Status report on regulatory aspects of demand side flexibility

NordREG
Nordic Energy Regulators

Contents

Introduction

The Nordic regulators recognize an increased focus on and interest in the topic of demand response both on a national, Nordic as well as a European level. The increased attention is driven by both a technological development, such as smart meters and load control devices, making it possible for the demand side to take a more active part in the market, combined with a general increase in the need for system flexibility related to the renewable transition facing both the Nordic and the European energy systems. In order to reach a more renewable electricity system in a cost efficient way, a more active and flexible demand side will play a vital role.

As a response to the increasing attention in the topic, NordREG decided to write this status report. The report aims to give a brief overview on some of the potential regulatory changes both in the EU legislation and at national level, accompanied with and overview of some relevant pilot project and research development which may affect the potential development of demand response in the Nordics.

In 2016 and 2017 NordREG is, in cooperation with Nordic Energy Research and the Nordic Council of Minister's Electricity Market Group, planning to commission two separate studies regarding demand side flexibility. The first study focuses on the flexibility from the DSO perspective, while the other study is a more general study concentrating on the regulators' actions regarding the development of demand side flexibility and possible regulatory improvements.

While demand side flexibility is receiving increased attention, NordREG believes, as a general principle, that the network regulation and market design should ensure utilization of the most cost efficient resources at all times, be it on the demand or the supply side. This implies that generation and demand should as far a possible be placed on equal footing. The overall aim would therefore be to ensure that this is realised.

1 Wholesale markets

1.1 Potential barriers

Though demand flexibility already plays an important role in the Nordic wholesale markets, the development may be regarded as relatively low comparted to its potential. This may partly be explained by a relatively low competitiveness compared to other types of flexibility stemming from the generation side, such as hydropower, but potentially also as a result of barriers preventing market access for demand side flexibility resources.

In order to ensure equal treatment and a cost efficient utilisation of all available resources, regulators should aim at identifying potential barriers, and design a regulation which facilitates an efficient market access for all resources, including the demand side.

This section aims to give a brief overview of some of the existing potential barriers in the wholesale market arrangement, and at the same time describe how these barriers can or will be tackled in the coming years.

1.1.1 Inefficient settlement solutions

A potential barrier for an efficient participation and utilisation of flexibility resources in the electricity markets, including demand response, is that the market participant is not settled based on metered values on a sufficiently high frequency, and further that the market time resolution of the wholesale markets is not at a sufficiently high frequency.

A settlement based on the market time resolution requires the investment in sufficient metering equipment, such as smart meters, in addition to a general settlement system which collects the meter data an allocates them accordingly to the market price signals.

Conversely, if the load is estimated based on profiles instead of actual metered values, the price signals and the corresponding response to these price signals will most likely not be correctly allocated and ensure an efficient demand response. At the moment there is divergence in the metering infrastructure in the Nordic countries. For instance, while all customers in Finland already have smart meters, this is still not the case for the other Nordic countries.

The imbalance settlement period (ISP) in the Nordic market is currently set to 60 minutes, and has served the historical needs well. At the same time, the electricity systems in Europe are changing and the Nordic region is no exception.

An ISP and a market time resolution of 60 minutes implies that the market results are adapted to 60 minute blocks, which does not necessarily reflect the physical production and consumption patterns and the scheduled exchanges between bidding zones. To limit the potential imbalances that result from the mismatch between the market results and the physical patterns, TSOs apply pre-emptive administrative requirements, such as various ramping restrictions for both generation and interconnectors, combined with the activation of balancing energy in real time.

Related to the development of the Electricity Balancing Guideline1, which is currently being developed, a coordinated European move towards a 15 minutes ISP has been discussed. Today, 8 EU Member States, consisting of Germany, Netherlands, Belgium, Luxembourg, Switzerland, Austria, Slovakia and Hungary already apply a 15 minutes ISP.

While a shift from a 60 minutes to a 15 minutes imbalance settlement period may reduce the overall structural imbalances of the system and reduce the need for ramping restrictions, a reduced imbalance settlement period may potentially also improve the potential for demand response participation. With shorter ISPs, the price signals in each ISP would to a higher degree reflect the status of the overall system and, subject to system security constraints, potentially enable automatization of implicit demand response as a direct response to these price signals.

1.1.2 Minimum bid size requirements

For the day-ahead and intraday market, the minimum bid size requirements are set at 0.1 MW. These can be considered relatively low and sufficient to allow the participation for most of those who consider entering into these two markets. For the balancing markets, on the other hand, the minimum bid size requirements may by some market participants, and especially the demand side, be considered too high and thus act as a barrier for their participation. As an example, the minimum bid size in the Nordic Regulating Power Market is 10 MW[2].

The minimum bid size requirements set by the TSOs may be a result of the TSO's historical needs, technical possibilities for market participants and the technical and practical organisation of the activation of orders at the TSO's control centres. As an example, the ordering of mFRR is still performed by phone from the TSO's control centres, which may serve as a practical barrier for TSOs potential to lower the minimum bid sizes, as the number of phone orders during the same time interval could be too high and cause coordination challenges.

The Nordic TSOs are currently carrying out pilot projects on electronic ordering of mFRR, which could ease some of the coordination challenges and potentially pave the way for a reduction of the minimum bid size requirements. Further, the upcoming Electricity Balancing Guideline prescribes in its latest public draft[3], that TSOs shall define standard products for electricity balancing for mFRR and aFRR within six months after entry into force of the Guideline, including minimum bid size requirements. TSOs have already started this work as an early implementation project, and in their latest draft proposal for standard products proposed a minimum bid size requirement of 1 MW for aFRR and mFRR.

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[1] http://www.acer.europa.eu/en/electricity/fg_and_network_codes/pages/balancing.aspx

[2] Except in SE4, where the bid size is 5 MW, and in Finland, where the bid size is 5 MW for bids with electronic activation.

[3] Version recommended by ACER 20 July 2015: http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Pages/Annexes-and-supporting-documents-to-the-ACER-Recommendation-03-2015-on-the-Network-Code-on-Electricity-Balancing.aspx

The Nordic regulators are closely following this work, and expect that the barriers of a too high minimum bid size requirements will be reduced within the next few years. At the same time, the Nordic regulators recognise that technical systems to ensure a safe system operation must be in place before the minimum bid size requirements are reduced.

1.1.3 Balancing product design

For certain demand response units, it can be assumed that the costs of adjusting the load, such as stopping a process in a factory or turning off the heating/cooling in a household, may have changing marginal costs as a function of time. Thus, the product duration and the frequency of activation may play an important role for the demand response units' costs of providing demand response.

One example of a product requirement, is the duration of the bid. E.g. in the Nordic regulating power market for mFRR, the units must be able to provide the power for up to 60 minutes. In practice, this may increase the overall costs of providing demand response, if the costs are rapidly increasing with time.

The product duration is also to a certain extent a result of the length of the ISP, as the TSO's need for regulating power is correlated with the duration of the ISP, while at the same time the order and prices of the common merit order lists could change from one ISP to another. By reducing the ISP to e.g. 15 minutes, it may also pave the way for a reduction of the product duration requirements of balancing energy.

Another example of the product design and the potential influence on demand side participation, is the possibility for demand response providers to define certain resting times between the different activations of the balancing energy bids, as the marginal costs may be increasing as a function of the frequency of each activation.

The product design is a complex issue, which must also take into account operational security concerns. The Nordic regulators are therefore closely following the work and discussions related to both the duration of the standard products for balancing energy in relation to the forthcoming Electricity Balancing Guideline, and the related discussions on harmonization of ISPs.

1.1.4 Locational information requirements

In the day ahead and intraday markets, bids are submitted at a bidding zone level. For the Nordic regulating power market on the other hand there are certain exemptions to this. E.g. in Norway, the Norwegian TSOs also requires that the bids are specified at station groups/node. The justification of this requirement is to ensure a more detailed overview of the system effects related to the activation of the bids, as well as to enable bids to be utilised for redispatching and countertrading purposes. In practice, these locational requirements may serve as barriers for aggregation of demand response.

The potential for aggregation of units in the balancing markets is a complex issue, which must also take into account operational security concerns. The Nordic regulators are closely following the work and discussions related both nationally and EU-wide in relation to the forthcoming Electricity Balancing Guideline, in order to gradually ensure that aggregation to a higher extent could be a viable tool to improve demand response, according to the requirements set in this guideline.

1.1.5 Pricing methodology for balancing capacity

In the procurement of balancing capacity, one may distinguish between pricing methods based on the pay-as-cleared scheme, so called marginal pricing, and a pay-as-bid scheme.

In a marginal pricing scheme, each market participant receives the clearing price of the merit order list. This ensures that each market participant receives the same price, and that they receive a profit consisting of the difference between the clearing price and their own marginal costs.

In a pay-as-bid scheme, on the other hand, market participants receive only the price of their own offer, with no additional profit. At the same time, the TSO would, as a single buyer, extract the producer surplus from the market participants.

In general, a pay-as-cleared pricing scheme should provide the most efficient long-term price signals to market participants, as the potential gains of investing in new equipment enabling participation in the market solutions would be larger, and at the same time driving the clearing price down. In a pay-as-bid scheme on the other hand, the TSO will extract this potential profit at the expense of the market participants. One may therefore regard that the existence of pay-as-bid pricing schemes could act as a barrier for the development of demand response.

1.1.6 Transparency of prices

Transparency of prices is important for all market actors, including the demand side. For market actors, especially those who consider investing in order to enter the market, knowledge about prices and potential future income may be decisive for their investment decision. At the same time, publishing individual bids in a non-aggregated level could also lead to market abuse when the number of participants in the market is low and market power exists.

The Nordic regulators are closely following the progress of the Electricity Balancing Guideline, which will set requirements for the publication of information of prices, to ensure a sufficient transparency, while at the same time avoiding the potential for market power abuse.

1.2 European development

As the development of regulations to an increasing extent is set at the European level and harmonised through network codes and Commission guidelines, the ongoing activities at the European level plays an increasingly important role.

