# Recommendations on Common Nordic Metering Methods

Report 2/2014

# Common Nordic Metering Methods

**Report 2/2014**

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# Preface

The Nordic Energy Regulators (NordREG) have for several years been promoting the idea of a harmonised Nordic electricity market. This includes both the wholesale and the retail markets. The work is supported by the Nordic ministers for energy to create harmonised Nordic solutions to for the retail markets.

One of NordREG tasks has been to further elaborate on the introduction of automatic meter readning (AMR) in the Nordic countries and review national AMR requirements and their impacts on a common Nordic end user market. This work carried out by the project team has resulted in this report.

In order to get input NordREG sent a draft version of this report in September 2013 to stakeholders (the input team of the NordREG Metering Task Force including the nordic TSOs, representatives of nordic DSOs and the nordic regulators). A public hearing was also organised by the project team.

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# Summary

The purpose of this report is to contribute to a lowering of the barriers for establishing a harmonised Nordic end-user market by analysing the introduction of automatic meter reading (AMR) in the Nordic countries. While considering the future end-user model, the existing and planned national AMR requirements and their impacts on a harmonisedNordic end user market need to be taken into consideration.

The EU is strongly aiming towards the roll-out of smart metering in all member states. NordREG has expressed a target of introducing automatic meter reading (AMRs AMR) in the Nordic region as extensively as possible, if it is determined that the socio-economic benefits outweigh the costs. However, when to implement the AMRs is a questions of national concern.

The equal treatment of suppliers and customers in the harmonised Nordic end-user market is crucial and the recommended model should not require that suppliers should have costly parallel system solutions to handle recommended metering methods. When taking into account that the profit from electricity supply in the case of a small consumer is not high, investments in and operation of two or more parallel systems to handle different metering methods will increase the market players system costs. Thus, a combination of various metering methods can be an entry barrier for some suppliers while it also may give an advantage for large suppliers already operating in several countries because of a greater volume of customers.

NordREG issues the following recommendations:

Metering method: Automatic meter reading should be implemented in all four Nordic countries for all of the customers[1] to facilitate effective and functioning Nordic retail market. Time frame for implementation shall be decided nationally.

Meter capabilities: Meters should be capable to register energy usage at least on an hourly basis. However the time frame for implementation should be decided on a national basis. For cost reasons it could be allowed nationally to make an exception in the hourly metering requirement in cases when electricity consumption at the consumption point can be estimated exactly, meaning that the consumption is time-wise constant (e.g. combustion gas fans, automatic traffic control cameras, single traffic lights, street lights etc.).

Meter reading frequency: Meter reading should be done daily[2]. For customer with low consumtion, the meter reading frequency could be decided upon nationally according to e.g. a cost-benefit assessment. The meter reading frequency should be in compliance with the time limit decided for the balance settlement period so that verified consumption data is used.

[1] except for clearly defined customer groups based on the results of CBA

[2] except for clearly defined customer groups based on the results of CBA

NordREG finds that it would be beneficial to continue working toward future harmonised metering functionalities. Other metering method related issues such as harmonised rules for correction of metered data may be areas to be further considered by NordREG when planning future activites.

# 1 Background

## 1.1 Harmonised Nordic end user market

During 2012 NordREG focused on the work towards a common Nordic retail market. By doing this, the Nordic region once more is a pioneer for connecting electricity retail markets across borders. The common harmonised Nordic end user market is anticipated to bring benefits for all stakeholder groups, with the customer in the centre.

Competition among suppliers is expected to increase when all the Nordic retail markets are harmonised. This will improve the efficiency in the market and bring benefits for the customers, partly by increasing the pressure on end-user prices and providing new electricity products. It is also anticipated that the larger market will provide customers with a wider choice of offerings and quality products to meet their needs. For example, more specialised products could be offered through the expanded end-user markets.

The harmonised harmonised Nordic end user market is also expected to provide an opportunity for suppliers to operate on a larger electricity market, leading to improved efficiency and reduction in suppliers' unit costs. The Nordic market would thus also be more attractive for new entrants. Yet, the benefits for the suppliers to penetrate a new market area depend on the fact, that the basic rules and functions such as requirements concerning metering should be harmonized thoroughly enough.

A harmonised Nordic end user market will reduce the possibility to develop end user market regulation only from a national perspective. Suppliers and DSOs are as such expected to benefit from a relatively stable regulatory environment with more predictable rules if future changes are to be implemented the same way in all Nordic countries. In sum this will reduce the so-called regulatory risk for the market actors. DSOs and TSOs will benefit from the harmonised Nordic end user market through improved efficiency and automated processes. Harmonised rules will also lead to better quality of system development and cheeper systems. Stable end user market regulation including clear definitions of the roles and responsibilities of different market actors will reduce the regulatory risk also for the network operators.

Furthermore the society is also expected to benefit from increased competition and improved efficiency at all levels. NordREG believes that in the long term it is more efficient to operate one market compared to four national markets. The project on harmonising the four markets is also a golden opportunity that should be used to further develop and improve the electricity market, making it friendlier for customers while improving competition and efficiency and making sure that the DSO role is limited to the tasks of facilitating a good market and maintaining high level of security of supply. Another important aspect of the Nordic harmonisation work is that this project can be seen as an example for European market integration.

## 1.2 NordREG work and the Metering Task Force

In the Work Program 2012 it was stated that metering was one of the working areas in the project of designing the main elements of the future harmonised Nordic retail market. Thus the metering task force was given the task E1 to further elaborate on the introduction of

AMR in the Nordic countries and national AMR requirements and their impacts on a harmonised Nordic end user market. In the task the metering task force was supposed to produce a report identifying potential problems and eventually proposing solutions on the task E1.

The responsibilities on metering have been defined in the Rights and Obligations report of 2011.

The work of metering task force has many links to the work of other task forces, mainly business processes but also the ad hoc group on the Nordic balance settlement. Especially the outcome of the work of metering task force can have implications to the work of business processes task force.

The Metering task force was composed of representatives of the industry and the regulators. The working method was based on a pragmatic approach where consensus to various complex issues was sought through homework assignments.

## 1.3 Objectives of this study

The purpose of this report is to present the basic ideas that have been developed by NordREG in close cooperation with the stakeholders from the Nordic countries during 2011 and 2012. The report investigates what are the advantages and problems related to different metering methods from the perspective of Nordic TSOs, DSOs, suppliers, customers and other actors. Investigation is done by comparing different kind of models where remotely read hourly metering is either the only metering method in all countries or just one metering method used along with other methods in the countries. Based on this comparison the report looks into the possibility of recommending a harmonised Nordic metering methods in a longer term.

The Report evaluates what impact the different approaches to metering that have been chosen in the Nordic countries will have on the introduction and functioning of a harmonised end user market. The report also aspires to map obstacles and benefits of harmonizing the metering requirementsand aim to provide recommendations on how the possible negative effects on the harmonised market could be minimized. The main goal for the Metering Task Force (MTF) is to further elaborate the introduction of AMR in the Nordic countries and national AMR requirements and their impacts on a harmonised Nordic end user market. One of the key questions in this task is to outline if it is possible to move forward in developing the harmonised Nordic end user market if the introduction of AMR and especially hourly registrering does not take place in all Nordic countries and, if it is possible, on what terms this could happen so that customers and market players should not be discriminated.

The general approach of the MTF work is that the customer viewpoint should be primarily considered but in a way that neither customers nor market players should be discriminated.

# 2 Starting point for the work of Metering task force

## 2.1 NordREG reports related to metering

### Rights and Obligations report

In the Rights and Obligations report the responsibilities for metering was defined as follows:

- Meter reading and information about meter reading values :

*The DSO has the responsibility to read the meter when the customer is moving. The DSO also has a responsibility to provide the meter reading and/or energy consumption values to the supplier or suppliers – both the new and the old one if the supplier has been changed in connection with the move. The supplier has the responsibility to give the meter values to the customer with the last bill.*

- Metering and meter value reporting:

*The DSO is responsible and should be the primary contact point regarding technical metering issues however, from October 2014 this situation covers only Finland, Norway and Sweden.*

*The DSO is responsible for metering and for providing metering data to the market, but the supplier should be the primary contact point for queries about meter values.*

### Market Design report

According the Market Design report:

*The cost of large-scale smart meter installations is reduced compared to the costs of individual installations, and the number of customers with smart meters is increasing quite rapidly in different countries. Most Nordic countries have issued or are preparing timetables for large-scale smart meter installations. After that medium- and even small-scale end-users might have hourly metering.*

*NordREG notes that smart meters could enable many benefits for the customers and market participants, and could also reduce some of the obstacles related to business processes. In that sense, NordREG suggests that smart meters should be introduced in the Nordic region as extensively as possible, if it is determined that the socio-economic benefits outweigh the costs. However, NordREG finds hourly metering with a smart meter should not be seen as a prerequisite for being able to enter to the common Nordic end-user market.*

*NordREG sees that neither the minimum functional requirements nor the timetable for the rolling out of smart meters are critical to harmonise. However, processes like balance settlement and periodical financial settlement could be carried out more efficiently with smart meters.*

### Business processes work

The Business Process task force gave a recommendation for the harmonised Nordic supplier switching process. The report focuses on the time limits, roles and responsibilities in the data exchange in the supplier switching process. The report emphasized the meaning of implementing highly effective information exchange systems along with full scale deployment of smart meters in order to implement the recommendations succesfully.

