from four countries and is dependent on synchronised harmonisation of legislation and regulation in each country makes it very vulnerable to delays related to non-IT-related decision-making.

Figure 23: High-level cost breakdown – model 5[20]



Benefit elements: The domestic suppliers who are only operating in one Nordic country will not experience any benefit in relation to model 5. The suppliers who are active in more than one

[20] Benefits (~savings) are not displayed in the figure

market will – as in model 3 and 4 – be able to benefit a great deal from this as they would be able to operate in multiple Nordic countries and serve retail customers using only one IT system instead of one IT system per country. From a data hub perspective there are huge operational savings as full retirement of the local data hubs is possible once the new data hub application finally is put into production, and data has been migrated. The cost of operating one common data hub will be higher than operating one national data hub, and around the level of two existing according to experience of consolidation of other large transactional systems, which means that the cost saving potential is significant over time.

Risk and model considerations: The risk of model 5 relates to the time it will take to carry out and finalise a project of this size. The time and cost overruns from the national data hub implementations can be used as an indicator of the complexity of the task. However, the technical and stakeholder complexity is reduced by the fact that there is already experience with data hub implementation, and that supplier unbundling has already been implemented in the markets when the project is initiated.

The same risk related to inter-Nordic governance and dependence on national processes to harmonise legislation and regulation apply, only with higher complexity as the model requires a full harmonisation. If the project is dragged and does not show progress, there is a risk of the project losing support. It could seem as if the effort of establishing the data hubs in each country is wasted when are replaced by a new common platform, however, this should be weighed against the cost saving potential of not having to operate four similar platforms.

7.2 Cost modelling and data

Overall, we look at delta changes to the data hubs', suppliers' and DSOs' existing cost base meaning any change from a cost and/or benefit (savings) perspective introduced by the five conceptual archetype models.

By definition the *data sharing, message broker and common platform* do not cause additional IT cost for DSOs nor suppliers remaining active in only one market. These solutions only add IT cost for data hubs and suppliers operating across borders. The *common data format* model will have an impact on all IT systems exchanging data with the data hubs, and the *common market* model will cause fundamental changes to all those systems. For these solutions we have included IT costs across the population of suppliers and DSOs.

As a method for cost modelling, we have used ranges to indicate a low and high estimation point. The low estimation point represents a best-case scenario, where the archetype is implemented in a linear, non-complex fashion, with limited elements that add additional costs. On a contrary, the high estimation point represents a worst-case scenario, where implementation is complex and costly.

Assessment of data hub costs in the different conceptual archetype models is based on data from past data hub implementations in Denmark and implementation in Norway combined with information from interviews with industry experts with technical and commercial insights into the data hub setup. As Denmark was the first Nordic country to implement the data hub supported supplier centric model, additional information from consultation papers assessing the cost of the implementation is available and has been used as a reference for the cost estimates.

As a key driver for modelling cost and benefits to suppliers and DSOs is the number of market participants and their data hub interfaces in each market. The number of market participants is important because this gives an indication of the number of interfaces and IT systems, which potentially is affected by change in how these IT systems interact with the data hub. The magnitude of cost or benefit impact caused by a change will vary depending on size of the supplier and DSO as well as on maturity with relation to e.g. IT process and documentation. In

order to address this, we assessed and applied the average investment in internal and external man-hours needed to implement the changes that the respective archetypes introduce.

The estimations reflect a period of 10 years in which we have allocated project related costs to year 1–2, while operational costs are allocated from year 3 to 10.

7.2.1 Cost and benefits per player

Data hub costs are modelled with two input

Investment in each case is modelled bottom-up based on the development and implementation activities estimated to be necessary for safe introduction of the features of the model. The components of each model are described in detail in section 0.

Data hub benefits relate to savings from a consolidated rather than national operation as described in section 0.

The cost of the *common platform* and *common market* models are assessed using experience with previous and ongoing data hub implementations as a reference.

Based on the data and experience from IT implementation projects in general, the operating cost (recurring application maintenance cost after implementation) year 3-10 has been estimated to 15% (against best-case and worst-case initial investment/project cost for all models with the exception of the *standard technical interfaces* model which is assumed implemented as an enhancement to the existing applications and as such this does not introduce a delta change – low or high – to the existing cost base relation to maintaining the application.

The activities include pre-studies, consultations and other stakeholder engagement processes directly related to the development of the solution. The cost of other activities which are necessary for enabling a solution but are not naturally included in an implementation project is not included in the model. These activities include the political process to reach a joint Nordic decision on an interoperability solution, development of necessary legislation and secondary legislation, and the establishment of a relevant governance structure for the solution.

Benefits from data hub consolidation is assessed based on current data hub budgets using standard assumptions about the economies of scale as applied in M&A valuation processes (Implement benchmarks for consolidation of IT organisations processing similar transactions).

7.2.2 DSO-related cost

Costs for DSOs are mainly based on a bottom-up model describing the development activities and maintenance costs related to maintaining the new functionality.

The results are cross-referenced with evaluations of the cost of implementing the supplier-centric market model in Denmark. This source is used under the assumption that models based on the harmonisation of market rules will require reimplementation of IT systems; however, this implementation will be significantly less costly than the first implementation of the supplier-centric data hub-based market model.