This section aims to give an overview of some relevant development identified in the ongoing European processes, in relation to the potential for demand side flexibility.

1.2.1 CEER Flexibility Task Force

In the beginning of 2015, the Council of European Energy Regulators (CEER) established a Flexibility Task Force, in order to respond to questions regarding the role of demand side flexibility in Europe. They have so far produced two papers.

1.2.1.1 Scoping of Flexible Response

In May 2016, the CEER published a discussion paper, "Scoping of Flexible Response"[4] which highlighted the challenges of the integration of demand side flexibility in the electricity system. The main focus of this paper was on the market arrangements, by examining different arrangements in various segments of the market, with particular reference to wholesale markets (forward, day-ahead, intraday and balancing), ancillary services, capacity markets as well as network aspects. The paper reviewed the valuation of demand response as well as the necessary arrangements to facilitate flexibility, with the aim to create a common understanding of the topic among the member states and the different markets. Despite the substantial efforts, CEER found it challenging to define specific concepts and coherent understanding of demand side flexibility. The paper should thus be considered to provide information on the available solutions for flexibility and the specific national needs and circumstances. It was recognized that further work regarding the topic would be needed in the form of a more detailed policy paper.

1.2.1.2 Position Paper on Principles for Valuation of Flexibility

In July 2016, the CEER published a "Position Paper on Principles for valuation of flexibility"[5]. The paper had a special focus on regulatory arrangements for the participation of demand response. The aim was to provide a common understanding of obstacles and possibilities for increased flexibility while also contributing positively to any upcoming proposals affecting the regulatory framework. This paper agrees on a set of principles for introducing demand response in the markets, ranging from product requirements and market settlement to aggregation and information sharing. The paper also highlights the need to allow different measures for the different national markets due to the significant differences between them. Due to the varying characteristics of the different markets throughout Europe, it was concluded that one predefined and common EU-wide solution for the role of aggregation, was not seen as resulting in an advantageous outcome. Due to this, the paper recommends that the solution regarding demand response and aggregation should be tailored according to the principles specified in the paper, while also taking into account the market specific factors.

1.2.2 Electricity Balancing Guideline

The Electricity Balancing Guideline is currently in the comitology process, and is expected to enter into force sometime during the second half of 2017. Since the EB GL has not yet been approved, it is not possible to conclude on the exact outcome and how it will influence the potential for demand response.

The EB GL's target is to establish one integrated EU wide balancing market, where demand response providers are treated on equal terms as other providers of flexibility. For the development of demand response, the design of the European standard products for balancing energy, which is to be proposed by all TSOs, would be of high importance. Relevant characteristics of the standard products may be the minimum bid

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[4] http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Electricity/2016/C16-FTF-08-04_Scoping_FR-Discussion_paper_3-May-2016.pdf

[5] http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Electricity/2016/C16-FTF-09-03_Principles%20for%20Valuation%20of%20Flexibility.pdf

sizes, the duration, the full activation time, the possibility for resting time, the linking of upward and downward bids, etc. Another relevant aspect for the development of demand response may also be any harmonisation of imbalance settlement period, pricing rules imbalances and pricing rules for balancing energy.

The last publicly available version of the EB GL, is the ACER recommendation[6] from June 2015. Though there are still uncertainties regarding which requirements will be included in the final EB GL, ACER's recommendation contained the following requirements, which may be relevant for the development of demand response in the coming years:

- In the EB GL's preambles, it is underlined that the pricing method used in the procurement of Balancing Capacity and for each Standard Product of Balancing Energy shall strive for an economically efficient use of Demand Side Response and other Balancing resources subject to Operational Security limits
- The EB GL shall facilitate the participation of demand side response including aggregation facilities and energy storage, while ensuring they compete with other balancing services
- The national terms and conditions for balancing service providers shall allow the aggregation of demand facilities when appropriate to offer balancing services
- standard products for balancing capacity and balancing energy shall facilitate the participation of demand facility owners

The Nordic energy regulators are closely following the development of the EB GL through the relevant ACER working group.

1.2.3 System Operation Guideline

The System Operational Guideline (SO GL) received a positive vote in comitology 4 May 2016[7], and is expected to enter into force sometime early 2017.

The voted SO GL is merged from the three network codes *Operational Security*, *Operational Planning and Scheduling* and *Load Frequency Control and Reserves*. The first part on Operational Security, deals with the operational security of the interconnected Transmission Systems of Europe and is vital for the continuous and secure electricity supply of European citizens and for the functioning of the electricity market. The second part defines the minimum Operational Planning and Scheduling requirements for ensuring coherent and coordinated preparation of real-time operation of the transmission system applicable to all Transmission System Operators and Distribution System Operators as well as Significant Grid Users. The third part defines the principles for Load-Frequency Control and Active Power Reserves in terms of technical needs, while considering market solutions compatible and supporting to maintain the security

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[6] http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Pages/Annexes-and-supporting-documents-to-the-ACER-Recommendation-03-2015-on-the-Network-Code-on-Electricity-Balancing.aspx

[7] https://ec.europa.eu/energy/sites/ener/files/documents/SystemOperationGuideline%20final%28provisional%2904052016.pdf

of supply, for instance the technical requirements of Demand Side Response Active Power Control.

The Article 2.1.d of the voted SO GL states that: "The rules and requirements set out in this Regulation shall apply to the following Significant Grid Users: existing and new demand facilities, closed distribution systems and third parties if they provide demand response directly to the TSO in accordance with the criteria in Article 27 of Commission Regulation No [000/2015 DCC]." For Article 27 in DCC, please see below in 2.2.4.

This means that smaller consumers will not be affected by the code, since they most likely are not a Significant Grid User, nor providing demand response directly to the TSO.

Regarding flexibility in the DSOs network, and DSOs selling ancillary services to the TSO, the SO GL describes the relationship between the DSO and the TSO and affected data exchange (see for example Article 52 and 53) and communication and responsibilities (see for examples Article 55).

1.2.4 Demand Connection Code

The Demand Connection Code entered into force in September 2016[8].

The network code states in article 27 (27.1.a and 27.1.b) that the criteria's of demand response services provided to system operators are set based on the two categories: Remotely controlled and autonomously controlled. The categories referred to are not exclusive and the network code does not prevent other categories of demand response from being developed. The network code does not apply to demand response services provided to other entities than relevant system operators or relevant TSOs.

The network code sets out technical requirements for entities participating in demand response services to system operators:

- Article 28: Specific provisions for demand units with demand response active power control, reactive power control and transmission constraint management, for example to be capable of operation across the frequency and voltage ranges specified
- Article 29: Specific provisions for demand units with demand response system frequency control, for example to be capable of operation across the frequency and voltage ranges specified
- Article 30: Specific provisions for demand units with demand response very fast active power control, for example a change of active power related to a measure such as the rate-of-change-of-frequency

According to Preamble (8) of the network code "Demand response is an important instrument for increasing the flexibility of the internal energy market and for enabling optimal use of networks. It should be based on customers' actions or on their agreement for a third party to take action on their behalf. A demand facility owner or a closed distribution system operator ('CDSO') may offer demand response services to the market as well as to system operators for grid security. In the latter case, the demand

[8] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.223.01.0010.01.ENG&toc=OJ:L:2016:223:TOC

facility owner or the closed distribution system operator should ensure that new demand units used to provide such services fulfil the requirements set out in this Regulation, either individually or commonly as part of demand aggregation through a third party. In this regard, third parties have a key role in bringing together demand response capacities and can have the responsibility and obligation to ensure the reliability of those services, where those responsibilities are delegated by the demand facility owner and the closed distribution system operator."

The demand connection code set out supplementary requirements for demand units compared with today. Since the requirements are the same throughout Europe, these requirements cannot be regarded as hindering the development.

1.2.5 The 2016 Winter Package

30 November 2016, The European Commission announced the legislative package called "Clean Energy for All Europeans – unlocking Europe's growth potential", also known as the "Winter Package". This was EC's next step towards the implementation of the Energy Union.

The package consists of multiple proposals and strategies by the European Commission and include several relevant part regarding demand flexibility. The most relevant are proposals related to retail market principles, the future DSO role and DSO's use of flexibility, the role of aggregators, and other improvements of the market design in general.

The Nordic regulators will evaluate the proposal of the package and follow the process closely both at a national, Nordic and European level.

The information related to the "Clean Energy for All Europeans – unlocking Europe's growth potential", can be found at the web-page of the EC:

https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

1.3 Regional initiatives

This chapter gives a short overview of some regional regulatory initiatives dealing with demand response issues.

1.3.1 NordREG

In January 2015, the Nordic energy regulators (NordREG) established an ad hoc working group on demand response, as a response to a request from The Nordic Council of Ministers' Electricity Market Group (EMG) to evaluate the report "Demand response in the Nordic electricity market" by Thema Consulting, and consider potential needs for Nordic initiatives that require coordinated actions at ministry level. So far, the group has prepared two deliverables.

1.3.1.1 Memo on need for coordinated actions at ministry level

In August 2015, the assignment resulted in a memo to EMG, where NordREG concluded that the need for coordinated actions at ministry level will most likely be related to the various ongoing EU processes. Such coordinated actions could be related to promoting that the Nordic energy markets to a high degree already are well-functioning, to avoid implementation of measures that may be in conflict with already well-functioning solutions, and to promote that the Nordic region takes the next step to ensure that flexibility is efficiently included in the markets. As these EU processes at that time were, and still are, running, it was too early to state specific coordinated actions.