## 2.2 Other Nordic reports related to metering

### Nordic balance settlement (NBS)

The Nordic TSOs have prepared a harmonised Nordic Balance Settlement (NBS) model which describes a harmonised procedure for the future balance settlement in the Nordic countries. The harmonized balance settlement will be carried out in three Nordic Countries Finland, Sweden and Norway since Denmark decided to opt out of the project. The NBS model is currently in an implementation phase and legal changes are in progress in all three countries.

The NBS model will demand changes for example regarding consumption estimation methods and consumption data reporting. The TSO:s have decided not to include reconciliation settlement in the NBS model which implies that automatic meter reading with frequent meter reading is expected to be the main metering method to be used in the three Nordic countries.

## 2.3 The EU-based requirements for hourly metering and its implementation

### EU-legislation

EUs 3rd package, Directive 2009/72/EC, states that in all member states where roll-out of smart meters is assessed positively at least 80 percent of the consumers shall be equipped with intelligent metering systems by 2020.

Directive on the internal markets 2007/72/EC encourages member states to deploy smart grids[3] and smart metering systems (Article 3). Such deployment might be subject to long term cost benefit analysis, as mentioned in Annex 1 of the Directive.

Smart metering standardization is covered by a specific Mandate (M/441) by the Commission to the European Standardization Organizations (ESOs), within the framework of the following Directives:

- 2006/32/EC Directive on energy end-use efficiency and energy services.

- 2009/72/EC Directive for the Internal Electricity Market (replaces 2003/54/EC).

- 2009/73/EC Directive for the Internal Electricity Market (replaces 2003/55/EC).

- 2004/22/EC Measuring Instruments Directive.

In addition, the European Commission Digital Agenda for Europe (COMMUNICATION A Digital Agenda for Europe COM (2010) 245 final/2, 26.8.2010) takes over this objective

[3] Additional information on smart grids in this report is placed in the annex- part.

and sets as a goal, in Action 73: “Member States to agree common additional functionalities for smart meters”, by the end of 2011. Recently published Commission Recommendation of 9.3.2012 on preparations for the roll-out of smart metering systems states that, Member States are required to ensure the implementation of smart metering systems that assist the active participation of consumers in the electricity supply and gas supply markets and implementation of those metering systems may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual consumer or which form of smart metering is economically reasonable and cost-effective and which timeframe is feasible for their deployment.

## Other EU documents

EU Commission Task Force for Smart Grids/Expert Group 1: Functionalities of smart grids and smart meters, 2010. The key deliverable of the EG1 is the services and functionalities of smart grids together with initiatives related to standardization with regards to a future smart grid mandate. The work, taking into account stakeholder inputs from the group, considers e.g. the following topics:

- Smart Grids concepts and definitions
- Functionalities of Smart Distribution Grids
- Functionalities of Smart Metering Systems, highlighting that smart metering is a pillar for building a number of smart grids functionalities and focusing on mandate M/441
- Reference to the wide set of existing standards, codes and guidelines, and related to smart grid services and functionalities and the international activities for mapping them.

# 3 Metering in Nordic countries

## 3.1 Roles and responsibilities in metering

Good quality metering is required to ensure the functioning of the electricity market. On the other hand, costs for replacing existing meters with more sophisticated ones have until now been quite high. Metering can be performed automatically or manually, and the manual reading can either be performed by the customers through self-reading, or by the company responsible for metering (i.e. the DSO). The DSO may also outsource the actual meter reading to a service provider, even if the responsibility of the metering remains with the DSO.

## 3.2 Present situation in each Nordic country

### Denmark

In Denmark, the DSOs are today responsible for the metering. This covers 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.

The metering points shall be read upon changing suppliers, moving situations, or if the electricity supply is terminated. In Denmark the meter must be read at least once a year during supply. Normally this is done by the customer (MMRs). If that is not possible or the value is incorrect then estimated metering values are used

**Hourly metering**

As of January 1st, 2003, hourly metering was mandatory for metering points (customers) with an annual consumption exceeding 200.000 kWh/year. As of January 1st, 2005, the limit was lowered to 100.000 kWh/year. The DSOs are allowed to further reduce the declared levels for hourly metering if the company can offer the service to its entire grid area, and in a simple and secure way. In the long term, all metering points may be subject to hourly metering (see further below).

For the customers without hourly metering due to a 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.

However, it is important to note that access to hourly metering is available for all customers. Any customer who is included in the harmonised profile (template) can choose whether the metering point shall be changed to hourly based metering and settlement for a prorated charge to the grid company.

**Functional requirements/technical demands for the hourly meters**

Government Order 783 of 29 June 2011 includes technical requirements relating to directly connected electricity meters which can be remotely read and which network entities choose, at their own initiative, to install at the premises of the electricity end consumer.

The meter is to be able to

- separately register the collection and delivery of electricity in the collective electricity supply system and register this every 15 minutes,
- change the registration frequency settings via a remote reading system,
- store metered data for subsequent use in consumption settlement and
- register power supply failures at the point of consumption and transfer supply interruption data on the request of the network entity.

The meter is to be able to communicate metered data on the collection and delivery of electricity, for each time series, to the network entity and an external unit. The meter is, as a minimum, to be able to be set such that it displays accumulated values for the collection and delivery of electricity and the current electric power.

The interval at which metered data is transferred to the network entity is to be able to be adjusted and be adapted to the entity's settlement and invoicing procedures as specified in the current market regulations issued by Energinet.dk.

Metered data is to be able to be obtained from the meter by the network entity at all times.

It is to be possible for the consumer, using open standards, to connect external units to the meter and to continuously extract consumption related data.

The transfer of metered data is to be secured via encryption or similar.

External units are to be able to be connected by a lay person without seals or similar needing to be broken. The network entity can decide that activation is to be carried out externally by the network entity. This must not result in that the consumer is required to bear unnecessary additional costs.

Extraction of data must not in any way impede the network entity's use of the meter.

**Template (profile) customers**

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.

The residual consumption is defined as the total consumption in the DSO minus the total of hourly measured/ settled end user consumption. Loss in the distribution grid is also included in the residual consumption and is made up as an "ordinary" settlement of load profile.

Based on this system load profile, each DSO must calculate the daily consumption of every template customer. These consumption values for template customers and the actual consumption for hourly metered customers form the basis for distributing balancing costs among balancing responsible parties – mainly suppliers.

In short, all metering points (customers) with an annual consumption below the mandatory limit are subject to load-profile settlement unless the customer requests hourly settlement.

In the latter case, such hourly settlement must be based non-discriminatory criteria and against payment of a cost-based amount to the grid company.

Table 1 shows that more than 60 % of the metering points (template customers) have or will get a smart meter with remote reading very soon. But as the table indicates only around 2 % of the customers have hourly settlement today (that is hour-by-hour reading and hour-by-hour settlement).

Table 1: Smart meters in Denmark

| | | % |
|---|---|---|
| Template customers with remote reading ultimo 2011 | 1.380.000 | 42 |
| Template customers decided to get remote reading in 2012 | 330.000 | 10 |
| Template customers decided to get remote reading after 2012 | 270.000 | 8 |
| Template customers without plans for remote reading | 1250.000 | 38 |
| Customers with hourly settlement | 50.000 | 2 |
| Total | 3.280.000 | 100 |

Source: Danish Energy Association (2012).

Please note that a customer with a smart meter usually gets a smart (remote) reading of the meter. But it does not necessarily imply a smart settlement of the customer on an hour-by-hour basis by the DSO. Further, it does not necessarily imply that the customer has a smart display installed and/or access to data to react on price changes each hour. All these elements are so far decided by the DSO and are indeed required to get a 100 % benefit of the implementation of smart meters.

## Finland

In the year 2009 Finland made a decision to implement hourly metering and remote reading. Measurement of electricity consumption and production has to be based on hourly registering and it has to be read remotely with few exceptions. According to the decree of the Council of State at least 80 % of all delivery sites have to be hourly registered and remotely readable by the end of 2013. The decree allows exception in hourly metering for at the most 20 % of the delivery sites if the delivery site is equipped with max. 3 * 25 A main fuse or if the delivery site is equipped with over 3 * 25 A main fuse but electricity consumption is less than 5000 kWh per year and it's on the sales of supply-obligated seller. All production sites and delivery sites equipped with over 3 * 63 A main fuse have to be equipped with hourly registering remotely readable meter already today and also over half of the delivery sites equipped with max 3 * 63 A main fuse already have a hourly meter. It

seems that close to 100 % of all delivery sites will be equipped with hourly registering and remotely readable meter by the end of year 2013 or soon after that.