The bottom-up components are listed in section 0. There are no net benefits on DSO cost in any of the models.

7.2.3 Net costs for suppliers

Some of the models will impose IT changes on suppliers, even if these have no intention to compete in more than one market. As for the above analyses, the cost is estimated based on a bottom-up IT cost estimate. As with DSOs, assessment of historical costs of implementation of the supplier-centric model is used as a reference, but under the assumption that re-

implementation of a system based on a similar market logic will drive significantly less cost than the original separation of DSO and supplier systems.

There are no net benefits on IT cost for locally oriented suppliers in any of the models.

Notice that the domestic suppliers will eventually bear much of the surplus cost of data hub operation in all models, as data hub cost is allocated to the users of the hub. We assume that the cost for introduction of data hub interoperability is passed on to all suppliers. If the data hubs were to charge a fee specifically for the use of cross-border functionality this would introduce a new market barrier and thus disincentivise inter-Nordic competition despite the purpose of doing the opposite.

Inter-Nordic suppliers will experience project and operating cost economies, as they can maintain one system with or without local adaptation (according to the model), rather than one system per country. See section 0.

7.2.4 Cost units and drivers

In order to model cost estimates across models and countries a number of key cost unit and cost drivers have been applied. These cost units are listed in the table below.

Table 11: Cost units and drivers

Unit description	Unit	Comment
Average internal FTE hourly price (cost price)	63 (€)	Based on Implement benchmark data
Average external FTE hourly price (cost price)	122 (€)	Based on Implement benchmark data
Average internal FTE cost price/year	100,750 (€)	Based on Implement benchmark data
Average external FTE cost price/year	195,000 (€)	Based on Implement benchmark data
Number of suppliers - DK (domestic)	43	Based on data from Nordic regulators
Number of suppliers - SE (domestic)	125	Based on data from Nordic regulators
Number of suppliers - NO (domestic)	118	Based on data from Nordic regulators
Number of suppliers - OY (domestic)	83	Based on data from Nordic regulators
Number of suppliers - DK (inter-Nordic)	2	Assumption that 5% of suppliers are inter-Nordic based on Implement questionnaire and market insight
Number of suppliers - SE (inter-Nordic)	5	Assumption that 5% of suppliers are inter-Nordic based on Implement questionnaire and market insight
Number of suppliers - NO (inter-Nordic)	5	Assumption that 5% of suppliers are inter-Nordic based on Implement questionnaire and market insight
Number of suppliers - OY (inter-Nordic)	4	Assumption that 5% of suppliers are inter-Nordic based on Implement questionnaire and market insight
Number of DSOs - DK	43	Based on data from Nordic regulators
Number of DSOs - SE	170	Based on data from Nordic regulators
Number of DSOs - NO	130	Based on data from Nordic regulators
Number of DSOs - OY	77	Based on data from Nordic regulators

ANNEX 2: DETAIL OF COST COMPONENTS PER COST ELEMENT AND MODEL

Model 1: Data sharing

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Data hub	Project cost	Development work building a backend that extracts and transforms data (ETL work) from the 4 data hubs into one common data model	Design and development of backend to data solution estimated to 130 kEUR per country	Design and development of backend to data solution estimated to 195 kEUR per country	One-time cost	€ 520,000	€ 780,000	Year 1-2	All 4 countries
Data hub	Project cost	Development work building a frontend through which data users can access and analyse data	Solution is dimensioned to 500 users. Assumption: yearly growth of 100 data users as solution is implemented. Approx. 85 EUR per license/user per year.	Solution is dimensioned to 500 users. Assumption: yearly growth of 100 data users as solution is implemented. Approx. 117 EUR per license/user per year.	One-time cost	€ 84,500	€ 117,000	Year 1-2	All 4 countries
Data hub	Project cost	Handover from project/development to operation	Estimated that effort to handover to operation will amount to 10% of initial project cost (backend and frontend - optimistic estimate)	Estimated that effort to handover to operation will amount to 10% of initial project cost (backend and frontend - pessimistic estimate)	One-time cost	€ 60,450	€ 89,700	Year 1-2	All 4 countries
Data hub	Operational cost	Running storage cost	Storage cost will increase as data volumes will increase over time (2 TB per country per month). Year 3-4: 130 kEUR each year Year 5-6: 260 KEUR each year Year 7-8: 390 kEUR each year Year 9-10: 520 kEUR each year	Storage cost will increase as data volumes will increase over time (2 TB per country per month). Year 3-4: 195 kEUR each year Year 5-6: 390 kEUR each year Year 7-8: 585 kEUR each year Year 9-10: 780 kEUR each year	Recurring cost	€ 2,600,000	€ 3,900,000	Year 3-10	All 4 countries
Data hub	Operational cost	Supporting the users of the data sharing solution, incl. Creating reports	Estimated that the need will be 0,5 fulltime internal FTE per country = 2 internal FTEs	Estimated that the need will be 0,75 fulltime internal FTE per country = 3 internal FTEs	Recurring cost	€ 1,612,000	€ 2,418,000	Year 3-10	All 4 countries
Data hub	Operational cost	Application maintenance and operation, incl. minor enhancements, user support/incident management, data management, documentation etc.	Estimated to be in the high range with other benchmarked data solutions - 20% of initial project investment (optimistic estimate)	Estimated to be in the high range with other benchmarked data solutions - 20% of initial project investment (pessimistic estimate)	Recurring cost	€ 967,200	€ 1,435,200	Year 3-10	All 4 countries