Further to that, NordREG also commented briefly to some of the recommendations from the report by Thema Consulting. The full memo is available at the NordREG web-page.[9]

1.3.1.2 Different arrangements for aggregation of demand response

During 2015, the NordREG analysed the potential consequences of different arrangements for aggregation of demand response, and published in February 2016 the paper "Discussion of different arrangements for aggregation of demand response in the Nordic market". This paper is available at the NordREG web-page.[10]

The main message from NordREG in the paper was that both implicit and explicit demand response should be able to develop within well-functioning and competitive markets, such as the Nordic retail markets, if consumers are willing to change their consumption pattern and if it provides a benefit for the consumers. To efficiently enable implicit demand response, NordREG believes it is necessary that the consumers are both metered and billed at the same resolution as the price signals. Further, the price signals should in some way reflect the scarcity of either capacity in the grid or in the electricity production. As smart metering is already installed or planned to be installed in the Nordic countries, and as the consumers are free to choose a contract with variable prices from a wide variety of suppliers, NordREG did in general not see any regulatory barriers for the development of implicit demand response in the Nordic retail markets.

With regards to the development of explicit demand response through aggregation, NordREG generally considered that this is most efficiently developed through retail market competition, where the suppliers/aggregators compete in providing the best "package" of supply and demand response services, while preserving the principle of one BRP per connection point.

Further, NordREG described some of the challenges with and consequences of models for the so-called "independent aggregators", which NordREG believes it is important that both stakeholders and MSs should be aware of. NordREG also underlined the importance of giving MS and/or NRAs the possibility to assess the consequences any of potential models, and have national freedom to decide on the most efficient instrument, given the national market situation. Thus, one common EU requirement to introduce "independent aggregators", was not recommended by NordREG. Instead, NordREG recommended that the focus of any EU legislation should be to allow demand response as a choice for all consumers, where "independent aggregators" is one possible option to reach this goal.

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[9] http://www.nordicenergyregulators.org/wp-content/uploads/2015/03/NordREG-Memo-to-EMG-on-demand-side-flexibility.pdf

[10] http://www.nordicenergyregulators.org/wp-content/uploads/2016/02/NordREG-Discussion-of-different-arrangements-for-aggregation-of-demand-response-in-the-Nordic-market.pdf

1.3.2 Other European regional initiatives

1.3.2.1 The Pentalateral Forum

The Pentalateral Energy Forum is the framework for regional cooperation in Central Western Europe. It was created in 2005 by Energy Ministers from Benelux countries, Austria, Germany and France (with Switzerland as a permanent observer) in order to promote collaboration on cross-border exchange of electricity.

In June 2016, the Pentalateral Energy Forum identified regional measures to remove barriers for flexibility[11.] These measures are that balancing responsibilities need to be strengthened and streamlining balancing arrangements is important. This could be to agree on the target of further integration of balancing markets', a more harmonised regulatory framework and to establish a roadmap for a further integration by end of 2016. Further, a growing consensus are reached on the need for harmonising (and shortening) lead times and product durations in the medium term for the alignment of cross-border intraday market arrangements and a roadmap developed until summer 2017.

In the SG 3 demand side response paper12 the Forum points out the main existing barriers to the development of demand side response and the path to reach desired solutions. The paper highlights the importance of scarcity price signals, the need to enable consumers to react to prices through implicit demand side response, the need for a clear market framework for explicit demand side response, the need for fair access for all players to the different markets and the ability of consumers to valorise their flexibility.

1.3.2.2 The Baake-initiative

The Baake-initiative is an ad hoc group created by Germany, and the other participants are Austria, Belgium, France, Luxembourg, the Netherlands and Switzerland. Later Sweden, Norway, Poland and Czech Republic was invited to an ad hoc group dealing with among others flexibility issues.

In July 2016, the Baake initiative arrived at a number of non-exhaustive, common views as regards removing flexibility barriers, partly as a comment to the Pentalateral Energy Forums paper from June 2016[13], which are the following:

- Barriers for flexibility in the market should as far as possible be removed to ensure a level playing field for all flexibility options. A fair competition between flexibility options both within and across participating states' borders will be key for contributing in a cost-efficient way.
- Intraday markets should be developed, as they will become an increasingly important platform for trading flexibility options. Harmonising and shortening of lead times and product durations in the medium term as an important condition

[11] http://www.benelux.int/files/9314/6882/8919/Penta_DGs_conclusions.pdf
[12]http://www.benelux.int/files/6614/6882/8921/PentaSG3_Technical_Background_Paper_Demand_Side_Response.pdf
[13] Unpublished paper from 6th of July, Berlin: Conclusions of the Electricity Neighbors on Flexibility Barriers in the Internal Energy Market

for the alignment of cross-border intraday market arrangements. Exploring the introduction of a “15-min intraday cross-border product” can be local pilot.

- Balancing markets should be developed, as they provide an efficient market-based correction of imbalances in the electricity system. Key elements is to ensure that balancing responsible parties fulfil their financial balancing responsibility and to foster the reduction of product duration in order to incentivise power producers to react on price signals in the Day-ahead and Intraday markets. Also providing non-discriminatory access for all actors. Clear balancing responsibilities for market actors are key and market actors should therefore be balancing responsible.
- In order to deploy and strengthen demand side response (DSR) focus should be on ensuring non-discriminatory market access of all players. This includes reducing barriers for DSR and flexibility service providers to participate in the different market segments.
- The upcoming EU-framework with regard to the role of flexibility service providers (aggregators) should include the right by each consumer to bring its flexibility to the markets (either via an independent aggregator or his own supplier) and the possibility for DSR to participate in all market segments in all time frames on a real level-playing field. They will work towards an exchange of best practice on reducing barriers for DSR and flexibility service providers to enter the short-term electricity markets.
- A flex-check is suggested, which is to analyse new and existing regulations, with the aim to minimise any negative impact on, and if possible increase, system flexibility. Non-binding flexibility checks will be used as a basis for an improved best practice exchange. View and best practices to be developed until summer 2017 with the first results available by summer 2018. National flexibility checks could be an analysis of the technically available flexibility potential in relation to costs and need, structure of grid tariffs and of fees and charges, regulatory disincentives for flexible operation of capacities and grid operator regulation.

1.4 Finnish activities

The changes in the energy system and hence the need to adjust the energy balance has emphasized the need for flexible resources. As a result, the Finnish regulator in cooperation with the universities, ministries and stakeholders have been in close interaction regarding DSF during the past years. Regardless of the fact that there is an increased need for flexibility, the amount of flexible resources available in the markets has been relatively low. However demand side flexibility already plays an important role in reserve markets. Due to this, the discussions have largely concentrated on finding the reasons for this as well as assessing if there is need for revising market conducts or contributing in some other way to increase the supply of flexibility regardless of whether it stems from the demand or supply side of electricity. The ongoing discussion is currently concerning the optimal solution for the market model of flexibility in Finland. The main issues consider the possibility of an independent aggregator to have a role in providing flexibility or not. Special attention has also been put in examining and enabling the participation of the private electricity end users in the markets.

The Finnish Ministry of Economic Affairs and Employment has recently launched a Smart Grid Task Force, which in short aims at advancing the adoption of smart grids, increasing flexibility and improving the security of supply facing the upcoming challenges regarding the changes in the electricity markets. This task force chaired by the Ministry includes also the Finnish Regulator, TSO and various other stakeholders and experts. The task force operates for two years, during which it aims at solving the upcoming problems and forming a vision for the future Smart Grid.

1.4.1 Market places for DSF

There are several market places for DSF in the current Finnish electricity market. The following table lists these as well as the estimated amount of flexibility currently available from that source. [14]:

Marketplace / Source of DSF	**Estimated amount**
Elspot Day-ahead	200-600 MW
Elbas Intraday	0-200 MW
Regulating power market and balancing capacity market, FRR-M	100-300 MW
Peak load reserve	10 MW
FRR-A (currently not procured)	0 MW
FCR-N	0,2 MW
FCR-D	100 MW

As can be seen in the table, the majority of current flexible resources stem from the day-ahead, intraday and regulating power or balancing capacity markets. At the same time, only a minority of the household end-users have flexible or adjustable contracts with their supplier, and a large portion of the flexibility can be expected to be the result of industry-level optimization. What this means is that substantial flexible resources that could be derived from the Finnish households that are presumably underutilized at the moment.

1.4.2 Some examples of DSF pilot projects

Regardless of the relatively low amount of flexibility in the markets, there is an assortment of different flexible products ranging from offerings tailored for industry usage to household electricity consumption optimization. The following is a concise listing of the products and pilots in operation at the moment in Finland the regulator has been made aware of.

[14] http://www.fingrid.fi/fi/sahkomarkkinat/Kysyntajousto/Sivut/default.aspx

There are some demand flexibility products offered on the market specifically aimed at commercial end-users of energy. For example Helen, a large energy company, is offering the possibility for large consumers of electricity to participate in demand response by allowing its consumption to be changed and optimized depending on the market situation. It should be noted that at the same time many of the large companies are themselves already optimizing their consumption according to the price level without having specific services for this. The significance of this kind of optimization can however be substantial for smaller companies, which otherwise would not have the resources to adjust their consumption according to the market situation. There was an aggregator pilot of freezer warehouse utilization for frequency containment reserve FCR-N, which is conducted as a joint study by SEAM and KWH Freeze. The target of the project was to find common practices for aggregation in the electricity markets. The project was based on controlling the load by linear basis using automation software. The load of the freezer is quite stable and the project started with 0,3 MW flexibility,. Being part of FCR-N reserve, it had no effect on normal usage.

Prisma, a major hypermarket chain in Finland conducted a pilot regarding DSF, in which seven individual stores participated in a project to find appropriate market places. The project was conducted by controlling devices like HVAC system, outdoor lightning and back-up power. The suitability of flexibility derived from the back-up power production was examined concerning the day-ahead and intraday as well as balancing markets, while flexibility derived from other sources was tested for FCR reserves.

A recent development has been that the Finnish households are for the first time participating in FCR-N market. The electricity consumption of the end users is optimized by Fortum.

The Finnish TSO Fingrid has recently started a new pilot project to study the participation of an independent third party aggregator participating in the reserve markets, as well as aggregating the reserve bid from flexible resources under multiple different balances. The current reserve markets allow aggregation only under one single balance and the provider of the reserve has to own the resource or be a retailer or BRP in the delivery chain. While this pilot concentrates on the ancillary markets, a similar study is planned for the balancing markets.