The decree of the Council of State allows an exception in executing metering of small scale production. Normally all production has to be measured with a separate hourly registering distance readable meter but small scale production located in a delivery site equipped with max 3 * 63 A main fuse doesn't require a separate meter if the hourly registering remote readable meter on the delivery site is able to register inbound and outbound energy separately. Also DSOs electrical apparatus and consumption points equipped with less than 3 * 25 A main fuse can be left completely without metering equipment if the consumption can be estimated accurately enough.

Technical demands for the hourly registering remote readable meters and the DSOs data system handling the metering data are as follows:

- AMR
- Measuring device needs to register over 3 minutes non-voltage periods (starting and ending time)
- Measuring equipment has to be able to receive and execute or transmit forward load balancing commands coming through the network
- Hourly registered data and information on non-voltage periods registered by the measuring equipment needs to be stored in the DSOs data system for at least 6 years in case of hourly registered data and for at least 2 years in case of non-voltage period information
- Data security of the measuring equipment and the DSOs data system need to be properly assured
- DSO also has to provide upon customers request measuring equipment with a standardized interface for real time consumption reporting

Reading frequency for the hourly registering meters is once a day. Non-hourly registering meters such as mechanical meters need to be read three times a year from beginning of year 2014 onward. Two of the readings can be provided by the customer. When no values are received from the non-hourly registering meter the DSO is responsible to estimate the values and the estimation method has to be published. DSO is responsible for providing the measured data to the customer, the customers' supplier and to the balance settlement the day after the meter reading. Final measured data has to be provided during 14 days balance window. For all hourly registered remote readable delivery sites also the balance settlement is done based on daily read hourly values.

For delivery sites without hourly registering meter the DSO has to calculate the consumption based on meter reading and one of the 3 type load curves. The final consumption information has to be provided as a sum of suppliers' delivery sites during 14 days balance window. Consumption of non-hourly metered delivery sites is reconsiled annually.

## Norway

On June 24th, 2011, the Norwegian Water Resources and Energy Directorate made changes to "Regulation No. 201 of 11 March 1999 relating to metering, charging and concerted action in energy sales and grid service billing", requiring that the network company shall have installed Advanced Metering and Management Systems (AMS) in all meter points[4] in their concession area by 1.1.2019, and that households with hourly read meters shall be billed on the basis of actual consumption. Further specified is a set of functional requirements that all installed AMS must fulfill, regulatory requirements for collection, storage and use of meter values, as well as for provision of information to customers and the option of providing an in-home display.

**Functional requirements**

AMS shall:

a) store the meter values with a maximum time resolution of 60 minutes, and be prepared for meter reading of 15 minutes intervals,

b) have a standardized interface that facilitates communication with external devices based on open standards,

c) be connected and communicate with other types of meters,

d) ensure that stored data is not lost during power outages,

e) be able to break and limit the power in each meter point, except for transformer metered customers,

f) be able to send and receive information about electricity prices and tariffs, as well as to transfer management and earth fault information,

g) provide protection against misuse of data and unauthorized access to control functions and

h) register the flow of active and reactive power in both directions.

**Meter values**

Meter values must be registered and stored in the meter point until the meter values are transferred to the network company. The meter values are to be transferred to the network after the operating day has ended. Meter values must be available to end users and third parties, authorized by the end user, by 09.00 the next day. The supplier will have access to total consumption per hour, for all its customers in the network areas by 09.00 the next day.

Network companies shall via the Internet present information about consumption in the individual meter point. The information should be presented in a way that enables comparisons of consumption, prices and costs over time. Providers of energy services, including energy suppliers authorized by the customer shall at no charge, have access to meter values from the network company in a standardized format.

[4]The Network company is exempt from this duty if: I) consumption in the meter point is very low and predictable, (ii) installation of AMS is causing a substantial disadvantage that can be documented

Network companies shall store meter values with a time resolution of 60 minutes, for a minimum of 3 months and up to 15 months. The network company shall store the meter values with a time resolution of monthly, for the preceding three calendar years.

**Information to end-user and display**

When the network company has installed AMS, end user shall have access to the meter values locally, and the network company shall provide the end user, free of charge, with information about their own consumption via the Internet.

The network company shall ensure that the end users upon request can connect a in-home display[5]. The network company is not required to provide such a display, but the customer may purchase and connect a display from a third party through the local standardized interface. Suppliers shall be able to send price information to the display. The network company shall be able to send the tariff information to the display.

## Sweden

In Sweden, a major roll-out of new meters was finished by July 1st 2009. The roll-out was conducted in two steps. From the 1st of July 2006 hourly metering was introduced to customers with main fuses of 63 A and from the 1st of July 2009 monthly metering was introduced to customers with main fuses at most 63 A[6]. With monthly meter readings no yearly consumption estimations is needed and customers receive bills based on actual consumption. Results from a survey published by Ei in May 2010 indicate that 91% of the remotely read meters were able to register hourly values but only 30% of the meter data management systems could handle the hourly values.

According to an amendment to the Electricity Act that came into effect on October 1st 2012, all customers with main fuses of 63 A or less can have hourly metering upon request if their supply contract is based on hourly metering. The DSO has to supply the hourly metering to the customer at no extra charge. The main driver for the aforementioned legislation was for customers to get a greater awareness of energy consumption and promote customer activity.

There are no legal requirements regarding communication systems for remote reading in Sweden. The majority of meters are connected to communication systems that with some adjustments can transfer hourly meter values. The meters are also, in most cases, capable of two way communications (AMI).

[5] At the outset there are no further requirements as to which functions such a display should have. However, AMS is required to be able to deliver meter values, prices, tariffs and as well as total electricity expenditures to such a display. Furthermore it is assumed that competition will ensure that customers are offered appropriate services such as in-home displays.

[6] The new legal demand for monthly reading led to a major roll-out of AMR meters, introducing remotely readable meters for the most part of the customers except for those that are electro-sensitive or for those that the DSO had problems to contact to inform that a change of meter was imminent

**Summary**

Metering and its requirements are based on

| | **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|---|
| National law | §§ 22 and 28 of the electricity supply act | Electricity market act (588/2013) | Energy act § 4-3, Regulation concerning Metering, Settlement and Co-ordinated Action in connection with Electricity Trading and Invoicing of Network Services chapter 4. | Electricity act (1997:857), Government Decree (1999:716), |
| Administrative decrees | BEK (gov. order) no. 1035 from 17/10/2006 (Elmålerbek.)<br><br>BEK (gov. order) no. 783 from 29/6/2011 (Bek. om måling af el i slutforbrug) | Government Decree (66/2009) | | EIFS 2011:3, EIFS 2012:2 |
| Recommendations and guidelines by industry organizations or TSO | Danish TSO Market rules: "D1" Settlement metering (Afregnings-måling)<br>"H2"<br>Load-profile settlement etc. (Skabelon-afregning mv.)<br>Danish Energy Association: Electricity metering (Elmåling)<br>5. edition 2012 | An industry recommendation<br><br>Energiateollisuus: Principles of hourly metering | | Svensk Energi: Elmarknadshandboken<br>Svenska Kraftnät:<br>Teknisk Riktlinje TR3-01 |

Delivery sites hourly metered

| | **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|---|
| **Number of all delivery sites** | 3,2 million | Approx. 3,2 million | Approx. 2,8 million | 5,2 million |
| **Number/percentage of those that are at present within hourly metering** | More than 60% | 80% need to be hourly measured by the end of 2013[7] | About 7 % | At least 1130000 |
| **On which criteria do delivery sites have to be hourly measured (e.g. size)/exeptions to these** | Consumption above 100 MWh/year<br><br>Approx. 50.000 customers or 2% have mandatory remote hourly metering and hourly settlement; approx. 1.958.000 or 60% are template<br><br>customers with hourly remote reading but without hourly settlement. | Over 3 * 63 A are already hourly measured<br><br>Exceptions after 2013:<br><br>a) Delivery site has maximum 3 * 25 A fuse<br><br>b) Over 3 * 25 A fuse and usage less than 5000 kWh/annually | Yearly consumption above 100000 kWh.<br><br>Could previously be requested by customer | All delivery sites are required to have hourly based metering upon the request of the customer if the customer has a hourly based supply contract. All producers are required to have hourly based metering and all consumers with a fuse of more than 63 A must be hourly metered. |
| **Future development, is there mandatory** | A Government Order which requires the installation of | Not mandatory after 2013. Voluntarily almost 100 % of | All delivery points must be hourly | Functional requirements are envisaged |

[7] Over 2, 6 million consumption sites are already hourly metered.

| | | | | |
|---|---|---|---|---|
| **basis to increase the number** | smart meters for all customers by 2020 is under preparation. | consumption sites will be hourly metered by 2014. | measured within 2017 | |