Model 2: Standard technical interfaces

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Data hub	Project cost	Development work on data hub side to agree and establish common technical standards and to make each data hub ready to support this through a technical implementation.	Estimated to 520 kEUR per country based on information about the cost of approx. 2,1 mEUR when implementing the 'Skemaændring' project in Denmark	Estimated to 780 kEUR per country based on information about the cost of approx. 3,12 mEUR when implementing the 'Skemaændring' project in Denmark	One-time cost	€ 2,080,000	€ 3,120,000	Year 1-2	All 4 countries
Domestic supplier	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per supplier (~43 domestic suppliers in Denmark)	320 hours per supplier (~43 domestic suppliers in Denmark)	One-time cost	€ 270,766	€ 866,450	Year 1-2	Denmark
Domestic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per IT vendor per supplier (~43 domestic suppliers in Denmark). Assumption: One IT vendor per supplier to execute IT change.	500 hours per IT vendor per supplier (~43 domestic suppliers in Denmark). Assumption: One IT vendor per supplier to execute IT change.	One-time cost	€ 786,094	€ 2,620,313	Year 1-2	Denmark
Domestic supplier	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per supplier (~125 domestic suppliers in Sweden)	320 hours per supplier (~125 domestic suppliers in Sweden)	One-time cost	€ 787,109	€ 866,450	Year 1-2	Sweden

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Domestic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per supplier (~125 domestic suppliers in Sweden). Assumption: One IT vendor per supplier to execute IT change.	500 hours per supplier (~125 domestic suppliers in Sweden). Assumption: One IT vendor per supplier to execute IT change.	One-time cost	€ 2,285,156	€ 2,620,313	Year 1-2	Sweden
Domestic supplier	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per supplier (~118 domestic suppliers in Norway)	320 hours per supplier (~118 domestic suppliers in Norway)	One-time cost	€ 743,031	€ 866,450	Year 1-2	Norway
Domestic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per supplier (~118 domestic suppliers in Norway). Assumption: One IT vendor per supplier to execute IT change.	500 hours per supplier (~118 domestic suppliers in Norway). Assumption: One IT vendor per supplier to execute IT change.	One-time cost	€ 2,157,188	€ 2,620,313	Year 1-2	Norway
Domestic supplier	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per supplier (~83 domestic suppliers in Finland).	320 hours per supplier (~83 domestic suppliers in Finland).	One-time cost	€ 522,641	€ 866,450	Year 1-2	Finland
Domestic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along	150 hours per supplier (~83 domestic suppliers in Finland). Assumption: One IT vendor per supplier to execute IT change.	500 hours per supplier (~83 domestic suppliers in Finland). Assumption: One IT vendor per supplier to execute IT change.	One-time cost	€ 1,517,344	€ 2,620,313	Year 1-2	Finland

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
		with deployment of change and update of relevant documentation libraries							
Inter-Nordic supplier	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per supplier (~2 inter-Nordic suppliers in Denmark)	320 hours per supplier (~2 inter-Nordic suppliers in Denmark)	One-time cost	€ 12,594	€ 40,300	Year 1-2	Denmark
Inter-Nordic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per supplier (~2 inter-Nordic suppliers in Denmark). Assumption: One IT vendor per supplier to execute IT change.	500 hours per supplier (~2 inter-Nordic suppliers in Denmark). Assumption: One IT vendor per supplier to execute IT change.	One-time cost	€ 36,563	€ 121,875	Year 1-2	Denmark
Inter-Nordic supplier	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per supplier (~5 inter-Nordic suppliers in Sweden)	320 hours per supplier (~5 inter-Nordic suppliers in Sweden)	One-time cost	€ 31,484	€ 100,750	Year 1-2	Sweden
Inter-Nordic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per supplier (~5 inter-Nordic suppliers in Sweden). Assumption: One IT vendor per supplier to execute IT change.	500 hours per supplier (~5 inter-Nordic suppliers in Sweden). Assumption: One IT vendor per supplier to execute IT change.	One-time cost	€ 91,406	€ 304,688	Year 1-2	Sweden

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Inter-Nordic supplier	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per supplier (~5 inter-Nordic suppliers in Norway)	320 hours per supplier (~5 inter-Nordic suppliers in Norway)	One-time cost	€ 31,484	€ 100,750	Year 1-2	Norway
Inter-Nordic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per supplier (~5 inter-Nordic suppliers in Norway). Assumption: One IT vendor per supplier to execute IT change.	500 hours per supplier (~5 inter-Nordic suppliers in Norway). Assumption: One IT vendor per supplier to execute IT change.	One-time cost	€ 91,406	€ 304,688	Year 1-2	Norway
Inter-Nordic supplier	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per supplier (~4 inter-Nordic suppliers in Finland)	320 hours per supplier (~4 inter-Nordic suppliers in Finland)	One-time cost	€ 25,188	€ 80,600	Year 1-2	Finland
Inter-Nordic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per supplier (~4 inter-Nordic suppliers in Finland). Assumption: One IT vendor per supplier to execute IT change.	500 hours per supplier (~4 inter-Nordic suppliers in Finland). Assumption: One IT vendor per supplier to execute IT change.	One-time cost	€ 73,125	€ 243,750	Year 1-2	Finland
Inter-Nordic supplier	Operational cost	Estimated OPEX cost saving of maintaining existing interfaces as the technical interface specifications are harmonised. This will apply for all suppliers with presence in more than one country and hence can gain	40 kEUR per interface	13 kEUR per interface	Recurring	- € 624,000	- € 208,000	Year 3-10	Denmark