1.5 Danish activities

1.5.1 Overview

In principle it is today possible to bid in demand response bids in all the Danish electricity markets i.e. spot, intraday and all the balancing markets. However, the market design is designed to accommodate production units and not demand response units. As a result the current market design does not take into account any special regulation for demand response. The minimum bid sizes for the different markets can for instance be a barrier for allowing demand response to develop. For an overview of the bid sizes in the different markets in Denmark, see the figure below. For most of the markets it is possible to pool either demand or production resources so as to make it easier to reach the prevailing minimum bid size.

Market	DK1	Demand Pooling	DK2	Demand pooling
Day-ahead market	0,1 MW	Yes	0,1 MW	Yes
Intraday market	0,1 MW	Yes	0,1 MW	Yes
FCR/FCR-D/FCR-N	0,3	Yes	0,3	Yes
FRR-A	1 MW	Yes	NA	NA
Leveringsevne Kontrakter	1 MW	No	NA	NA
FRR-M	10 MW	Yes	10 MW	Yes

Energinet.dk has therefore teamed up with more than 20 energy companies, consumer organisations and government authorities, etc. to analyze current and future challenges, and to develop solutions to future-proof the electricity market. The project is called Market Model 2.0[15].

1.5.2 Projects

Energinet.dk has as a follow up on the Market Model 2.0 invited the market participants to participate in a pilot project to investigate how to accommodate demand response in a future market design.

The following topics are among others addressed in the projects:

- Baseline from consumption
- Verification
- Online measurement – onsite and from aggregator
- The use of the DataHub
- The use of sub-meters
- 3rd party aggregator's role in the market

[15] http://energinet.dk/EN/El/Engrosmarked/Ny%20markedsmodel/Sider/default.aspx

1.5.2.1 NUVVE/DTU: Parker Project

The Project[16] seeks to validate that electric vehicles, as part of an operational vehicle fleet, can be made to participate in advanced, vertically integrated, smart grid services i.e. frequency regulation services. Further the project should identify and remove barriers to 3rd party aggregation solutions for regulation services

The project is in the phase of testing and verifying 10 cars at Frederiksberg Forsyning. The electrical vehicles are today providing FCR-N through a BRP.

The project will continue until the summer 2017, where the scope of the project at that time would include approximately 40 vehicles. The project will afterwards be evaluated.

1.5.2.2 Insero & NeoGrid: Heat pump-project

The purpose of the project is to demonstrate the delivery of regulating power to balance the system from a pool of heat pumps, including the delivery of consumption data from a sub-meter to the DataHub for the purpose of billing. The project will develop first develop the setup for the aggregation, then to a series of demonstration and finally an evaluation in the summer 2017.

1.5.2.3 EnergyCool & EConGrid: Battery project

The purpose of the project is to the framework for baselines and online measurement for a distributed system of batteries delivering FRR-M.

The project will develop first develop the setup for the aggregation, then to a series of demonstration and finally an evaluation in the summer 2017.

1.5.2.4 Energi Danmark: Flexibility from industries

The purpose of the project is to test the framework for delivering flexibility from industries regarding to online measurements, baseline, pricing etc. The project will run in different phases which consist of setup up of software, test and evaluation.

1.5.3 Anticipated regulatory changes

If the pilot projects are a success, DERA will most likely receive a methodology application from Energinet.dk of the parts of the pilot projects that were successful. At this point DERA cannot conclude how and if the above mentioned projects will lead to new regulation.

At this moment there is one methodology application from Energinet.dk, which purpose is to loosen the requirement for measuring equipment of the fastest reserves – i.e. the FCR in DK1 and the FCR-D and FCR-N in DK2. This loosening would make demand response participation in these markets more feasible, as the investment in this specific measuring equipment would make the business case for demand response participation too expensive.

[16] http://energinet.dk/DA/El/Saadan-driver-vi-elsystemet/Dialog/Sider/Pilotprojekt-Nye-teknologier-paa-markedet.aspx

Besides the abovementioned loosening of the measurement requirement Energinet.dk has elaborated a bit on, which conclusions/ future challenges they already now seem to be able to get out of the pilot projects:

- In context of the abovementioned loosening of the measurement requirement, would it for example suffice having fewer than 10.000 measures for 10.000 electric cars? Could 1 measure for 10.000 electric cars be sufficient?
- As a result of Market Model 2.0 Energinet.dk and the Danish Energy Association has started a project to define the framework for aggregators in the Danish market. The project is considering how to make a more appealing business case for the aggregators by having several meters for instance one for the electric car, one for the freezer, one for etc. This could make it possible to solely bid in the electric car/freezer/etc. to the reserve markets, and not the entire household's consumption. Related questions would then be how many meters? Which demands should the meters live up to?

1.6 Norwegian activities

1.6.1 Pilot on flexible consumption in NO1

NO1 is the Norwegian bidding zone with the highest consumption, but at the same time lowest flexible production. In order to increase the availability of resources in the Regulating Power Market (mFRR) in NO1, Statnett will during January and February 2017 (week 1 -9) implement a pilot project with the aim to increase the RPM volumes in NO1 during these weeks, and at the same time gather information on whether one can develop permanent solutions to increase the RPM volumes.

The pilot contains two temporary exemptions from current requirements. First, actors can apply to participate with portfolio bidding at a larger geographical area than the station group/node, which is normally required. This applies for 10 MW bids. Second, actors offering flexible load through so called interruptible load contracts (ILCs) can apply to participate with the same load in the option market for mFRR (RKOM). The current requirements for the option market for mFRR prohibit such simultaneous participation. The exemption applies only for the pilot period and for a limited volume up to 50 MW per actor. Volume exceeding this limit will be evaluated separately.

More information of the pilot project can be found in the following document[17], available at Statnett's web-page.

1.6.2 Pilot on large scale load control from Regional Control Centre North

The pilot on large scale load control from the Regional Control Centre North (RCCN) is a part of the Statnett's research program on Smart Grids. The goal is be able to use demand side response to handle strained situations in the transmission grid. Tripping of lines combined with high load and long transmission distances are examples where DSR can prevent blackout of larger areas.

[17] http://www.statnett.no/Global/Dokumenter/Kraftsystemet/Markedsinformasjon/RKOM/Pr%c3%b8veordning%20med%20unntak%20for%20NO1%20i%20januar%20og%20februar%202017.pdf

The pilot project aims to access and control up to 300 individual consumer loads through smart grid solutions. The loads will be grouped under transmission grid nodes and electronically activated from RCCN. The response time for disconnection should be less than 2 minutes.

The expected impact of the project is to stimulate the development of smart grid concepts and give market actors an opportunity to interact and develop their roles connected to providing DSR services. Secure communication and applicability in grid operation are amongst the key features that will be evaluated. The results from the project may also provide inputs to market development and solutions.

1.7 Swedish activities

1.7.1 Strategic reserve

The Swedish bids to the Nordic Regulation Power Market are mainly from production, but for most of the hours there are also bids from demand side. The demand side volumes are about 10-20 MW. In addition demand side has been a part of the Swedish strategic reserve for almost 10 years. The volumes offered to the strategic reserve are about 860 MW and around 340 MW have been procured the last years. This potential of over 800 MW from demand side, today offered to the strategic reserve, could potentially be offered to other markets. However, in the other markets there is no capacity payment.

1.7.2 Demand Side Flexibility – on the agenda for the Energy Markets Inspectorate[18]

Sweden has during the last years been working with Demand Side Flexibility, DSF, discussing the possibility for the consumer to change the consumption as a response to the market price signal and/or to a system signal.

In 2016 Ei has three governmental tasks connected to flexibility:

- Increased demand side flexibility, see 2.7.2 below
- The Hub project, a centralised data management, see 2.7.4 below.
- The impact on the energy system with a higher amount of a renewable intermittent power production, see 2.7.3 and 3.6.3 below.

1.7.3 DSF in the Swedish System

Ei has a government assignment to investigate opportunities or conditions for and challenges related to improving energy market efficiency through increased customer activity and demand side flexibility. This task is scheduled to be completed by January 2017.

Ei’s assignment focuses on actions that can either be implemented in the market (day ahead, intraday and balancing) or are related to network tariffs that gives different market players incentives to take action and stimulate DSF. An increased DSF could contribute to avoiding situations of shortage of electricity in the system and to replace

[18] Energimarknadsinspektionen (Ei), www.ei.se

peak capacity production. This would also contribute to minimising the need for production from non-renewable sources.

During the assignment the Ei team has collected views and highlighted DSF from different perspectives through hearings and seminars.[19]

To find out more about different customers' willingness and ability to participate in DSF, Ei procured SWECO to undertake a survey of Swedish customer segments (industries etc.) through a questionnaire. The results were presented in a report "Elkunders möjlighet till flexibel elanvändning"[20] that was presented in May 2016.

In 2016 Ei published the report "Slopad schablonavräkning för timmätta kunder? Ei R2016:03"[21] where Ei suggest that the present, simplified settlement (for small consumers) is changed so that an agreement with hourly measurement can have an increased impact on the market. The basic criteria that need to be fulfilled to increase and have a full potential for demand side response is that the consumer have an hourly agreement and that the price sensitiveness of the consumer is part of the pricing.

In the spring of 2016 Ei presented 29 actions[22] within four areas regarding how to stimulate DSF and opened at the same time for stakeholders to comment on the proposals.

1.7.4 The impact of a higher amount of a variable power production

In addition, Ei has a government assignment to analyse the impact of an increasing share of variable power production on the profitability of the producers, the wholesale price and end-user prices.[23] This assignment is to be finalised 1st of December 2016.

An important part of the assignment is dedicated to simulating the profitability of producers depending on the sources of energy available in the system and how this impacts the incentives to invest in current and new power sources.

The simulations done within the assignment will give an indication of how prices and profitability of the producer depends on the amount of sun, wind and nuclear power in the future Swedish electricity system. In addition, both the average price of electricity over the day and year and also how many hours a year the price will be very high and very low will be presented. The calculations cover the time period to 2030. On the 21st of September there was a seminar about this assignment and information and data is available at Eis web[24].