Metering Systems Capabilities

| | **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|---|
| **Is remote reading required?** | No (but under preparation by the government, see above). | Yes | Yes | No direct legal requirements but in practice, yes. This is due to the requirement that all customers should at least have monthly reading. |
| **Does the meter need to register inbound and outbound energy separately?** | No, a separate meter for the generation unit can be installed. | Yes | Currently yes.<br>Future AMS regime: no<br>(4 quadrant meters may be used) | Yes |

Meter Reading

| | **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|---|
| **By whom the meter reading is done (customer/ DSO)** | Customer (regular meter).<br>DSO (smart meter)<br>Some suppliers read also read the regular meter by installing | DSO | Customer | DSO |

| | | | | |
|---|---|---|---|---|
| | a small monitor nearby the meter. | | | |
| **How often non-hourly registering meters need to be read?** | Template customers: Once a year<br><br>(some suppliers read more frequently by installing a small monitor nearby the meter).<br><br>Datahub:<br>Template customers:<br>Once a year (minimum).<br><br>Template customers with hourly remote reading (but no hourly settle-ment): If the hourly values are sent to the datahub, they must be sent not later than one week after being transmitted from the meter to the DSO.<br><br>(From 2014<br>DSOs must bill the suppliers on a monthly basis which may imply changes of DSOs reading frequency). | Three times a year<br>(2 can be done by the customer and at least1 by the DSO) , but also the DSO can read all 3 times. from the beginning of 2014 | Yearly consumption below 8000 kWh: once a year<br>Yearly consumption over 8000 kWh: every second month<br>Business: monthly | Monthly |
| **How often meters that are hourly registering capable need to be read?** | Daily.<br>Final checked data must be ready by DSO within 5 days<br><br>Datahub:<br>Daily.<br>Final checked data by DSO must be delivered to datahub within 3 days (5 days). | Daily<br>Final checked data within 14 days | Today: once a week<br>Future AMS: once a day | Daily (EIFS 2011:3, EIFS 2012:2) |

| | | | | |
|---|---|---|---|---|
| | Collection period:1st-3rd working day, control period: 3rd -5th working day. | | | |

If no hourly data is received from the meter

| | **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|---|
| **What is the procedure** | Manual reading (self-reading). Values of consumption are estimated by DSO if no values are received from customer.<br><br>Datahub:<br>No change. DSO must replace incorrect/unreliable<br>metered data or missing values with estimated values. | Values are estimated latest on the 5th day (within 14 days balance window)<br>-Detailed estimation method is used | Mo-Tue: collection retrials<br>Wed: estimate substitute values (copy from last week)<br>After 1week: Actions are planned / made | Missing data has to be replaced by data from a control meter or estimated data by a reliable method. There has to be a message that the estimated data shall be replaced by correct data. |
| **Are all hourly values delivered or only new and changed values** | When changed values are delivered, unchanged values from e.g the same day may also be delivered.<br><br>Datahub:<br>If the DSO discovers errors in the sent metered data per metering point, it will send the corrected<br>data to the datahub.<br><br>The DSO (and datahub) are normally not allowed to | Only new and changed | Only the changed values | All hourly measured values shall be reported - applies to delivery sites over 63 A and also to customers below 63 A *that have* hourly metering shall be reported. |

| | | | | |
|---|---|---|---|---|
| | send corrected time series together<br>with non-corrected time series.<br><br>In exceptional cases (from 3rd to 5th working day when fixing takes<br>place), all time series may be (re-) sent if DSOs first sending<br>of time series was incomplete. | | | |

Delivery of Values to Suppliers

| | **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|---|
| **When hourly values are delivered to suppliers, balance window?** | Within 5 days<br><br>Datahub:<br>3 days (5 days if errors are discovered). | The day after the day of measuring | Every Wednesday<br>Balance window: 3 years | The day after the day of measuring, at the latest |
| **Responsibility of the DSO** | DSO is responsible for collecting and checking metering values.<br><br>Datahub: DSOs: No change.<br>Hub is depending of input from i.e. DSOs. Hub is responsible for validation of and | Deliver the data. Validate the data. | 1. Deliver the data weekly<br>2. Deliver the corrected data weekly | The DSO is responsible for the registration and reporting of values. |

| | | | | |
|---|---|---|---|---|
| | to give access to data for suppliers etc. | | | |

Customer Reporting

| | **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|---|
| Is there an additional obligation to deliver values to customers in a way other than in a bill? | No, but some DSOs give access to data via web portals.<br><br>Datahub:<br>When hub is running in 2013 all customers are granted access to own consumption data in the datahub (access via supplier's website to the hub). | The DSO is obliged to make the data available via web portals, MSCONS-messages for bigger customers | It's not an obligation, but most utilites make the data available via web portals | The DSO is obliged to report values in the electronic format of EDIEL, upon request from the consumer. If the customer has opted for hourly metering, the DSO must make the metering data available via web portals. |

Data Access

| | **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|---|
| Which parties have access to the meter values (alternative: | DSO, supplier, customer | DSO, customer. Data is | DSO, customer. Data is | DSO, customer. Data is |

| | | | | |
|---|---|---|---|---|
| DSO, supplier and customer) | Datahub: DSOs, suppliers, customesrs, BRPs, other interested or relevant parties (energy consultants, public authorities and others) | delivered to the suppliers. | delivered to the suppliers. | delivered to the suppliers. |

## 3.3 Plans of implementing hourly metering in each Nordic country

### Denmark

The Danish government has decided on a national roll out of smart meters by 2020. But as indicated above, many DSOs have already issued plans for a rolling out of smart meters. Existing plans and already handled roll out of smart meters covers more than 60 % of all customers today.

The Danish TSO has in 2009 conducted a cost benefit analysis to examine whether the government should require smart meters for all customers. One main result of the study was that neither the social net benefit nor the net benefits of the users were significant enough to give room for a reduction of the existing requirement of a consumption of 100.000 kWh / year for hourly metering. The problems seem related to both high prices of home automation equipment and a too small reduction of the capacity investments (plants investments) if the limit of mandatory hourly metering was reduced. But the study did suggest repeating the analysis within few years.

According to a Energy Agreement of 22 Mach 2012, the parliament decided that a comprehensive strategy for establishing smart grids in Denmark is to be drawn up, and an agreement with DSOs on roll-out of remotely readable hourly electricity meters is to be accomplished. A Government Order which requires the installation of smart meters for all customers by 2020 is now under preparation (autumn 2013).

**A wholesale model**

A wholesale model centered on a datahub will be introduced in 2014. All players will feed information into the datahub which handles the calculation of billing information for each customer. This will not change the main duties of the DSOs for instance regarding meters but the relationship to the customers will be different in the future according to the new regulation.

### Finland

By the year 2014 at least 80 % of all delivery sites will be equipped with hourly registering remote readable meter. All production and over 3 * 63 A delivery sites are already equipped with hourly registering remote readable meter. It seems that hourly metering will cover almost 100 % of all delivery sites by the end of year 2013 or soon after that. Metering sites remaining without hourly metering are likely to be sites with fixed consumption which can be accurately estimated over time or small delivery sites with small consumption.

## Norway

The final roll-out deadline for AMS is set to 1.1.2017. At least 80 % of relevant meter points shall meet the functional requirements by 1.1.2016. The network company shall report periodically to the Norwegian Water Resources and Energy Directorate on their progress in relation to the roll-out, from 1.1.2012 until 2017.

## Sweden

Since the 1st October 2012 hourly metering is available for customers below 63 A, if they have an hourly-based supply contract (hourly electricity pricing).

## Summary

| **Denmark** | **Finland** | **Norway** | **Sweden** |
|---|---|---|---|
| A Government Order which requires the installation of smart meters for all customers by 2020 is under preparation | By the year 2014 at least 80 % of all delivery sites will be hourly metered and daily remotely read | 80% of relevant meter points shall meet the functional requirements by 1.1.2016. 100 % by 1.1.2017. | *Sweden has not decided upon if hourly metering will be mandatory for all customers or not. Hourly metering is enforced in some cases for customers below 63 A and mandatory for customers with more than 63 A.* |

# 4 Harmonisation of metering requirements

Meters, the requirements of the meters, and the metering processes are of the highest importance to the electricity distribution industry today. Large customers in all the Nordic countries have automatic meter reading systems installed (AMR), where the DSO can automatically get signals from the metering point. In addition, some also have the potential for two-way communication, where the DSO sends of signals directly to the terminal connected to the meter.

The costs of large-scale AMR installations are reduced compared to the costs of individual installations, and the number of customers having an AMR meter is increasing quite rapidly in all countries. The Nordic countries have issued or are considering preparing timetables for large-scale AMR installations. After that, medium and small end users will to a large extent also have hourly metering. It is also important to consider whether there is need to set different meter reading requirements for medium and small end users with hourly metering than for large customers considering the cost of metering. Some countries have already started an analysis of this question.