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
		benefits of similar communication with data hub.							
Inter-Nordic supplier	Operational cost	Estimated OPEX cost saving of maintaining existing interfaces as the technical interface specifications are harmonised. This will apply for all suppliers with presence in more than one country and hence can gain benefits of similar communication with data hub.	40 kEUR per interface	13 kEUR per interface	Recurring	-€ 1,560,000	-€ 520,000	Year 3-10	Sweden
Inter-Nordic supplier	Operational cost	Estimated OPEX cost saving of maintaining existing interfaces as the technical interface specifications are harmonised. This will apply for all suppliers with presence in more than one country and hence can gain benefits of similar communication with data hub.	40 kEUR per interface	13 kEUR per interface	Recurring	-€ 1,560,000	-€ 520,000	Year 3-10	Norway
Inter-Nordic supplier	Operational cost	Estimated OPEX cost saving of maintaining existing interfaces as the technical interface specifications are harmonised. This will apply for all suppliers with presence in more than one country and hence can gain benefits of similar communication with data hub.	40 kEUR per interface	13 kEUR per interface	Recurring	-€ 1,248,000	-€ 416,000	Year 3-10	Finland
Inter-Nordic supplier	Operational cost	Estimated CAPEX cost saving of when making re-investment in new IT system after 4 years as harmonisation of technical interface specifications will enable that the supplier can reduce multiple interfaces to just one.	15% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	10% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	Recurring	-€ 290,160	-€ 193,440	Year 3-10	Denmark
Inter-Nordic supplier	Operational cost	Estimated CAPEX cost saving of when making re-investment in new IT system after 4 years as harmonisation of technical interface specifications will enable that the supplier can reduce multiple interfaces to just one.	15% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	10% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	Recurring	-€ 725,400	-€ 483,600	Year 3-10	Sweden

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Inter-Nordic supplier	Operational cost	Estimated CAPEX cost saving of when making re-investment in new IT system after 4 years as harmonisation of technical interface specifications will enable that the supplier can reduce multiple interfaces to just one.	15% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	10% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	Recurring	- € 725,400	- € 483,600	Year 3-10	Norway
Inter-Nordic supplier	Operational cost	Estimated CAPEX cost saving of when making re-investment in new IT system after 4 years as harmonisation of technical interface specifications will enable that the supplier can reduce multiple interfaces to just one.	15% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	10% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	Recurring	-€ 580,320	-€ 386,880	Year 3-10	Finland
DSO	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per DSO (~43 DSOs in Denmark).	320 hours per DSO (~43 DSOs in Denmark).	One-time cost	€ 270,766	€ 1,677,000	Year 1-2	Denmark
DSO	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per DSO (~43 DSOs in Denmark). Assumption: One IT vendor per DSO to execute IT change.	500 hours per DSO (~43 DSOs in Denmark). Assumption: One IT vendor per DSO to execute IT change.	One-time cost	€ 786,094	€ 2,620,313	Year 1-2	Denmark
DSO	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per DSO (~ 170 DSOs in Sweden).	320 hours per DSO (~ 170 DSOs in Sweden).	One-time cost	€ 1.070.469	€ 6.630.000	Year 1-2	Sweden

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
DSO	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per DSO (~ 170 DSOs in Sweden). Assumption: One IT vendor per DSO to execute IT change.	500 hours per DSO (~ 170 DSOs in Sweden). Assumption: One IT vendor per DSO to execute IT change.	One-time cost	€ 3.107.813	€ 10.359.375	Year 1-2	Sweden
DSO	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per DSO (~130 DSOs in Norway).	320 hours per DSO (~130 DSOs in Norway).	One-time cost	€ 818,594	€ 5,070,000	Year 1-2	Norway
DSO	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per DSO (~130 DSOs in Norway). Assumption: One IT vendor per DSO to execute IT change.	500 hours per DSO (~130 DSOs in Norway). Assumption: One IT vendor per DSO to execute IT change.	One-time cost	€ 2,376,563	€ 7,921,875	Year 1-2	Norway
DSO	Project cost	Internal development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	100 hours per DSO (~77 DSOs in Finland).	320 hours per DSO (~77 DSOs in Finland).	One-time cost	€ 484,859	€ 3,003,000	Year 1-2	Finland

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
DSO	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	150 hours per DSO (~77 DSOs in Finland). Assumption: One IT vendor per DSO to execute IT change.	500 hours per DSO (~77 DSOs in Finland). Assumption: One IT vendor per DSO to execute IT change.	One-time cost	€ 1,407,656	€ 4,692,188	Year 1-2	Finland