[19] http://www.ei.se/sv/Projekt/Projekt/efterfrageflexibilitet-i-det-svenska-elsystemet/
[20] http://www.ei.se/Documents/Projekt/Efterfrageflexibilitet/Elkunders_mojlighet_till_flexibel_elanvandning_sweco_2016.pdf
[21] http://www.ei.se/Documents/Publikationer/rapporter_och_pm/Rapporter%202016/Ei_R2016_03.pdf
[22] http://www.ei.se/Documents/Projekt/Efterfrageflexibilitet/hearing_4_april/Ei_underlag_hearing_4_april_2016.pdf
[23] http://www.ei.se/sv/Projekt/Projekt/vilken-paverkan-har-en-okad-andel-variabel-elproduktion/
[24] http://www.ei.se/sv/Projekt/Projekt/vilken-paverkan-har-en-okad-andel-variabel-elproduktion/senaste-nytt/nu-kan-du-ta-del-av-materialet-infor-seminariet/

1.7.5 Projects within the responsibility of the TSO

The Swedish TSO, Svenska kraftnät, participates in the Nordic project for 2016 to investigate how a shorter settlement period can be introduced. The projects name is «Finer Time Resolution».

Svenska kraftnät are also developing the role of the Balance Service Provider (BSP). The role of the BSP is closely linked to the model of the aggregator.

Svenska kraftnät are also working with the hub as a government assignment. See also 3.6.3. They are responsible for: The processes, to do a process map and to define the roles and responsibilities. They will also have the responsibility to develop and operate the Hub. In June Svenska kraftnät published a report[25] regarding their work with the hub. Svenska kraftnät have gone through the processes that will be affected by the hub and a shift to a supplier centric model. This work will result in a number of process descriptions and a specification to be used as a basis for the procurement. The metrics are suggested to be stored centrally, to make it possible to have fast access to the data. This solution provides also a high level of cyber security. Experiences from other Nordic countries shows that it takes about 45 months to have a hub up and running. This time applied to Sweden could mean a hub up and running in late 2020. The question about which entity that should run the hub is not yet solved. The mission for the Nordic hubs are in the long run to pave way for a common Nordic retail market.

Svenska kraftnät plan to start a pilot in December 2016. One hundred households can volunteer to have their water heater to be aggregated as a product for FCR-N during two months. The aggregated demand will be centrally manged by an equipment placed at every unit. The purpose with the pilot is primarily to give input to the strategy that Svenska kraftnät are developing to enable demand side response as a resource for frequency containment and to evaluate if demand side response can meet the requirements for primary regulation.

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[25] http://www.svk.se/siteassets/aktorsportalen/elmarknad/utveckling-av-elmarknaden/hubben/rapporter/redovisning-av-vissa-fragor-ang.-tjanstehubbens-utformning-m.m.pdf

2 Retail markets

2.1 Potential barriers

This section aims to give a brief overview of some of these potential barriers for demand side flexibility in the retail markets, and at the same time describe how these barriers can or will be tackled in the coming years.

2.1.1 Choice for consumer to be exposed to time-of-use prices

In order for retail prices to enable an efficient demand response, the energy component should reflect the marginal generation costs of electricity, set in the wholesale market. Such retail contracts are often called time-of use contracts, where one example is the so-called spot price contract commonly used in the Nordic retail markets[26]. The availability of such contracts, at the choice of the consumers is vital in order to enable demand response, as consumers can be incentivised to change their consumption in respond to price signals provided through the contracts.

If consumers do not have the choice of such contracts, because they don't have access to hourly metering for example, or the consumers are uninformed about the possibility, it poses a potential barrier for demand side flexibility in retail markets.

2.1.2 Consumer's lack of information and knowledge

In order to enable demand response, it is necessary that the electricity consumers have sufficient knowledge regarding electricity usage and knows the potential for providing demand response. To take an active part in the market can be a complex issue and can thus be hard to comprehend for the average customer. Lack of knowledge can result in low interest in taking an active part in the market to provide flexibility.

These barriers can be partially overcome by designing flexibility products, which limit the end-user's participation to a minimum using automation. Special attention should also be given to increasing the knowledge about flexibility products available.

2.1.3 Availability of data and easy data access at consent of consumer

In the Nordic countries it is the DSO that is responsible for metering, and shares the metered information to the customer and/or supplier according to national requirements.

The availability of data is a key factor in order to be able to map customers' consumption patterns, to offer products that enable a smarter consumption of energy etc. Today the Nordic customer has access to data in different ways. The most common would be through a website that the customer can log into in order to see historic data and the data on which the bill is based.

With the establishment of national data hubs, all DSOs will report relevant data to the hub and the competitive stakeholders can access this data via a portal. The customer can then access the hub directly and/or via the suppliers' website.

[26] This is not the case for end customers in Denmark, this will be at latest implemented with the role out of the smart meter in 2020.

The Nordic recommendation is that the customer should be in control of the data. Therefore the customer should first of all know which stakeholder has access to the customers' data and secondly decide if the relevant party should have access to the data or not. More easy access of these data for the customer could act as an enabler for demand response.

2.1.4 Market access for energy service companies

In a NordREG report[27] Vaasa ETT was commissioned to identify barriers that electricity suppliers and energy service companies (ESCOs) face when entering the Nordic electricity markets.

For ESCOs, one identified barrier is that the markets for flexibility services are immature. This could hinder new solutions needed for demand side flexibility.

Further, the report describes a concern that there might be an un-level playing field in favour of integrated incumbents to new players who would like to provide energy services. The report states: "There is a lot of concern that DSOs are allowed to provide additional services, such as feedback, smart home and other services, either on their own or with their bundled supplier, that compete directly with the services of new entrants, unbundled suppliers or ESCOs." An un-level playing field is a barrier to the development of new and innovative energy services.

Smart metering systems with open interface makes competition easier for new entrants. Another technical solution is the usage of hubs with common processes, all metering data and all flexibility data gathered in one place.

2.2 Regional initiatives

NordREG's retail Market Working Group has developed harmonised Nordic recommendations for key processes such as moving, switching, meter data management and billing. These recommendations are now being implemented nationally, often in connection with the establishment of a hub. The work is now focussed on information exchange regarding the national hub-development, following the European development and providing best practices when relevant.

A centralised solution for metering-data makes for a one stop shop for competitive stakeholders to access relevant information. The information can be used to customize deals for energy supply contracts and/or for energy services. The hub also provides information for the customers that the customer can access via for example the suppliers' website. This makes it easier for the customer to gain access of the metering-data and enables the customer to better control of, and possibility to change, their energy usage.

2.3 Finnish activities

Regarding demand flexibility and the retail markets of electricity, the amount of Finnish activities are so far relatively low. There are however some products and projects, which do fall under this category. Please note that this list of projects should not be considered

[27] http://www.nordicenergyregulators.org/wp-content/uploads/2014/12/VaasaETT-Report-Market_Entry_Barriers.pdf

as a comprehensive cover of all activities. Instead, this represents the projects the Finnish NRA has been informed of and is currently aware of.

2.3.1 Flexibility products in the Finnish market

A Finnish company, OptiWatti, is offering flexibility solutions for the heating of domestic buildings. The system is based on optimizing the heating of individual rooms or spaces depending on the user´s needs, electricity prices and weather forecast. The system operates using multiple sensors, which the company installs in the building. The information obtained using these sensors is combined with the end-user´s preferences in a learning control system to optimize the usage. The user pays for installing and purchasing the devices (1000 -2000 € depending on the selected solution), after which the user pays an additional monthly fee of 5 € for the optimization, software etc. The amount of households participating is unknown, but presumably scarce (in the size range of 10 to 100).

There are also somewhat similar products offered by Fortum. The company installs additional equipment, which can be used for optimizing the usage of electricity remotely or depending on different notifications. The system is also able to alternate between oil and electrical heating depending on the electricity price.

As explained, there are some demand flexibility products available on the Finnish retail markets. The adoption of these products in use is however still quite low, possibly due to the low level of electricity prices.

In addition to the products mentioned, there is a growing number of electricity contracts based on hourly market prices. Currently the percentage of these contracts is somewhere around 10 %.

2.3.2 Datahub

The Ministry of Economic Affairs and Employment has commissioned the Finnish TSO, Fingrid, the task of establishing a central datahub for metering values and market processes in the Finnish electricity market. This Datahub will ensure effective storage and distribution of metering values and customer information between all market parties in the electricity market. The development of this kind of a plaform can be expected to increase the amount of flexibility products in the markets, as it enables more efficient data transfer for the future smart grid solutions.

2.4 Danish activities

2.4.1 Anticipated regulatory changes

In December 2014, the Electricity Regulation Committee published recommendations concerning changes of the regulation of the DSOs. The committee recommended higher transparency in the DSOs tariff setting. This has, to some degree, been met by the revised industry wide tariff model, including among others time-differentiated tariffs (time-of-use tariffs). Further the Danish government just recently published its strategy: “Supply for the future” in which an analysis of cost reflective tariffs is foreseen, among others analysing advantages and disadvantages of transition from primarily consumption-based payment to capacity-based payment.

2.4.2 The latest developments in market regulation

The so-called wholesale model was launched the 1st of April 2016. It does not change the general frame for promoting demand side flexibility, but does support the market development in general as well as concerning DSF.

According to the wholesale model the electricity retail suppliers became the central players on the electricity retail market. They buy electricity from an electricity exchange such as NordPool, from electricity wholesale traders or directly from electricity producers (whole sale market). The suppliers buy and bill the customer for grid services. Thus the suppliers sell "delivered electricity" to the consumers, i.e. including both supply and transportation of electricity, relevant taxes and duties, etc.

The suppliers are obliged to inform the consumer on his electricity consumption and its development. Consumers with remotely read meters receive information on their consumption and are billed four times a year, at the latest 2 months after a three month period.

2.4.3 The datahub

The information exchange according to the wholesalemodel is handled by the datahub. The datahub was launched 1st of March 2013 and the TSO, Energinet.dk, is responsible for establishing and handling the datahub.