In this task which was given as a homework assignment to the task force participants, the main point was to discover the possible advantages and problems related to different kind of metering requirements in the Nordic countries. The perspectives of DSOs, suppliers, customers and other actors were to be taken into consideration. Most important things to consider in the report were equality, non-discrimination and competition aspects. The given task was carried out by hearing all the market participants in the input team for their experience and their views on this issue. The comparison presented in this report is based on besides the experience of the input team, but also on the views and experience of regulators and on related information gathered from national or EU based sources. Based on the information gathered it is salient that there are both benefits and disadvantages in all three presented models, but all in all it seems clear that having same rules in all countries would be beneficial.

## 4.1 Scenario 1: Daily read hourly metering for all metering points (with AMI)

In this case it was assumed that there is only one type of metering in all Nordic countries and that is remotely readable hourly metering. All hourly meters are read daily and balance settlement and billing is based on hourly metered data. In this case no reconciliation settlement is needed.

## Pros

Advantages in daily read hourly metering for all metering points using two way communication can be divided in three parts. The actual hourly metering meaning hourly registering of consumption, the bautomatic meter reading meaning more frequent cathering of metered data from the meter to DSOs systems and the AMI meaning two way communication between DSOs systems and the meter which makes it possible to control customers' loads.

### Hourly metering

Smart metering can be divided in three different functions. The first function is registering consumption and production frequently enough. In this case the registration is assumed to be done hourly or even more frequently. Hourly registered data instead of cumulative reading for longer metering periods will give much faster access to information about the time-wise consumption on a certain consumption site and on certain consumer groups and also on the whole network level, leading to more accurate forecasting of the balancing of power in the network. With better forecasting, less of expensive balancing power in standby will be needed resulting in a less expensive and more accurate network operation.

Hourly metered data will be beneficial to suppliers and grid operators but it will also provide a business possibility to third parties for providing services to customers and maybe also for market actors. The biggest pros of hourly metering are the empowerment of the customers, whom the network is built for. When the customers are in control of their metering values, and are aware of them, together with the market price of energy, the customer can make an educated choice and save money. A higher frequency of metering also has great potential in reducing greenhouse gas emmisions, and the wasting of energy. Without frequent metering the incentives and the ability for customers to react to price signals are poor.

Using hourly consumption values will lead to more accurate bills more frequently and better information for forecast. In that way the suppliers are also able to design and offer new electricity products and services for customers in the whole Nordic market. Using hourly consumption values for all consumption points allows the suppliers to offer the same variety of products and services for all customers. This enables a non-discriminatory treatment of customers. Contracts can also be made based on customers' exact consumption pattern. These products can contain different prices for every hour due to hourly consumption values or the products can be even more allocated to certain kinds of consumers. This would not only lead to new electricity products and services but also enhance competition among suppliers. One example of these hourly priced electricity products is one with market price. In this product the price is determined by the hourly energy prices in Nord Pool having a margin set by the supplier on top. This product will shift the price risk from the supplier to the customer, because the supplier will pass through the wholesale price to the customer. This will have a major effect in supplier business since thanks to reduced risk suppliers don't have to include the risk in the energy prices and can thus sell electricity products on lower price. From the customers viewpoint the product can be a risk without

having any load control but on the other hand electricity price is also lower most of the time. More cost reflective and innovative pricing that benefits energy efficiency and overall system efficiency is also possible on distribution tariffs.

Customers will receive bills based on actual consumption and won't need to pay under/overpayments which will be corrected afterwards. Customer will pay only for the actual amount of electricity he or she has used during the billing period. Bills based on actual consumption will give the customer better view of his or her consumption and may encourage customers to be more energy efficient and may reduce the claims (cash flow) between customer and supplier. More accurate consumption information for customers will increase energy efficiency by making it easier to locate and carry out energy saving actions. This can be a market for service providers who upon customers' request produce more usable information of customer's metering data. Customers can be offered with very detailed information about their consumption habits via internet services e.g. It will increase customers' ability to control their own consumption behavior and to act more energy efficiently. Service providers can also upon a customer's request solve different kinds of ways for the customer to control his or her own energy consumption and thus to save energy. Information through home portals and gateways, or direct communication to other in-home devices empowers customers to make choices about their energy consumption.

Hourly metering in small consumption sites will also provide "prosumers" (costumers with own production of electricity) an easier way to sell their electricity production to the market via aggregators or suppliers. Hourly metering can make the production procedure lighter for small renewable energy and also enable demand side participation when hourly metering validates the demand side actions performed at a consumption site, thus making it possible to calculate the actual value of a performed action. These actions will have a big role in operating networks in future.

### Automatic meter reading (AMR)

The second function is the automatic meter reading (AMR) which combined with the hourly registering will give the actual gains. Actual gains are attained when the hourly registered data is read from the meter frequently enough. In this case the reading frequency is assumed to be once a day.

When hourly registered data is read daily instead of for example cumulative yearly reading it is possible to use these meter readings in balance settlement. When using cumulative meter reading the whole estimated or calculated consumption on the metering period is divided by the hours of the metering period using a load profile. Because the load profile is only an artificial model that tries to estimate the average hourly consumption behavior of similar kind of consumers or of certain network area, it will not give accurate information on certain customers consumption. This will lead to inaccuracy in balance settlement. Using exact hourly registered data instead will improve the quality of balance settlement and thus the imbalances will be pointed more exactly to the parties responsible for it. For example nowadays in Finland most of the inaccuracy in balance settlement is calculated in to incumbent suppliers' balance

and thus balance settlement based on registered hourly data for all consumption points will drastically enhance the quality of incumbent suppliers balance. Hourly data will give the DSO and suppliers more accurate information on customer's consumption and also for the DSO on the losses of the DSOs network. Because there is no full proof way of calculating the network losses some part of it is always calculated to incumbent suppliers balance. Even if whole calculated amount of network losses on yearly level or even shorter time period is close to the actual realized losses it is not correctly divided on hourly level. Thus using frequently read hourly registered data will enhance the quality of network loss estimations and because of this the DSO has the possibility to tender the losses to as low price as possible and thus lower the loss costs which will lead to rationalization of the network operation to some extent. Fully implemented hourly metering with frequent reading will make it possible to determine losses based on actual metered information, not estimates.

Using hourly registered data in balance settlement will also have another major effect on the market actors. With daily read hourly data there's no need for calculating consumption based on load curves or profiles and thus there's either no need for reconciliation settlement between suppliers. Nowadays suppliers sell electricity to consumption points upon consumption estimation for metering period given by the DSO. In reconciliation settlement this consumption estimation is being compared to the metered consumption on the consumption point for the metering period and depending on the sign of the difference in energy the supplier is obliged to either pay or to gain compensation for this amount of energy. The reconciliation energy price is the daily market price in Nord Pool. Reconciliation settlement is quite a risk for the suppliers because consumption estimations are often only indicative and the price of reconciliation energy is often quite high, compared to the price when supplier has tendered and price-proofed it's electricity purchase in advance . Using hourly registered data in balance settlement and thus not using the reconciliation settlement will make it fairer and also more transparent for the suppliers. This will clearly improve the functioning of the market and thus it also increases competition. This may also lower the customer prices since the risk suppliers are facing is lower.

Daily read hourly metering will also benefit other suppliers, customers and other market actors. More accurate consumption data will give better picture of consumption behavior of certain customers which normally don't fully follow the pattern of the load profile. This will make it easier for the suppliers to estimate customers' consumption and make better offers.

Daily read hourly metering will also lead to more accurate billing when the customer is billed for the exact amount of energy used during every hour of the billing period. This will reduce supplier's economic risk at least if billing is done frequently enough so that there is no need for billing based on estimations. With frequent billing based on actualized energy consumption both DSO and supplier can at some extent avoid economic risk due to selling electricity on credit, because they get paid for the energy distributed and consumed shortly after the delivery date. Nowadays, if a manually read meter is read for example once a year, the yearly consumption is divided throughout the year using a load profile

and because of the estimated load profiles both DSO and supplier are actually billing the customer less compared to actualized consumption during winter time and billing more during summer time.

Automatic meter reading will also reduce the amount of incorrect meter readings and also minimize the effects of a possible fault in the meter because of the high frequency of reading. Possible faults and mistakes will be detected and thus fixed fast so that they will not lead to big effects on energy consumption or billing. At the same time it also minimizes the risk for the supplier for losing money when the customer is billed with incorrect meter readings.

Besides producing more accurate data, AMR with hourly registerin is also the key in automating some of the DSOs' business processes like meter reading, supplier switching and moving. By having an hourly registering AMR system there's no need for on-site meter reading or asking meter readings from the customer in case of for example supplier switch and thus there is also no need for manual work for the DSO. This will not only make the processes faster and more effective when the process can be done fully automated but also saves money when no on-site work is needed. It enables customers to be more active in the electricity market.