Model 3: Message broker

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Data hub	Project cost	Development work on data hub side to build message broker functionality / integration engine.	Estimated price tag of implementing one process is 585 kEUR (based on total 50 processes implemented i DK in data hub ver. 2 model with a total cost of 225 mDKK/~29,25 mEUR) 5 core processes. Implementation cost will decline from country to country due to increased efficiency and because work and code can be reused: 20% reduction from implementation to implementation	Estimated price tag of implementing one process is 975 kEUR (based on total 50 processes implemented i DK in data hub ver. 2 model with a total cost of 225 mDKK/~29,25 mEUR) 10 core processes Implementation cost will decline from country to country due to increased efficiency and because work and code can be reused: 20% reduction from implementation to implementation	One-time cost	€ 8,190,000	€ 27,300,000	Year 1-2	All 4 countries
Data hub	Project cost	Source and implement message broker technology solution (e.g. blockchain) to orchestrate algorithm	Estimated to 1,3 mEUR	Estimated to 1,95 mEUR	One-time cost	€ 1,300,000	€ 1,950,000	Year 1-2	All 4 countries
Data hub	Project cost	Handover from project/development to operation	Estimated effort to handover to operation will amount to 10% of initial project cost (optimistic estimate)	Estimated effort to handover to operation will amount to 10% of initial project cost (pessimistic estimate)	One-time cost	€ 949,000	€ 2,925,000	Year 1-2	All 4 countries
Data hub	Operational cost	Application maintenance and operation, incl. minor enhancements, user support/incident management, data management, documentation etc.	Estimated to 15% of initial investment/project cost (optimistic estimate)	Estimated to 15% of initial investment/project cost (pessimistic estimate)	Recurring cost	€ 12,526,800	€ 38,610,000	Year 3-10	All 4 countries
Inter-Nordic supplier	Operational cost	Estimated OPEX cost saving of being able to retire one application over time as message broker enable the use of one local platform to serve multiple Nordic countries.	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 1,071,070	-€ 856,856	Year 3-7	Denmark
Inter-Nordic supplier	Operational cost	Estimated OPEX cost saving of being able to retire one application over time as message broker enable the use of one local platform to	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,677,675	-€ 2,142,140	Year 3-7	Sweden

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
		serve multiple Nordic countries.							
Inter-Nordic supplier	Operational cost	Estimated OPEX cost saving of being able to retire one application over time as message broker enable the use of one local platform to serve multiple Nordic countries.	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,677,675	-€ 2,142,140	Year 3-7	Norway
Inter-Nordic supplier	Operational cost	Estimated OPEX cost saving of being able to retire one application over time as message broker enable the use of one local platform to serve multiple Nordic countries.	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,142,140	-€ 1,713,712	Year 3-7	Finland

Model 4: Common platform

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Data hub	Project cost	Sourcing and establishment of new common application platform, incl. Investment in hardware, servers and software licenses	Estimtated to same cost as implementation of Danish data hub version 2: 10% of 225 mDKK (~29,25 mEUR)	Estimated to same cost as implementation of Danish data hub version 2: 20% of 225 mDKK (~29,25 mEUR)	One-time cost	€ 2,925,000	€ 5,850,000	Year 1-2	All 4 countries
Data hub	Project cost	Development work of integrating the four separate data hubs into one platform, incl. Ensuring a seamless cohesion between the four data models, middleware, application and message broker	Estimated to same cost as implementation of Danish data hub version 2: 100% of 225 mDKK (~29,25 mEUR)	Estimated to same cost as implementation of Danish data hub version 2: 120% of 225 mDKK (~29,25 mEUR)	One-time cost	€ 29,250,000	€ 35,100,000	Year 1-2	All 4 countries
Data hub	Project cost	Development work on data hub side to build message broker functionality / integration engine.	Estimated price tag of implementing one process is 585 kEUR (based on total 50 processes implemented i DK in data hub ver. 2 model with a total cost of 225 mDKK/~29,25 mEUR) 5 core processes. Implementation cost will decline from country to country due to increased efficiency and because work and code can be reused: 20% reduction from implementation to implementation	Estimated price tag of implementing one process is 975 kEUR (based on total 50 processes implemented i DK in data hub ver. 2 model with a total cost of 225 mDKK/~29,25 mEUR) 10 core processes Implementation cost will decline from country to country due to increased efficiency and because work and code can be reused: 20% reduction from implementation to implementation	One-time cost	€ 8,190,000	€ 16,380,000	Year 1-2	All 4 countries
Data hub	Project cost	Source and implement message broker technology solution (e.g. blockchain) to orchestrate algorithm	Estimated to 1,3 mEUR	Estimated to 1,95 mEUR	One-time cost	€ 1,300,000	€ 1,950,000	Year 1-2	All 4 countries
Data hub	Project cost	Handover from project/development to operation	Estimated that effort to handover to operation will amount to 10% of initial project cost (optimistic estimate)	Estimated that effort to handover to operation will amount to 10% of initial project cost (pessimistic estimate)	One-time cost	€ 4,166,500	€ 5,928,000	Year 1-2	All 4 countries
Data hub	Operational cost	Application maintenance and operation, incl. minor enhancements, user support/incident management, data management, documentation etc..	Estimated to 15% of initial investment/project cost (optimistic estimate)	Estimated to 15% of initial investment/project cost (pessimistic estimate)	Recurring cost	€ 54,997,800	€ 78,249,600	Year 3-10	All 4 countries