All information about Danish electricity consumption is collected in the datahub, which also handles information about consumer and business processes such as relocation, change of supplier, etc. Thus the datahub handles all meetering data and business processes for the about 3.3 million Danish electricity consumers. The network companies submit metering data of a measuring point to the datahub which again will forward the information to the appropriate supplier, who then can settle the customer.

The players in the Danish electricity market are the primary users of the DataHub. The datahub serves as a communication platform on among others Danish energy consumption and ensures the companies the necessary information to bill customers. The players can communicate with DataHub through their own IT systems or via datahub Market Portal, a web-based access to the datahub.

The Danish electricity customers may also access their own data in the datahub via their electricity supplier or via "eloverblik.dk". The conditions for access to the datahub are set according to methodologies which again according to the Electricity Supply Act must be approved ex ante by the regulator.

2.4.4 Smart meters

The Danish government has decided a national roll out of smart meters by 2020, and Denmark has implemented smart meters for roughly half of its electricity customers.

The DSOs are responsible for the metering including the smart metering, i.e. covering purchasing, owning, installing, and replacing the metering equipment, as well as inspecting, maintaining, and reporting metering data to the parties (e.g. datahubs) within the electricity trading. Customers with regular meters are obliged to read the meter themselves. However, some suppliers read the regular meters by installing a small monitor nearby the meter.

The metering points shall be read at least once a year for the bills and upon changing suppliers, moving situations, or if the electricity supply is terminated. Hourly metering is mandatory for metering points (customers) with an annual consumption exceeding 100.000 kWh/year. For the customers without hourly metering due to consumption below 100.000 kWh/year, the initial costs and the operation costs of the metering system might - according to some DSOs - be too high compared to the potential benefits offered by hourly metering.

For customers without hourly metering one profile for each DSO is established. The metering points of these customers are included in one harmonised customer profile (template). This template will be calculated for each DSO on an hourly basis from the grid area's residual hourly consumption.

2.4.5 Information

As a result of the project Market Model 2.0 the Danish Energy Association has launched a project with the purpose of raising the information regarding the possibilities to provide DSR in the current market.

2.5 Norwegian activities

This section presents some of the ongoing activities related to demand side flexibility in the Norwegian retail market. Please note that this list of projects should not be considered as a comprehensive cover of all activities.

2.5.1 Smart meters

Regulation provided in spring 2013 demands a complete roll-out of smart meters in Norway by 2019. Exceptions can be granted for customers with a small and predictable consumption or if the meter installation causes a substantial and documented disadvantage for the customers. All DSOs have completed the procurement process and most of the DSOs have started the installation process to roll out smart meters. Approximately 2.5 million meters will be replaced.

Most of the current demand response services and providers in Norway are geared towards large customers, as they have had hourly metering since 2005. The roll out of smart meters can stimulate the industry to develop new innovative products and new business models for residential customers as well, supporting the further development of demand response.

Functional requirements include 60 minutes metering frequency (support at least 15 minutes frequency), measuring both output and input energy, disconnecting or limiting power output, connection to other metering equipment (gas, heat, water) and a standardized interface for communication with external equipment. The grid company has to provide the possibility to connect the meter with a display. The electricity supplier and DSO have to be able to send pricing information to the display.

If an open standardized interface for smart meter communication with external equipment (HAN-interface) is not defined, it will pose a barrier for further development of DSF services. Different suppliers can adopt different standards and solutions, resulting in a lack of interoperability. This would increase the investment and operating costs for DSF service providers. The market for DSF services will as a result be limited and develop more slowly. In collaboration with NEK[28], NVE have recommended a standard for the HAN-interface[29].

NVE and NEK are currently collaborating with the smart meter vendors and the industry to define the content of the data stream and its interval. This is important in order to ensure that the consumer can receive relevant consumption data close to real time. It is important that the smart meters have an interface which will evolve to support the new products that become available.

2.5.2 Elhub

NVE has commissioned the Norwegian TSO, Statnett, the task of establishing a central datahub for metering values and market processes in the Norwegian electricity market. Elhub will facilitate efficient use of smart metering by ensuring effective storage and distribution of metering values and customer information between all market parties in the electricity market. Measured values will be available to the customer and electricity supplier on the following day. With the consent of the customer, third parties can also extract data that is needed to implement a service for their end users.

By making data more available for system and marked needs, this can support the further development of DSR solutions. Together with price signals from the wholesale market, settlement based on hourly meter values (or even 15 minutes) can make it easier for new business models to emerge, promoting demand side flexibility. Elhub will be the central register of all meter values used for balance settlement, and possibly in the future for forecasting and profiling of flexible consumers.

Elhub will go live in October 2017. More information about the Norwegian datahub can be found on www.elhub.no.

2.5.3 Reports commissioned by NVE

2.5.3.1 Assessing the Potential of Energy Consumption Feedback in Norway (VaasaETT 2014)[30]

Research shows that information on actual energy consumption is one of the most effective measures to raise awareness of a customer's electricity consumption and motivate to save energy. NVE therefore commissioned a report from VaasaETT analysing the potential for residential energy savings in Norway resulting from energy consumption feedback.

VaasaETT analysed 91 samples from international feedback programmes, relating to over 30.000 energy consumers. Based on this analysis, VaasaETT found that Norwegian household customers could save at least 11 percent on average if effective feedback were applied. The addition of home automation could double the savings realised through feedback alone.

A detailed estimate of the true benefit from such feedback would require a comprehensive pilot study involving the implementation of a major feedback

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[28] Norwegian Electrotechnical Committee

[29] http://www.enova.no/upload_images/3C6882F6519248C2BA24B53E6A96A395.pdf – the report is in Norwegian, conclusions in English can be found in appendix B.

[30] http://webby.nve.no/publikasjoner/rapport/2014/rapport2014_72.pdf

programme. As a first step, however, it was important to identify from research around the world to-date, if savings realised through consumption feedback could be successfully achieved in Norway.

2.5.3.2 Ongoing Activities Focusing on Demand Response (THEMA Consulting Group, 2015)[31]

The report summarizes and compares a selection of ongoing activities focusing on demand response in Norway, both solutions already implemented in the market and different types of demonstration and research projects.

THEMA found that the largest volume of current demand response services and providers in the Norwegian market is geared towards consumers with annual consumption larger than 100 000 kWh. These consumers have had hourly metering and network tariffs that support dynamic pricing for several years. Where there are underlying flexibility in the consumption, and price signals make it profitable, flexibility are triggered.

THEMA further presents the various types of services and technologies offered in today's market, such as energy efficiency services, aggregator services, direct load control and dynamic pricing.

Ongoing Norwegian activities aimed at household customers are testing various aspects of demand response: the potential, different types of technology and the customer's reaction to feedback, different price signals and preferred technology for load control. THEMA provides a detailed description of four different demonstration projects and the preliminary results. Common for the activities was that the consumers did not understand the difference between energy and power. Hence, the observed load reduction was probably a result of a general reduction in consumption rather than the moving of loads in time.

THEMA believes that increased focus on the value of flexibility in the power system, both in the long and short term, should be emphasized in future activities. The main goal should be increased knowledge on how market design and regulation must develop to exploit demand response efficiently.

2.5.3.3 A Theoretical Approach to a Market Solution for Local Flexibility (THEMA Consulting Group, 2016)[32]

The report outlines important aspects that needs to be addressed when developing a possible market solution for local flexibility. It highlights i) what is needed in order for DSOs to consider local flexibility as an alternative to grid investments, ii) what different providers of flexibility can contribute with, and iii) how a market for local flexibility can be designed.

The analysis indicates that a market solution for local flexibility may emerge as an attractive alternative to grid investments in Norway, particularly where the increased capacity will have few full load hours.

[31] http://publikasjoner.nve.no/rapport/2015/rapport2015_07.pdf
[32] http://publikasjoner.nve.no/rapport/2016/rapport2016_38.pdf

In order for grid companies to see local flexibility as a real and effective alternative to grid investments, THEMA found that they must have a good overview of current and future capacity challenges in their grid, gain access to necessary flexibility resources at locations with capacity constraints, and be able to count on the availability of the resources when needed. Rollout of smart meters and new technology should improve the grid companies overview of actual power flows, and increase the ability to exploit flexibility sources among local consumers and generators.

Further, the analysis showed that both generation, storage and consumption probably have the potential to deliver a greater volume of flexibility services to the grid than they do today. THEMA believes the biggest barriers to the supply of local flexibility is complexity and uncertain profit opportunities. However, outlooks indicate that several of these barriers will decrease in the future as a result of new technology and the rollout of smart meters, developments which may also cater for as a basis for developing aggregator services.

Regarding implementation of a market solution for local flexibility, THEMA recommend a stepwise approach based on the current ILC[33]-scheme that includes local generation. This market based scheme would entail long-term contracts for disconnection of all or part of the flexibility suppliers' load. The flexibility suppliers would be compensated by a reservation price, and there would be no compensation for activation. The price of ILC-contracts would be determined through an auction process, so that it becomes clearer when it is cost-effective to use flexibility rather than to expand the grid capacity.

2.5.4 National pilots focusing on demand response

In 2015, the state-funded energy efficiency organization Enova, in collaboration with NVE, announced a contest where power suppliers could receive funding for pilots focusing on daily demand response. The project, named "Smart Meters – Smarter Consumption", shall demonstrate different technologies, services and business models for real-time electricity consumption feedback among household consumers[34].

Seven pilot projects was selected, located in various parts of Norway. They will commence in 2016 and run until the end of 2021. Over this six year period, the project will collect and analyse data on energy usage and customer experiences from a total of 25.000 households. The pilots will utilize smart metering, pricing based on the hourly spot price combined with a time of use network tariff and consumption feedback provided to the customers. Some of the pilots will also involve remote load control. The aim of the project is to provide increased knowledge on what motivates residential consumers to save energy and hopefully stimulate the industry to develop new innovative technology and services that the consumers can benefit from.