Using only hourly registered values will also remove the need for designing different service models for different regions and nor is there need to provide different kind of metering data for different suppliers when the hourly data is read frequently enough. The DSO doesn't for example have to calculate readings for different time tariffs such as nighttime and daytime tariffs when suppliers can calculate them from the hourly registered values by themselves. Thus also the time limits of the suppliers' tariffs can differ from the DSOs' tariffs when electricity consumption can be determined by summing up certain hourly values. This will reduce need for different kind of calculations in the DSOs' systems and this will allow the DSOs' systems to run more efficiently with more simplified data models, and could potentially lead to more homogenous DSO services across networks. Using only hourly registered consumption values will provide a level playing field for all suppliers and the same possibilities to operate in the harmonised Nordic market and will enable the DSOs' processes to be straightforward, transparent and equal. This will increase competition between suppliers.

Using remotely read hourly values attached with registeration with voltage quality offers the DSOs possibility to enhance their services for the customers as they can collect power quality information from all delivery sites and the meter also provides more accurate information about dead periods in case of faults in the networks. With the help of this information, customers can be better informed about outages. Locating and repairing cause of outage can be done faster. DSO can for example provide the customers with specific information on outages and in that way make it unnecessary for the customers to call the DSO. This may decrease the need for the DSOs' customer service. DSOs can also utilize the power quality information in their network planning and thus avoid outages or other problems in the network.

### Automated meter infrastructure (AMI)

The third function and the main key to enhance the opportunities smart metering offers is to use two-way communication between the meter and the DSO's system. Smart metering itself is one of the means for direct communication to the customer and certainly the most cost effective means today, but two-way communication is a necessary prerequisite.

Accurate measurement through hourly registering meter is essential in building a new set of functions to support the smart grid. Again, the support for advanced tarification and payment enable utilities to manage the grid in close contact with their customers, by using pricing signal to reduce peak loads. Best way to involve the customers in the smart grid is to offer products which contain different prices for different hours and a remote control of the customer's loads. In this way a service provider, supplier or other agreed actor can control the customer's loads accordant with electricity price. This will not only ease the stability of system but also gains savings for the customer. Remote load control can be done via smart meter using automatic meter infrastructure (AMI) or by home automation.

Remote disablement and enablement of power supply through AMI gives an additional tool to enhance system reliability for example in critical load situations. This is a function used by the DSO only and only in critical situation as a last resort in order to keep the system stable. Remote disablement and enablement is not really a part of an electricity product with a customer but a tool that DSO can use when running the network every day. Remote disablement can be used in situations where there is no valid electricity contract between customer and supplier. In that way using electricity without valid contract, which is a harmonised problem in some countries at least in Europe can be prevented. Also in case of unpaid bill disconnection of the consumption point will reduce the cost for the DSO but will also prevent the customers' debt rising even higher. Remote disablement and enablement are also efficient tools in case of a moving process where customer is moving out but no-one is moving in. Thus if the consumption point is disconnected there won't be any costs neither for the DSO due to network losses or for the customer due to network service and energy payments.

Data collected through smart metering systems, that include consumption profiles, outage data and distribution network status can be further used for smart grid strategic planning, asset management and improvement, through data analysis and forecasting.

### Summary

Comprehensive usage of frequently read hourly registered values will ease the work of DSOs, minimize the risks for suppliers and all in all enhance competition. As it can be seen there are many business opportunities emerging from the usage of hourly registered values and two way communication. Also the customer can have more active role on the electricity market. It will provide alevel playing field for all market actors throughout the Nordic countries and,

furthermore, customers will be treated equally. There will be no dividing of customers based on different metering methods in different countries.

To get the best advantages of hourly registered values the meter should be read remotely frequently enough, preferably daily and there should be a two-way connection between the meter and the DSOs' system to make it possible to involve customers in energy saving and using smart grids.

### Cons

In countries where automatic meter reading or frequent reading of hourly registered values is not yet in use, there will be initiation costs from changing the meters and systems. DSOs will pass the cost forward to the customers if this is allowed in the regulation of the DSOs and fully exploiting of hourly registered data will thus, at least first raise network tariffs. Usage of hourly registered values also requires suppliers to change their systems and that will require work and money. In some countries costs may outweigh the benefits and it should be estimated nationally. It is possible that, without sufficient and accurate planning, costs from implementing and using new information systems (where needed) may be high due to a massive increase in the amount of data to be transferred.

There may be data quality issues with remote reading (mostly due to faulty communication), which means that not all readings can be received daily. Because of that, using hourly registered values requires DSOs to use a defined estimation method to fill in the missing values. There can also be some places where remote reading isn't possible because of for example location of the consumption site.

Hourly registering of consumption will increase the amount of data and thus put higher requirements on data exchange and data storage. The challenges related to data volumes, quality etc. will decrease over time. Thus it is also important to implement modern and efficient supporting structures ( e.g. in data hubs.) to be able to face these challenges. There is a risk that if only the customers with hourly registered consumption data available would be attractive for suppliers in a harmonised market and they would be the only ones able to participate the market where customers with manual meters would still be subject to the national markets this might lead to a dual market with less competition and higher prices for customers with manual meters.

## 4.2 Scenario 2: Several groups of metering points with harmonized metering requirements for each group

In this case it is assumed that there are several groups of metering points (hourly metering – daily read, hourly metering – monthly/weekly read, non-hourly metered) with harmonized metering requirements for each group.

### Pros

Implementation costs will be lower for DSOs compared to mandatory use of frequently read hourly registered values when countries don't have to change the meters. Also some of the national rules can be maintained when only basic principles will change.

Most advantages of hourly registered data and two way communication are still available for the customers having it. Customers with hourly registered consumption data available will have a wider variety of electricity products available and more suppliers to choose from. Also other customers, at least in some countries will probably have more suppliers to choose from.

Suppliers will gain from better quality of metering data and better predictability of consumption for those customer who have hourly registered consumption data available. metering Even with wider variety of metering methods the situation compared to the situation nowadays would be a little bit easier for suppliers due to harmonisation of rules. Several metering methods could be seen as a more realistic approach than moving straight to daily read hourly registered values for countries that haven't yet introduced hourly metering but not necessarily a future proof solution.

### Cons

The major problem with combination of different metering methods is that it treats both suppliers and customers unequally. Suppliers from a country where there is only daily read hourly registered consumption data in use may not have systems which can handle cumulative meter readings and all the calculations that it requires for estimations and balance settlement. Also a supplier from a country having no hourly metering may have system that cannot handle hourly registered values. Taking account that the profit from electricity supply in case of a small consumer is not high, building and running two or more parallel systems to handle different kind of metering points will increase system costs. Besides that it will be labor intensive system to use it's also risky system to build due to the fact that suplier will have to put the costs in to the energy price to cover the building expenses which again might be a disadvantage for the competition. Thus combination of various metering methods can be an entry barrier for some suppliers while it also gives advantage for large suppliers already operating in several countries because of higher volume of customers.

There is a risk that if only the customers with hourly registered consumption values available would be attractive for suppliers in a harmonised market and they would be the only ones able to participate the market where customers with manual meters would still be subject to the national markets this might lead to a dual market with less competition and higher prices for customers with manual meters.

DSO will benefit from hourly metering mainly when all network customers are hourly metered due to only one system and only one processes. Some of the cons listed below can be avoided if the customer is able upon a request free of charge to receive hourly metering, but even then some extra effort is required compared to the customers already equipped with the hourly metering before the same level of

service can be reached for the customer not to mention the costs for the DSO to build up the system metering point at a time.

The unequal treatment for customers emerge partly from the fact mentioned above when some suppliers are not able to operate and offer products to certain network areas having a metering method they cannot handle with their systems but also from the fact that the suppliers won't have as specific information about a customer's consumption when the customer has MMR than with hourly registering AMR. A supplier has to make different kinds of offers to different kinds of customers having different kinds of metering. Thus there will be less competing suppliers and fewer products and services available for the customers with MMR. Customers without hourly metering won't have the same amount of products available because hourly pricing isn't worthwhile for the customers. Less specific information about the customer's own consumption and billing not being based on the actual consumption will hinder the customer's possibility to control his or hers own consumption and will thus also hinder the energy efficiency.

Different metering methods may also treat customers differently if the customers having manual read meters have to pay fees for on-site meter reading, distribution tariff changes meaning metering method changes and other services while for customers with AMI these actions are done remotely free of charge. This will affect the customers' possibilities to switch supplier. Because of different metering methods there may be many misapprehensions among customers about electricity products available when neither the supplier nor the customer is fully aware of the metering method used at the customer's delivery site. Thus it may cause a lot of manual corrections when customers are trying to make contracts on electricity products not suitable for the metering method at his or hers consumption point if there isn't an easily accessible register for what kind of metering/settlement is applied at the specific delivery point.

Continuing with the current metering methods mostly as they are nowadays meaning that only reading frequencies might change but no meter equipment changes are needed, it may be cheaper for the DSOs but for suppliers it means double systems to handle the different kind of metering data. This will supposedly affect customer prices also in countries where no meter changes are made if the suppliers want to start operating on Nordic level. Customers having MMR need to be handled in a system that makes it possible to use cumulative values, load curves and estimations. Customers having hourly registered consumption values available instead need to be handled with a system that uses hourly values for estimating and billing. Thus for suppliers the model with several metering methods is not the cheapest and easiest and doesn't offer the best possibilities for competition. Also the customers may actually have to pay for the suppliers' system development without getting any actual benefits from the project.