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Data hub	Operational cost	OPEX saving of consolidating 4 data hubs into one common application platform	Estimated to 70% cost reduction of current infrastructure cost of operating a data hub (40% of total operational cost base per country - estimated to approx. 2,4 mEUR)	Estimated to 50% cost reduction of current infrastructure cost of operating a data hub (40% of total operational cost base per country - estimated to approx. 2,4 mEUR)	Recurring cost	-€ 51,996,672	-€ 37,140,480	Year 3-10	All 4 countries
Inter-Nordic Supplier	Operational cost	Estimated OPEX cost saving of being able to retire one application over time as message broker enable the use of one local platform to serve multiple Nordic countries.	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 1,071,070	-€ 856,856	Year 3-7	Denmark
Inter-Nordic Supplier	Operational cost	Estimated OPEX cost saving of being able to retire one application over time as message broker enable the use of one local platform to serve multiple Nordic countries.	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,677,675	-€ 2,142,140	Year 3-7	Sweden
Inter-Nordic Supplier	Operational cost	Estimated OPEX cost saving of being able to retire one application over time as message broker enable the use of one local platform to serve multiple Nordic countries.	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,677,675	-€ 2,142,140	Year 3-7	Norway
Inter-Nordic Supplier	Operational cost	Estimated OPEX cost saving of being able to retire one application over time as message broker enable the use of one local platform to serve multiple Nordic countries.	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,142,140	-€ 1,713,712	Year 3-7	Finland

Model 5: Common market

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Data hub	Project cost	Pre-analysis project/phase. Dialogue with key market stakeholders (suppliers, DSO, regulators in each country, IT service providers). Form strategy, business case, define common process/business requirements catalogue	120.000 man-hours, 50-50% split on internal and external hours	240.000 man-hours, 50-50% split on internal and external hours	One-time cost	€ 11,090,625	€ 22,181,250	Year 1-2	All 4 countries
Data hub	Project cost	Design, develop and implement new data hub	Able to reuse experience from existing implementations in the Nordics. Estimated total cost of establishing data hub would be 50% less expensive than the individual implementation of 4 data hubs, which is estimate to 13 mEUR	Able to reuse experience from existing implementations in the Nordics. Estimated total cost of establishing data hub would be 10% less expensive than the individual implementation of 4 data hubs, which is estimate to 13 mEUR	One-time cost	€ 26,000,000	€ 46,800,000	Year 1-2	All 4 countries
Data hub	Project cost	Handover from project/development to operation	Estimated that effort to handover to operation will amount to 10% of initial project cost (optimistic estimate)	Estimated that effort to handover to operation will amount to 10% of initial project cost (pessimistic estimate)	One-time cost	€ 2,600,000	€ 4,680,000	Year 1-2	All 4 countries
Data hub	Operational cost	Application maintenance and operation, incl. minor enhancements, user support/incident management, data management, documentation etc.	Estimated to 15% of initial investment/project cost (optimistic estimate)	Estimated to 15% of initial investment/project cost (pessimistic estimate)	Recurring cost	€ 34,320,000	€ 61,776,000	Year 3-10	All 4 countries
Data hub	Operational cost	OPEX saving of consolidating 4 data hubs into one common application platform	Estimated to 100% cost reduction of current infrastructure cost of operating a data hub (40% of total operational cost base per country - estimated to approx. 2,4 mEUR)	Estimated to 90% cost reduction of current infrastructure cost of operating a data hub (40% of total operational cost base per country - estimated to approx. 2,4 mEUR)	Recurring cost	-€ 74,280,960	-€ 66,852,864	Year 3-10	All 4 countries
Domestic supplier	Project cost	Internal development work on retail supplier side to implement new common market model, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1500 hours per supplier (~43 domestic suppliers in Denmark).	3000 hours per supplier (~43 domestic suppliers in Denmark).	One-time cost	€ 4,061,484	€ 8,122,969	Year 1-2	Denmark

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Domestic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1200 hours per supplier (~43 domestic suppliers in Denmark). Assumption: One IT vendor per supplier to execute IT change.	2000 hours per supplier (~43 domestic suppliers in Denmark). Assumption: One IT vendor per supplier to execute IT change	One-time cost	€ 6,288,750	€ 10,481,250	Year 1-2	Denmark
Domestic supplier	Project cost	Internal development work on retail supplier side to implement new common market model, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1500 hours per supplier (~125 domestic suppliers in Sweden).	3000 hours per supplier (~125 domestic suppliers in Sweden).	One-time cost	€ 11,806,641	€ 23,613,281	Year 1-2	Sweden
Domestic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1200 hours per supplier (~125 domestic suppliers in Sweden). Assumption: One IT vendor per supplier to execute IT change.	2000 hours per supplier (~125 domestic suppliers in Sweden). Assumption: One IT vendor per supplier to execute IT change	One-time cost	€ 18,281,250	€ 30,468,750	Year 1-2	Sweden
Domestic supplier	Project cost	Internal development work on retail supplier side to implement new common market model, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1500 hours per supplier (~118 domestic suppliers in Norway).	3000 hours per supplier (~118 domestic suppliers in Norway).	One-time cost	€ 11,145,469	€ 22,290,938	Year 1-2	Norway
Domestic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1200 hours per supplier (~118 domestic suppliers in Norway). Assumption: One IT vendor per supplier to execute IT change.	2000 hours per supplier (~118 domestic suppliers in Norway). Assumption: One IT vendor per supplier to execute IT change	One-time cost	€ 17,257,500	€ 28,762,500	Year 1-2	Norway