[33] Interruptible Load Contract
[34] https://www.enova.no/finansiering/naring/ny-teknologi/ams/981/0/ (only in Norwegian)

2.6 Swedish activities

2.6.1 Consumer interest in DSR

In 2014 Ei published a report by Professor Runar Brännlund and his team at the University of Umeå, Sweden. Ei had tasked the team with studying the question of the consumers' interest in DSR (Demand Side Response). The first report was titled "En elmarknad i förändring – Är kundernas flexibilitet till salu eller ens verklig?"[35] and discusses to what extent the consumer is flexible and how much the customer is willing to change their pattern of consumption. In May 2015 a second report from the team was published by Ei, "An electricity market in transition"[36]. This report looks closer at the flexible versus the inflexible customer, and the characteristics that define the flexible customer.

2.6.2 Smart meters

Smart meters were introduced in 2006. Many of the systems, and meters, currently used were installed in the years of 2006-2009 when monthly meter-reading became obligatory. This means that there is time to replace them in the near future. Ei has proposed that there should be functional requirements for the meters, and that the meter should:

1. Be equipped with an open, standardized interface that delivers real time information on power, aggregated consumption, voltage and, if relevant, production. The consumer is given access to this information.
2. For all phases meter voltage, current, energy and active and reactive power in both directions.
3. Allow remote reading of all metered data.
4. Register consumption with a frequency of 60 minutes. It should also be possible to change the registration frequency to 15 minutes.
5. Register and save information on any interruption longer than 3 minutes on one or several phases, including start and end time of the interruption.
6. Detect zero faults and automatically send alarm when these occurs.
7. Allow remote upgrading of software and settings.
8. Allow remote connection and disconnection of electricity supply.

An implementation of the second generation of smart meters could be expected to take place between 2017 and 2025.

2.6.3 Government assignment: The Hub

The government decided in late June this year to ask the Swedish TSO (Svenska kraftnät) to establish and run a national data hub, a centralised information centre for the

[35] http://www.ei.se/sv/Publikationer/Rapporter-och-PM/rapporter-2014/en-elmarknad-i-forandring-ar-kundernas-flexibilitet-till-salu-eller-ens-verklig/
[36] http://www.ei.se/sv/Publikationer/Rapporter-och-PM/rapporter-2015/an-electricity-market-in-transition-demand-flexibility-and-preference-heterogeneity/

electricity retail market, and gave Ei the task to set up the legal framework. The Swedish government also gave Ei the task to review its proposal on a legal framework for a supplier centric model and if needed align the proposals with the legal framework for the data hub as well as the joint Nordic Balancing Settlement procedure. The model should include combined billing, and the process for moving and switching, which should be carried out by the supplier. And the customer should receive information of its consumption and total costs from the supplier.

Through the implementation of a service hub the consumer will have further possibilities to become flexible and participate in DSF. When all information is gathered centrally it makes it easier for ESCOs (Energy Service Company) to offer services within for instance energy savings to the consumers.

A hub is basically a platform to centrally operate the processes and information exchange of the DSOs and suppliers, for example in relation to connection, moving, change of supplier or collection of metrics etc. A central hub makes it easier for companies to enter the market and it also contributes to a level playing field considering information accessibility. It will in short open the market for new ESCOs, incentivising new solutions so that the consumer can be more flexible.

The hub simplifies all processes needed for a supplier centric model and contributes to a more harmonised Nordic retail market. And with a supplier centric model together with a hub in place, the Swedish customer can expect better and faster service from the supplier.

Within this assignment Ei cooperates with Svenska kraftnät. In September 2015 Ei and Svenska kraftnät invited stakeholders to a seminar to discuss the hub as well as cooperation and working methods.

The assignment to Ei is divided in nine different projects such as processes, personal integrity, proxies and billing.

2.6.4 Pilots in Sweden

2.6.4.1 Smart Grid Gotland

Smart Grid Gotland is a development project with the aim to demonstrate how existing power networks can be modernised to integrate more renewable energy with maintained or improved electricity quality. The project is collaboration between Vattenfall, ABB, Gotlands Energi AB, Svenska Kraftnät, Schneider Electric and Royal Institute of Technology (KTH) and is partly funded by the Swedish Energy Agency.

In the sub-project “market test” the objective is to make it possible for customers to lower their electricity costs and thereby lower the system costs by active participation on the electricity market. In the market test the price is based on current wind power production on Gotland and announced to the customer by use of price signals. The customers will get an indication whether the price is high or low via a smart energy box and hence be able to affect the electricity cost by automated control. The evaluation period spans from winter 2013 to spring 2015 and the final results will be presented by the end of 2016.

2.6.4.2 The Stockholm Royal Seaport

The City of Stockholm has decided to make the Royal Seaport a hub for the development of Swedish environmental technology, in everything from housing to creating smart solutions for public transport and the use of energy. And by 2030 Stockholm Royal Seaport is supposed to be completely fossil free.

Fortum, Ericsson, ABB and Electrolux, together with KTH, are responsible for the research project Smart Energy in Stockholm Royal Seaport. The project is supported by the Swedish Energy Agency. As a part of the project is related to the energy-smart home and what it could look like. It includes new ways to inform customers about what kind of energy they're using, how it affects the environment and how much it costs and opportunities make active green choices, with the help of a smart communication system and smart plugs, thermostats and appliances.

2.6.4.3 Hyllie

The third large scale testing ground for smart grids and smart energy solutions in Sweden is the district of Hyllie in Malmö where a new urban area is under establishment. The city, E.ON and the municipal authority VA SYD have the ambition to turning Hyllie into the most climate-smart city district in the region and that its energy supply, at the latest in 2020, will consist of renewable or recycled energy entirely.

Hyllie will also become a testing ground for new solutions to help customers actively influence their energy consumption. Five constructors involved in Hyllie have for example received SEK 50 million in grants from the EU for a project called BuildSmart in which climate-smart solutions for ventilation, cooling and heating are to be tested. One of the visions in this is for the technology to visualize to the user how he himself can influence and route the energy consumption.

3 Demand response in distribution networks

3.1 Potential barriers

This section shall describe potential barriers for demand side flexibility in relation to the role of the DSO, which we all agree on.

3.1.1 Network tariffs

Network tariffs can, when well-designed, contribute to demand flexibility. With tariffs that reflect the network costs, network users can adjust their consumption accordingly.

Tariffs that are known to stimulate demand response and reflect the network cost are those with some element of time differentiation and those based on power consumption (kW vs. kWh), or a combination of these. The majority of DSO tariffs applied (in the Nordic countries) are volumetric tariffs with no time differentiation. This tariff design may incentivise energy efficiency, but seldom leads to demand response or flexibility. The tariff design may therefore be seen as a barrier to flexibility.

There are numerous reasons why cost-reflective tariffs that only stimulate demand response to a limited extent are used. Network companies are regulated monopolies and their allowed incomes are set by the NRA in the respective country. The way the allowed income or revenue cap is calculated, incentivises DSOs to operate differently. Today, the revenue cap calculations to a varying degree incentivise the DSOs to stimulate demand response by their customers, and DSOs may therefore have limited economic incentives to design tariffs with this aim.

An alternative way of achieving such tariffs is through more regulatory requirements on tariff design. In Sweden for example, the tariffs are designed by the DSOs with the only legal requirements that they are objective, non-discriminatory and compatible with efficient network usage.

3.1.2 DSO procurement of flexibility

DSOs can in principle use flexibility to delay or avoid network reinforcement, reduce technical losses, outage/fault management and manage constraints at an efficient cost. In order for DSOs to view flexibility as a real and effective alternative to grid investments, they must have a good overview of current and future congestion in their grid, have access to necessary flexibility resources at locations with capacity constraints and be able to count on the availability of the resources when needed.

Lack of knowledge about actual power flows and load on network components over time makes it difficult for DSOs' to predict where and how often capacity challenges may occur. Without this overview, investments in new grid capacity will be a more attractive alternative than using flexibility to handle constraints. This barrier may be reduced with the roll out of smart meters and new technology, as it will improve DSOs' knowledge and increase their ability to exploit flexibility. However, DSOs' demand for flexibility is dependent on an available and reliable supply of local resources. The lack of market models reflecting the real value of flexibility, where DSOs can procure reliable flexibility resources when and where they are needed, also pose a barrier for DSOs' use of flexibility. Further, in the development of such market models, it is important that neutrality issues related to the DSOs procurement of flexibility are assessed and managed. What these neutrality issues consist of and how they should be handled, needs to be investigated further.

3.2 European development

As the development of regulations to an increasing extent occurs at the European level and is harmonised through network codes and Commission guidelines, the ongoing activities at the European level plays an increasingly important role.

This section aims to give an overview of some relevant development identified from the ongoing European processes, in relation to the potential for demand side flexibility.

3.2.1 CEER / ACER DS WG

3.2.1.1 Conclusions Paper on the Future Role of DSOs

In the CEER Conclusions Paper on the Future Role of DSOs[37], published July 2015, new opportunities and challenges for DSOs are discussed. The report concludes that further regulatory measures will be needed if DSOs participate in areas outside their core responsibilities such as flexibility, energy efficiency and engagement with consumers. Following on from this work, CEER has decided to carry out further work and analysis on the following key topics; future DSO-TSO relationship, network tariffs, flexibility use at distribution level and incentive schemes. All these topics are to some extent related to flexibility issues.

3.2.1.2 Position paper on the future DSO and TSO relationship

In the CEER Position Paper on the Future DSO and DSO Relationship[38], published September 2016, the key aspects of the future DSO-TSO relationship for electricity and gas are analysed, including the advantages of taking an integrated approach to electricity, gas and heating sources, focusing on these questions in the context of flexibility. Existing Network Codes, Guidelines and other legislation lay out the foundations for the high level principles proposed in the paper.

The paper explores how the relationship and regulatory arrangements between DSOs and TSOs may need to evolve to ensure deployment of efficient system solutions (including use of flexibility resources) and defines the high-level principles that are necessary to deliver benefits to consumers. Overarching principles set the framework within which the more specific principles and approaches on governance, network planning and system operation are developed.