Having several different metering methods, the suppliers also in the future face the economic risk that results from reconciliation settlement. When meters (using either MMR or AMR) are read less frequently than the length of balance settlement window is, the balance settlement needs to be done based on estimation. Because the estimations and actual consumption never fully correspond, the error subsequently

needs to be corrected and the method used for the correction is the reconciliation settlement. At least in Finland the reconciliation settlement has been a big disadvantage for suppliers because of the fact that the size of the error is hard to predict due to bad quality of consumption data and thus estimations. Bad quality in this case means inaccurate division of consumption over time because of coarse reading frequency and bad correspondence between the load profile and the actual consumption. Since errors between estimations and actual consumption can be significant, the reconciliation costs can be large.

Combination of several different metering methods will probably prevent effective operation of the electricity market when business processes cannot be fully automated. Otherwise, there needs to be at least two sets of rules to handle these different metering methods which leads to higher costs for both DSOs and suppliers. Additionally, the process of collecting manual meter readings is slow and troublesome. For example, the supplier switch process requires readings from the on-site readable meters read by the customer or the DSO if actual meter readings are to be used.

Using several metering methods also affects the network operations because manual meters don't offer information on outages or quality of delivery. Detecting and locating outages is slower than with AMR and the customers cannot be served with as good quality of information as when using AMR registering hourly values and voltage quality values. Nor do manual meters offer the possibility of demand response since changing consumption patterns between peak and off-peak hours will not have any impact on the customers invoice with set pricing. Services based on energy efficiency may be difficult to support when there are only few customers having hourly registering AMR.

A combination of several metering methods will cause costs to those states that have already moved towards hourly registering AMR when they need to move backwards and develop costly systems for handling other customer groups. These investments would probably be used only for a limited period of time.

## 4.3 Scenario 3: No harmonized metering requirements

### Pros

Continuing with nowadays metering requirements makes it possible for the DSOs to continue working with current national rules. No changes for systems and meters are needed and thus there will be no costs for DSOs and thus for customers either.

National supplier tend to have lower obstacles when entering the national markets than foreign suppliers. It is costly for foreign suppliers, although such a market barrier can hardly be seen as a relevant "pro".

### Cons

Disadvantages with having non-harmonized metering methods are the same as or bigger than with several metering methods with harmonized rules. In addition when there are no harmonised rules for metering methods in all countries the suppliers

need to find out how to operate in every certain country with the national rules. It will cause a lot of manual work and extra costs for suppliers and also the foreign language can be a problem when there are no harmonised rules available.

With no harmonized rules for metering methods meters and systems won't get cheaper when certain metering method is not harmonisedly used in the Nordic countries. Also system development will be more expensive and not so effective without harmonised rules since there is no harmonised demand for development.

It's also more difficult to build up new services like demand response etc. for customers when it has to be made by each DSO without harmonised procedure. There is no level playing field for service providers or suppliers and entry barriers are remarkable. Entering market is difficult or even impossible. Suppliers need to have either large system to handle different processes or have different systems in different countries to be able to work according to national rules and is thus quite costly to operate in several countries.

# 5 Recommendation of the future Nordic metering method

NordREG rationalizes its recommendation on the following facts:

## EU

The EU is strongly aiming towards the roll-out of smart metering in all member states. According to the EUs 3rd package in all member states where roll-out of smart meters is assessed positively at least 80 percent of the consumers shall be equipped with intelligent metering systems by 2020. The main targets are to enable deployment of smart grids and to assist the active participation of consumers in the electricity supply. As can be seen, using hourly registered consumption values as large as possible is in line with EU's targets and it is a goal that the whole Europe is eventually heading towards. Thus, to be in line with the EU targets implementing rules for remotely readable hourly registering meters can be seen as the optimal solution.

## Harmonised Nordic retail market

The main goal for the metering task force is to further elaborate the introduction of AMR in the Nordic countries and national AMR requirements and their impacts on a harmonised Nordic end user market. One of the key questions in this task is to outline if it is possible to move forward in developing the harmonised Nordic end user market if the introduction of AMR does not take place in all Nordic countries and on what terms this could happen so that customers and market players should not be discriminated.

It is expected that automated meter reading would set the scene for well-functioning and effective Nordic retail market. By introducing automated meter reading in all four Nordic countries some e.g. business processes could be easier to harmonize. Processes could be automated in large extent and time frames for processes could be set uniformly in all countries. Automation would make the processes more effective and thus would improve the functioning of the market.

Taking one step further with the automatically read meters by hourly registration and two way communication in all the meters would in the future potentially make the business processes more effective and also open the Nordic market for competition at whole new level. With full-scale usage of hourly registered consumption values for all delivery sites all customers could in equal manner participate the Nordic retail market without the wide variety of electricity products and services been restricted to only certain customer groups with certain metering methods. Nor would there be customer groups receiving different amount of interest from suppliers. Services from which the customer is able to choose between in the electricity market should not be limited by the location of the customers home and which services the local DSO is

willing to offer. Usage of only hourly registered values would all in all create a level playing field for all suppliers without entry barriers due to different procedures required by different metering methods. From a market point of view it is important that all suppliers who are willing can operate in all countries without unnecessary entry barriers. Entry barriers such as different operating systems for different countries will skew the functioning of the market.

Having the same metering method and rules would enhance the technical development of meters and data system as user volume increases. A harmonised market with harmonized rules for metering methods and thus with harmonised rules for processes is more attractive to system providers. This will increase competition between system providers and possibly lead to reduced costs and more effective systems in the whole Nordic. This will also improve energy companies' possibilities to work together with IT system providers and be more of a driving force when designing new systems. Harmonised metering method would also promote the energy saving targets by making it more profitable to offer energy saving services when it could be done on the whole Nordic retail market scale. Thus, moving towards using only hourly registered consumption data in all processes could eventually benefit also customers due to e.g. the daily reporting of one's own consumption, a tool for energy efficiency, improved network management and cost efficient meter reading.

## Nordic balance settlement

In the Nordic balance settlement model presented by the relevant TSOs a party called Settlement responsible will handle the calculation of balance settlement for all three countries Sweden, Finland and Norway and handle also other specific tasks related to balance settlement. To be able to do this it requires large amount of information. The TSOs suggest that the information eventually should be sent from the DSOs to the Settlement responsible. Due to different metering methods in different countries some calculations have to be done to make this information analogous. These calculations have to be done either by the TSOs or the DSOs before delivering the information or by the Settlement responsible after receiving the information. Either way needed functionality will incur costs in all countries. Since the hourly metering can already now be seen as the future solution in all four Nordic countries, the TSOs have decided that the Settlement responsible should not carry out reconciliaton settelement as a part of Nordic balance settlement. This should still be a country specific task for each TSO. Harmonizing metering methods and reading frequencies in the Nordic countries would result in more simple Nordic balance settlement model and thus less expensive solutions.

## Costs

The biggest downside of implementing full-scale usage of AMR and hourly registered consumption values is seen to be the resulting costs. Nevertheless all meters and DSOs data systems have to be in the future renewed or at least updated at some point in all four countries.

# NordREGs Recommendation

NordREG issues the following recommendations:

Metering method: Automatic meter reading should be implemented in all four Nordic countries for all of the customers to facilitate effective and functioning Nordic retail market. Time frame for implementation shall be decided nationally.

Meter capabilities: Meters should be capable to register energy usage at least on an hourly basis. However the time frame for implementation should be decided on a national basis. For cost reasons it could be allowed nationally to make an exception in the hourly metering requirement in cases when electricity consumption at the consumption point can be estimated exactly, meaning that the consumption is time-wise constant (e.g. combustion gas fans, automatic traffic control cameras, single traffic lights, street lights etc.).

Meter reading frequency: Meter reading should be done daily . For customer with low consumtion, the meter reading frequency could be decided upon nationally according to e.g. a cost-benefit assessment. The meter reading frequency should be in compliance with the time limit decided for the balance settlement period so that verified consumption data is used.

NordREG finds that it would be beneficial to continue working toward future harmonised metering functionalities. Other metering method related issues such as harmonised rules for correction of metered data may be areas to be further considered by NordREG when planning future activites.

# 6 Objects for further studies

## 6.1 Corrections concerning AMR

Remote reading is not bullet proof and there will always be a small percentage of meter readings missing. Because of that there need to be harmonised rules for corrections of meter readings. There is a risk that if a balance settlement window is defined too short, this will mean a great number of corrections in hourly values after the balance window. A harmonised way of handling these corrections is thus needed. Preferably this could be done by the NBS Settlement Responsible (SR) or bilaterally between suppliers (via DSO) or some other method.