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Domestic supplier	Project cost	Internal development work on retail supplier side to implement new common market model, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1500 hours per supplier (~83 domestic suppliers in Finland).	3000 hours per supplier (~83 domestic suppliers in Finland).	One-time cost	€ 7,839,609	€ 15,679,219	Year 1-2	Finland
Domestic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1200 hours per supplier (~83 domestic suppliers in Finland). Assumption: One IT vendor per supplier to execute IT change.	2000 hours per supplier (~83 domestic suppliers in Finland). Assumption: One IT vendor per supplier to execute IT change	One-time cost	€ 12,138,750	€ 20,231,250	Year 1-2	Finland
Inter-Nordic supplier	Project cost	Internal development work on retail supplier side to implement new common market model, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1500 hours per supplier (~2 inter-Nordic suppliers in Denmark).	3000 hours per supplier (~2 inter-Nordic suppliers in Denmark).	One-time cost	€ 188,906	€ 731,250	Year 1-2	Denmark
Inter-Nordic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1200 hours per supplier (~2 inter-Nordic suppliers in Denmark). Assumption: One IT vendor per supplier to execute IT change.	2000 hours per supplier (~2 inter-Nordic suppliers in Denmark). Assumption: One IT vendor per supplier to execute IT change	One-time cost	€ 292,500	€ 487,500	Year 1-2	Denmark
Inter-Nordic supplier	Project cost	Internal development work on retail supplier side to implement new common market model, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1500 hours per supplier (~5 inter-Nordic suppliers in Sweden).	3000 hours per supplier (~5 inter-Nordic suppliers in Sweden).	One-time cost	€ 472,266	€ 1,828,125	Year 1-2	Sweden

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Inter-Nordic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1200 hours per supplier (~5 inter-Nordic suppliers in Sweden). Assumption: One IT vendor per supplier to execute IT change.	2000 hours per supplier (~5 inter-Nordic suppliers in Sweden). Assumption: One IT vendor per supplier to execute IT change	One-time cost	€ 731,250	€ 1,218,750	Year 1-2	Sweden
Inter-Nordic supplier	Project cost	Internal development work on retail supplier side to implement new common market model, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1500 hours per supplier (~5 inter-Nordic suppliers in Norway).	3000 hours per supplier (~5 inter-Nordic suppliers in Norway).	One-time cost	€ 472,266	€ 1,828,125	Year 1-2	Norway
Inter-Nordic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1200 hours per supplier (~5 inter-Nordic suppliers in Norway). Assumption: One IT vendor per supplier to execute IT change.	2000 hours per supplier (~5 inter-Nordic suppliers in Norway). Assumption: One IT vendor per supplier to execute IT change	One-time cost	€ 731,250	€ 1,218,750	Year 1-2	Norway
Inter-Nordic supplier	Project cost	Internal development work on retail supplier side to implement new common market model, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1500 hours per supplier (~4 inter-Nordic suppliers in Finland).	3000 hours per supplier (~4 inter-Nordic suppliers in Finland).	One-time cost	€ 377,813	€ 1,462,500	Year 1-2	Finland
Inter-Nordic supplier	Project cost	External development work on retail supplier side to implement new common technical standards, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	1200 hours per supplier (~4 inter-Nordic suppliers in Finland). Assumption: One IT vendor per supplier to execute IT change.	2000 hours per supplier (~4 inter-Nordic suppliers in Finland). Assumption: One IT vendor per supplier to execute IT change	One-time cost	€ 585,000	€ 975,000	Year 1-2	Finland
Inter-Nordic supplier	Operational cost	Assumption is that with a new common market and single Nordic data hub cross Nordic suppliers will be able to retire parts of their IT system portfolio and thereby their operational cost base	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 1,071,070	-€ 856,856	Year 3-7	Denmark