3.2.1.3 Best practice Guidelines on Distribution Network tariffs

In a first step, best practice guidelines will be developed in an internal CEER report. These guidelines will be further elaborated in a second step and published externally by the end of 2016 (this is a preliminary plan). The aim is to explore how different network tariff structures may be used to manage future distribution network challenges such as integration of embedded generation and increased self-consumption. The status of today, the need for change and principles of tariff design will be included in the paper. The benefits of different approaches to tariff design will also be analysed in the context of the challenges and opportunities facing the distribution networks in the future.

3.2.1.4 Best Practice Guidelines for Flexibility Use at Distribution Level

This is planned to be a public consultation document, which will be based on an initial literature review and experiences among CEER members.

The aim of the paper is to support NRAs on how to stimulate flexibility use by DSOs when it is most efficient, with minimal market distortion. Based on the principle that DSOs should be neutral market facilitators and at the same time minimise operation and construction costs to the benefit of consumers, guidelines on when DSOs should and

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[37] http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Cross-Sectoral/Tab1/C15-DSO-16-03_DSO%20Conclusions_13%20July%202015.pdf

[38] http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Cross-Sectoral/2016/C16-DS-26-04_DSO-TSO-relationship_PP_21-Sep-2016.pdf

should not use flexibility will be developed. The guidelines will among others include how DSOs should be allowed to act as purchasers of flexibility, advises in relation to engagement with customers/aggregators and how regulators can facilitate flexibility.

3.2.1.5 Best Practice Guidelines on Incentive Schemes for DSOs

In this work stream CEER will develop guidelines of good practice for incentive schemes used in the regulation of distribution network companies, in particular to encourage efficient innovation by DSOs in areas such as smart grids. Smart grid solutions enable costs to decrease, investments to be avoided, and an improvement in the quality of service. They also allow new challenges to be tackled, for instance the increase in distributed energy. Therefore, these developments have brought about new roles for distribution activities and, consequently, new goals for regulators. Given this, regulatory intervention may put a stronger emphasis on innovation, flexibility, the role of data, and transparency issues as well as on sustainability and in addition define new regulatory aims.

Initial thinking on these issues will be presented in a consultation document covering current regulatory approaches, changing needs, changing aims and changing approaches. However, as distribution activities in Europe are characterised by different realities, the consultation document and the proposed guidelines can be viewed in this perspective.

3.3 Finnish activities

The energy industry and research institutes in Finland have been very active in researching possibilities for demand response. The main purpose of the research has been to increase flexibility in the energy system and to figure out what kind of practical solutions are suitable for Finland and what kind of an impact they would have on the DSOs. There is also a recently established task force to evaluate the power tariffs.

The previous and ongoing studies have had various approaches to examining demand response. Some studies have focused on smart meter services in private customer interface enabling demand response or on the behaviour of small customers and how demand response would affect load profiling of small-scale customers. There are also studies focusing on DSO acting as an enabler of the electricity market by connecting small-scale production and demand response, as well as studies on distribution power tariffs and how they impact network or on electrical vehicles as a part of demand response.

The role of regulation has been studied in terms of demand response and the possible obstacles for demand response. The aggregation of small-scale active resources has also been one part of the ongoing research. Some studies go even further in the daily operations of the DSOs and observe how demand response could used as a part of the typical DSO activities such as voltage control of LV networks or development of AC microgrid where consumption would follow production.

There is a pilot project conducted by a Finnish DSO, in which they have developed a demand response platform which makes it possible for the suppliers to control small customers' loads. This platform is mainly developed for controlling heating loads. The same system is used also by few other DSOs.

There is also an another DSO pilot in cooperation with a research institute where they built a LVDC-distribution system and energy storages. In this pilot they used demand response to balance the production and consumption in the LVDC-system.

The Finnish Energy Authority is currently examining, whether there is need for regulatory changes regarding flexibility for instance regarding the possibility of a DSO to participate in providing demand response. The work is ongoing and the need for changes in the regulation will be investigated more thoroughly after the publication of the European Commission's "Winter Package".

3.4 Danish activities

With the wholesale model, as recently implemented, the DSOs bill the supplier, but they do not as such lose all consumer contact. They have maintained responsibility for connecting the consumers to the grid, including receiving payment for the grid connection, and they are responsible for metering the electricity.

As concerns pricing, the DSO's develop a model for calculating the tariffs according to the principles stipulated in the electricity supply act, i.e based on their costs and their revenue cap , recalling the principles of objectivity, transparency and non-discrimination. They bill the suppliers according to the model and as concerns grid connection they bill the consumer.

According to procedure the model is developed by the Danish Energy Association on behalf of the DSOs. DERA may accept the model after which the DSO's may apply for approval according to the model. DERA has, though, always the authority to require DSOs to modify their terms and conditions, including tariffs, if these are inconsistent with the electricity supply act. Each DSO may individually chose to use the model or alternatively develop their own individual model. Tariffs may only be charged by each individual DSO prior to DERA's approval of the model they chose.

A new tariff model was developed in 2015 by the Danish Energy Association. The model continues the so-called waterfall principle according to which the calculation is based on the costs related to the each group of consumers. The model allocates the allowed revenue to the cost drivers. By doing this, it ensures that a consumer at a low voltage level, e.g. 0,4 kV, pays for the use of the entire grid. A consumer on a higher voltage level, e.g. 50 kV, does not pay for maintenance of the 10 kV and 0,4 kV grid. The model hence ensures that the DSO tariff is based on the specific DSO grid, and the consumer category. The model also allocates costs created by a single consumer (e.g. metering) to the consumers that creates them.

Further the new model opens up for time-differentiated tariffs (time-of-use tariffs) for all groups of consumers and thereby creates a possibility for the market to utilize smart meters and DSF. So far, 30 of the current 61 DSOs set their tariffs according to the new model, and the tariffs are as such set more homogeneous across the country.

3.5 Norwegian activities

3.5.1 Status on DSO tariff design

The main objective of the Norwegian network regulation is to provide the basis for efficient electricity markets and efficient control of DSOs as natural monopolies. Network tariffs are set by DSOs according to principles set by NVE. In the current regulation, tariffs are designed, as far as possible, to give signals on efficient utilisation and development of the grid. Tariffs can be differentiated according to objective and verifiable criteria based on relevant grid conditions. Tariff design differs depending on what voltage level the customer is connected to.

By 1 January 2019, all electricity customers in Norway will have a smart meter. Smart meters will provide consumers with better information regarding installed and used capacity and prices, and facilitate opportunities for new tariff designs and new energy related services.

NVE has undertaken a public consultation[39] on possible changes to the regulation for setting network tariffs in the electricity distribution system for customers connected to the grid with a voltage of 22 kV or lower (the lower distribution system). The intention is to improve the utilisation of the network. Stakeholders generally support the need to make changes to the regulation. It is NVE's intention to provide clearer guidelines for how DSOs design tariffs, as well as to standardise how the methods for calculation of the settlement and settlement period are determined.

How the network tariff is designed is important for how the network is utilised and developed, but also for cost allocation amongst network users. A more effective, or smarter, network utilisation can reduce or postpone the need for future network investments, and provide lower electricity bills for users of the network overall. New technology leads to consumers having a more active approach to their energy usage and as such reduce their demand at specific periods while still maintaining the same comfort and user-friendliness. Whether or not consumers take advantage of these opportunities depends partly on how network tariffs are designed.

3.6 Swedish activities

3.6.1 Coordination Council and National Knowledge Platform for Smart Grids

In May 2012, the Swedish Government decided to appoint a Coordination Council and National Knowledge Platform for Smart Grids (ToR 2012:48). The Coordination Council's mission includes stimulating dialogue and cooperation, developing a national knowledge platform and a national action plan for the development of smart grids in Sweden from 2015 to 2030. This resulted in a "Forum för smarta nät", please see the web[40] , which is now placed at the Swedish Energy Agency.

The recommendations and proposals in the action plan have been divided into three main areas:

[39] http://publikasjoner.nve.no/rapport/2016/rapport2016_62.pdf
[40] http://swedishsmartgrid.se/

1. Political framework and market terms and conditions. The political framework should be developed in order to take advantage of the new possibilities that smart grids can offer while at the same time maintaining competition on the deregulated electricity market.

2. Customer participation and societal aspects. Several of the recommendations and proposals have a clear customer perspective, primarily focussing on the pre-conditions and need for initiatives that support customers linked to the new opportunities for active participation that smart grids provide.

3. R&D, innovation and growth. How Sweden can benefit from the development of smart grids in the best possible way and create the conditions for smart grids to develop into a Swedish growth industry.

There are a number of reports written within this work, see Publications at the web.

3.6.2 Preliminary result from ongoing governmental assignment

As part of Ei's ongoing government assignment on how to promote demand response, the role of DSOs is emphasised. In the section on how DSOs can promote and enable demand response, three areas are identified as significant.

The first is tariff design where a number of tariffs have been raised as particularly suitable to promote demand response. These are time differentiated tariffs and power based tariffs. The second area is explicit demand response or load steering, where the emphasis has been on ensuring fair compensation for customers who contribute to cost reductions on the network through their consumption. The third area is information and data sharing, related both to DSOs role in communication their tariffs clearly and providing customers with access to their own meter data. Since the DSOs own the meters in Sweden, they play a role in both metering and making the data available to interested parties who are entitled to it.

When it comes to tariffs, already today there are numerous examples of DSOs with tariffs which actively contribute to demand response. These are generally time differentiated, and based on either energy or power consumption. Some DSOs offer these tariffs as a complement to their standard, generally energy-based tariffs, whereas others offer them as their only tariffs. The Swedish energy association "Energiföretagen Sverige" have a dialogue with their member DSOs about a standardised tariff design to promote demand response, but the work has not yet been made available to the public[41].

[41] http://www.svenskenergi.se/Vi-arbetar-med/Regional-verksamhet/Regionalt-kalendarium/Lista/N/Dialogmote-om-Tariffstrukturer-i-framtiden/