Errors in metering data can arise from various reasons:

- Errors in meter reading – temporary or more lasting communication problems that lead to missing metering data.
- Errors in values collected by the meter – broken meter on faulty wiring that leads to faulty metering data.
- Errors can cause metering data to be missing or the metering data received to be faulty.

## 6.2 Data protection

According to the EU Commission Recommendation on preparations for the roll-out of smart metering systems, Member States should strongly encourage network operators to incorporate data protection by design and data protection by default settings in deployment of smart grids and smart metering. Article 29 working party  stated that all data from smart metering is to be considered as personal data.

## 6.3 Remote load control

Of particular concern to all participants including the customer is the potential for the smart meter to be the gateway by which the electricity supply can be controlled remotely – either the entire supply (through remote disablement or load/small scale generation limitation) or individual appliances (e.g. through signals sent to chips in the equipment to effect load limitation or time shifting). There is likely to be considerable industry debate about how this area of functionality is to be provided and this will have implications for the commercial, technological, industry and regulatory structures within which such services will be made available. It should be researched and promoted the possibilities to make the most of AMRs in means of load control and demand response even though the actual service should be carried out byt service providers and not as a part of DSOs monopoly operation.

## Definitions and clarifications

Words or expressions used in this report:

***Automatic meter reading (AMR)***

Meter reading is done automatically and remotely via data transmission system. No on-site reading needed

***Advanced metering infrastructure (AMI)***

Differs from AMR in that it enables two-way communications with the meter

***Advanced Metering and Management Systems (AMS)***

Norwegian regulatory term for smart meters, and includes the same functionality as AMI.

***Balance responsible party (BRP)***

BRP is a party who has an agreement with the TSO to produce and/or consume balancing power or neutralize imbalances in a network area

***Balance window***

Period lasting from the electricity delivery to the end of the distribution networks balances

***Central database (CDB)***

Database for all customer data, consumption data and meter data

***Communication platform***

A platform for the means by which the electronic documents are exchanged

***Consumption data***

Estimated data, consumption profiles, meter readings and metered hourly loads

***Cumulative reading***

Metered quantity with an accumulated value

***Customer data***

Customer data can consist of for example customer name, meter address, billing address, birth date, customer identification number, phone number or other contact info etc.

***Data transmission protocol***

A set of rules, which devices must comply with to enable data transmission (data transmission frame)

***Delivery point***

A point in the electricity network where electric energy is transmitted from one party to another

***Distribution System Operator, DSO***

Network operator who controls a distribution network and practices licenced network operation.

***EDIFACT***

Predefined business documents to be used in business processes, e.g. PRODAT, MSCONS, UTILTS messages

***Electricity market participant***

Electricity vendor for the delivery point, vendor with a delivery obligation, system operator, or balance responsible party for one of the above

***Electronic data interchange (EDI)***

A structured data transmission between organizations by electronic means. It is used to transfer electronic documents or business data from one computer system to another computer system.

***Energy Service Company (ESCO)***

A commercial business providing a broad range of energy solutions including designs and implementation of energy savings projects, energy infrastructure outsourcing, power generation and energy supply, and risk management.

***Hourly data***

A general term meaning either hourly load or hourly reading

***Hourly load***

An average load for each hour. This may be calculated as a difference of two consecutive hourly readings

***Hourly metering***

Hourly measurement of the amount of electricity and the registration of this metering data in the memory of the metering equipment

***Hourly metering equipment***

Metering equipment for measurement and registering of electricity consumption or feed to the network in the memory of the equipment. The data registered by this equipment may be read from the memory of the equipment via the data transmission network

***Hourly value***

Cumulative reading measured and registered by the metering device for each full hour, not taking into account, e.g. two separate readings of two-rate products

***Information exchange system (IES)***

IES is a description of the way information is exchanged between DSOs and suppliers in the market. Such a system can therefore consist of many different components e.g. point to point EDI messages, web service like NUBIX, central databases etc.

***Load curve***

A load curve is a chart showing the amount of electrical energy that customers use over the course of time. Power producers use this information to plan how much electricity they will need to make available at any given time

***Load profile***

A graph of electrical load variation versus time. A load profile will vary according to customer type (typical examples include residential, commercial and industrial), temperature and holiday seasons

***Manual meter reading (MMR)***

Meter reading of mechanical meter done on-site

***Master data***

Information which can consist of data about customers, addresses, metering points etc. This information is the key to the operation of the business of suppliers, BRPs, datahubs and others.

***Meter data***

By this we mean information about the meter such as metering point ID, meter number, whether the meter is manually read, remotely read or just estimated, and also other relevant technical information about the meter

***Metering data management system***

A system used in the recording and processing of data gathered from the metering device. Inspection of metering data, correction of statuses and forwarding of hourly data take place in the metering data management system

***Metering device***

A general term for a meter at a metering site used for hourly energy metering

***Metering equipment***

An entity consisting of the metering device and the data transmission connection

***Metering point***

A point in the electricity network where the current transformer of meter of the metering equipment at the delivery point is connected

***National regulatory authority (NRA)***

The regulatory institutions of the Nordic countries responsible for promoting free choice of supplier, efficient and competitive prices and reliable and sustainable supply through the internal Nordic electricity market.

***Reading system***

A system for gathering readings and maintaining the settings of the metering device

***Supplier***

The company that is the seller of electricity to the end user

***Smart meter***

See AMI. 'Smart metering system' means an electronic system that can measure energy consumption, adding more information than a conventional meter, and can transmit and receive data using a form of electronic communication. 'Data protection impact assessment' means a systematic process for evaluating (Commission Recommendation of 9.3.2012 on preparations for the roll-out of smart metering systems.)

***Smart grid***

A Smart Grid is an electricity network that can cost efficiently integrate the behavior and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety. 'Smart grid' means an upgraded energy network to which two-way digital communication between the supplier and consumer, smart metering and monitoring and control systems have been added (Commission Recommendation of 9.3.2012 on preparations for the roll-out of smart metering systems.)

***Status of hourly data***

The status recorded for the hourly data indicates the reliability of the data to the recipient of the data

***Supplier***

The company that is the seller of electricity to the end user

***Supplier of last resort***

The electricity supplier that is appointed to deliver electricity to customers who cannot find a supplier on the market or when a supplier goes bankrupt. Is normally the same as the incumbent supplier

***Supply-responsible supplier***

A supplier that is in a cooperation with a DSO or is an integrated company in the DSO business. In some DSO-areas the incumbent supplier has the responsibility to deliver electricity to those customers who haven't raced their electricity contract

***TSO***

The transmission system operator which is obliged to transmit energy in the form of electrical power or natural gas on a national or regional level using fixed infrastructure facilities

# Annex

## Smart Grids

A Smart Grid is an electricity network that can cost efficiently integrate the behavior and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety. Though elements of smartness also exist in many parts of existing grids, the difference between a today's grid and a smart grid of the future is mainly the grid's capability to handle more complexity than today in an efficient and effective way. A smart grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies in order to:

- Better facilitate the connection and operation of generators of all sizes and technologies
- Allow consumers to play a part in optimizing the operation of the system
- Provide consumers with greater information and options for how they use their supply
- Significantly reduce the environmental impact of the whole electricity supply system
- Maintain or even improve the existing high levels of system reliability, quality and security of supply
- Maintain and improve the existing services efficiently
- Foster market integration towards European integrated market

Smart grids have an essential role in the process of transforming the functionality of the present electricity transmission and distribution grids so that they are able to provide a user-oriented service, supporting the achievement of the 20/20/20 targets and guaranteeing high security, quality and economic efficiency of electricity supply in a market environment. Smart grids can also form a level playing field for service providers enabling demand response services and small scale production. Their development will be facilitated by the wide-scale deployment of electricity smart metering, as envisaged in 3rd Energy Package, Directive 2009/72/EC. As electricity network infrastructures are investments with long-term returns, they require a stable framework. Some smart grid functionalities will depend also on certain of the additional functionalities provided by smart meters. Indeed the latter will allow the full capabilities of a smart grid system to be realized and the two projects may share the same telecommunications system.

The scale of smart meter deployment and their data capabilities offer the prospect for vast amounts of detailed data to be gathered. However in this context, the meter is only one of the sensors or actuators in a smart grid - other data will also be available and used by grid management and control systems. Smart grids thus encompass a much wider area than smart metering, but smart metering is an important first step towards a smart grid:

- Smart meters bring intelligence to the “last mile” between the grid and the final customer.
- Without this key element, the full potential of a smart grid will not be realized.

Accurate measurement through smart metering is essential to building a new set of functions to support the smart grid. Again, the support for advanced tariffs and payment enable utilities to manage the grid in close contact with their customers, by using pricing signal to reduce peak loads. Remote disablement and enablement of power supply gives an additional tool to enhance system reliability in critical load situations. Information through home portals and gateways, or direct communication to other devices in home empowers customers to make choices about energy consumption. Data collected through smart metering systems, that include consumption profiles, outage data, distribution network status can be further used for smart grid strategic planning, asset management and improvement, through data analysis and forecasting.