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
Inter-Nordic supplier	Operational cost	Assumption is that with a new common market and single Nordic data hub cross Nordic suppliers will be able to retire parts of their IT system portfolio and thereby their operational cost base	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,677,675	-€ 2,142,140	Year 3-7	Sweden
Inter-Nordic supplier	Operational cost	Assumption is that with a new common market and single Nordic data hub cross Nordic suppliers will be able to retire parts of their IT system portfolio and thereby their operational cost base	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,677,675	-€ 2,142,140	Year 3-7	Norway
Inter-Nordic supplier	Operational cost	Assumption is that with a new common market and single Nordic data hub cross Nordic suppliers will be able to retire parts of their IT system portfolio and thereby their operational cost base	Able to cut out 100% of operational fee (~107 kEUR) of existing application over 5 years	Able to cut out 80% of operational fee (~107 kEUR) of existing application over 5 years	One-time cost	-€ 2,142,140	-€ 1,713,712	Year 3-7	Finland
Inter-Nordic supplier	Operational cost	Estimated CAPEX cost saving of when making re-investment in new IT system after 4 years as harmonisation of market will enable that the supplier can refrain suppliers from making reinvestments in multiple IT system.	100% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	75% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	Recurring	-€ 1,934,400	-€ 1,450,800	Year 3-10	Denmark
Inter-Nordic supplier	Operational cost	Estimated CAPEX cost saving of when making re-investment in new IT system after 4 years as harmonisation of market will enable that the supplier can refrain suppliers from making reinvestments in multiple IT system.	100% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	75% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	Recurring	-€ 4,836,000	-€ 3,627,000	Year 3-10	Sweden
Inter-Nordic supplier	Operational cost	Estimated CAPEX cost saving of when making re-investment in new IT system after 4 years as harmonisation of market will enable that the supplier can refrain suppliers from making reinvestments in multiple IT system.	100% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	75% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	Recurring	-€ 4,836,000	-€ 3,627,000	Year 3-10	Norway
Inter-Nordic supplier	Operational cost	Estimated CAPEX cost saving of when making re-investment in new IT system after 4 years as harmonisation of market will enable that the supplier can refrain suppliers from making reinvestments in multiple IT system.	100% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	75% cost saving of initial IT system investment. Cost of establishing new IT system is estimated to 1 mEUR	Recurring	-€ 3,868,800	-€ 2,901,600	Year 3-10	Finland

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
DSO	Project cost	Internal development work on retail supplier side to adapt IT system to new common market and single Nordic data hub, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	500 hours per DSO (~43 DSOs in Denmark).	1.000 hours per DSO (~43 DSOs in Denmark).	One-time cost	€ 1,353,828	€ 2,707,656	Year 1-2	Denmark
DSO	Project cost	External development work on retail supplier side to adapt IT system to new common market and single Nordic data hub, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	600 hours per DSO (~43 DSOs in Denmark). Assumption: One IT vendor per DSO to execute IT change.	1.100 hours per DSO (~43 DSOs in Denmark). Assumption: One IT vendor per DSO to execute IT change.	One-time cost	€ 3,144,375	€ 5,764,688	Year 1-2	Denmark
DSO	Project cost	Internal development work on retail supplier side to adapt IT system to new common market and single Nordic data hub, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	500 hours per DSO (~ 170 DSOs in Sweden).	1.000 hours per DSO (~ 170 DSOs in Sweden).	One-time cost	€ 5.352.344	€ 10.704.688	Year 1-2	Sweden
DSO	Project cost	External development work on retail supplier side to adapt IT system to new common market and single Nordic data hub, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	600 hours per DSO (~ 170 DSOs in Sweden). Assumption: One IT vendor per DSO to execute IT change.	1.100 hours per DSO (~ 170 DSOs in Sweden). Assumption: One IT vendor per DSO to execute IT change.	One-time cost	€ 12.431.250	€ 22.790.625	Year 1-2	Sweden
DSO	Project cost	Internal development work on retail supplier side to adapt IT system to new common market and single Nordic data hub, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	500 hours per DSO (~130 DSOs in Norway).	1.000 hours per DSO (~130 DSOs in Norway).	One-time cost	€ 4,092,969	€ 8,185,938	Year 1-2	Norway

Entity	Cost item	Item description	Optimistic estimate description	Pessimistic estimate description	Type of cost	Total amount - optimistic	Total amount - pessimistic	Allocation of cost - year	Allocation of cost - country
DSO	Project cost	External development work on retail supplier side to adapt IT system to new common market and single Nordic data hub, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	600 hours per DSO (~130 DSOs in Norway). Assumption: One IT vendor per DSO to execute IT change.	1.100 hours per DSO (~130 DSOs in Norway). Assumption: One IT vendor per DSO to execute IT change.	One-time cost	€ 9,506,250	€ 17,428,125	Year 1-2	Norway
DSO	Project cost	Internal development work on retail supplier side to adapt IT system to new common market and single Nordic data hub, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	500 hours per DSO (~77 DSOs in Finland).	1.000 hours per DSO (~77 DSOs in Finland).	One-time cost	€ 2,424,297	€ 4,848,594	Year 1-2	Finland
DSO	Project cost	External development work on retail supplier side to adapt IT system to new common market and single Nordic data hub, incl. assessment of changes, plan and design change in local IT system, implement and test change along with deployment of change and update of relevant documentation libraries	600 hours per DSO (~77 DSOs in Finland). Assumption: One IT vendor per DSO to execute IT change.	1.100 hours per DSO (~77 DSOs in Finland). Assumption: One IT vendor per DSO to execute IT change.	One-time cost	€ 5,630,625	€ 10,322,813	Year 1-2	Finland

IMPLEMENT
CONSULTING GROUP_

IMPLEMENT CONSULTING GROUP
Strandvejen 54
2900 Hellerup, Denmark
implementconsultinggroup.dk

Phone: +45 4586 7900
Email: info@implement.dk

CVR 32767788
BANK 4845-3450018236
SWIFT DABADKKK
IBAN DK3030003450018236