Annual Report 2008

Nordel

Cover photo: Børje Heikkinen

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Nordel

Nordel is the collaboration organisation of the Transmission System Operators (TSOs) of Denmark, Finland, Iceland, Norway, and Sweden.

Nordel's objective is to perform the following core tasks within system responsibility across the national borders:

- to ensure the operational security of the power system,
- to maintain the instantaneous balance between supply and demand,
- to ensure and maintain the short term and long term adequacy of the transmission system,
- to enhance the efficient functioning of the electricity market.

Nordel is in continuous dialogue with the authorities and the market participants. This is important for the evolution of an efficient electricity market and for maintaining the security of supply.

The highest decision-making body is Nordel's annual meeting. The annual meeting elects the President of Nordel for a period of two years. The Presidency rotates between the countries. The President appoints Nordel's secretary and is responsible for the secretariat and its costs. The organisation has no budget of its own.

The Nordel Board consists of the chief executive officers of the TSOs. The Board has overall responsibility for the work within Nordel.

A major part of Nordel's work is carried out by the Market, Operations, and Planning Committees as well as working groups. The Committees consist of the leaders of the corresponding sections of the TSOs. The working groups are staffed by the TSOs' experts.

Key figures for 2008

		Nordel	Denmark	Finland	Iceland	Norway	Sweden
Population	mill.	**25.2**	5.5	5.3	0.3	4.8	9.3
Total consumption	TWh	**412.7**	36.1	87.0	16.6	128.9	144.1
Maximum load[1]	GW	**61.0**	6.1	12.5	1.7	18.4	22.2
Electricity generation	TWh	**414,0**	34,6	74,1	16,5	142,7	146,0
Breakdown of electricity generation:							
Hydropower	%	**58**	0	23	75	98	47
Nuclear power	%	**20**	-	30	-	-	42
Other thermal power	%	**19**	80	47	0	1	10
Wind power	%	**3**	20	0	-	1	1
Geothermal power	%	**-**	-	-	25	-	-

[1] Measured 3rd Wednesday in January - = Data are non-existent 0 = Less than 0.5 %

Report of the Board

From a Nordic to a European organisation

As the energy market develops, cooperation between the TSOs has to develop as well. Nordel is an organisation that has changed its way of cooperation several times through the years. From 2009 Nordel will take a new step when the organisation is incorporated into the new European TSO organisation, European Network of Transmission System Operators for Electricity (ENTSO-E). A long history will then come to an end, when Nordel as an organisation is wound up.

The Nordic TSOs have a long history of cooperation through Nordel. Nordel was established by the major Nordic power producers in 1963. When the liberalisation of the Nordic power market took its first steps in the early 90s, Nordel changed its statutes in order to better respond to the structure that emerged when the grid operations of the power companies were separated from the rest of their operations. Despite the fact that Nordel still was an organisation for producers and grid operators, the first step was taken to implement the important separation of grid operation and production. This was finalised in 2000 when Nordel became an organisation solely for the transmission system operators.

As a TSO organisation the objective was to prepare the conditions for an efficient and harmonised Nordic electricity market and to develop the market further. In 2007 Nordel's strategic agenda identified the most important actions to ensure further development, both on the Nordic and on the multiregional level. The strategic agenda is in accordance with and contributes to the European vision of an efficient European electricity market with high power system security. An important tool to achieve this goal is to establish ENTSO-E.

ENTSO-E was established December 19, 2008. The organisation has 42 members (TSOs) and will replace regional TSO organisations such as Nordel. The regional activities are transferred to ENTSO-E where the work will continue. The fact that ENTSO-E will be the only TSO organisation in Europe, made it crucial for Nordel to secure that ENTSO-E would become an efficient organisation where regional development could continue. Nordel has therefore put a lot of effort into securing Nordic issues. In our view we have succeeded and are convinced that ENTSO-E will further strengthen the TSO cooperation and contribute to integrate the European electricity market, and that this will benefit the Nordic market. Further information on ENTSO-E and the future Nordic cooperation is given in this year's article "From Nordel to ENTSO-E".

Nordel's strategic agenda

Nordel's mission is to promote a seamless Nordic electricity market as an integrated part of the North-West European electricity market and to maintain a high level of security in the Nordic power system. Nordel has therefore continued the work on the package of concrete actions according to the strategic agenda, and goals have been attained during the year.

A complete Nordic Intra-day market
Nordel has recommended that all the Nordic countries should be integrated in the Elbas market. As a consequence Norway joined the Elbas market on March 4, 2009. All Nordic countries are now a part of the intra-day market which makes Elbas the first regional intra-day market in the world. Elbas also enables cross-border intra-day trading between the Nordic countries and Germany via the physical cables to Denmark and Sweden.

Elbas gives the market participants a tool to handle their imbalances close to the operating hours. In expectation of a lot of new renewable energy in the coming years, the intra-day market will become an ever more important balancing tool in the future.

Common balancing management implemented
During 2008 one of Nordel's strategic actions has been to implement the Nordic harmonisation model for balance management. From January 2009, harmonised principles became effective in Denmark, Finland and Sweden. In Norway the principles are expected to become effective from September 2009. After implementing the agreed harmonised principles, the balance management in the Nordic countries could be regarded as well harmonized. This is a major step for a common Nordic retail market, which is on the agenda of the Nordic Governments and regulators.

Improved balance and frequency control
Maintaining the frequency quality in the synchronous Nordic system has been a challenge over the last years. The main reasons for this are the development of the power markets within the Nordic region and the increasing number of HVDC connections to the neighbouring synchronous areas. Several steps have already been taken by the Nordic TSOs to address these challenges since the introduction of the Nordic power markets. However the development requires new and improved measures and Nordel has therefore continued their work with actions in order to improve the balance and frequency control of the synchronous Nordic power system. The actions comprise further harmonisation of rules and principles, better tools for planning and balancing, and programs for training the control room staffs.

Increased multi-regional cooperation has been developed in operations as well, and the DC loop flow is a good example on how this can lead to more efficient operations. The DC loop flow is explained on page 12.

Nordic Grid Master Plan
During the last decade, the planning process in Nordel has moved towards integrated Nordic planning concerning grid reinforcements and expansions. This regional cooperation is unique in Europe and shows that Nordel is a forerunner in ensuring a well functioning regional electricity market. The successful Nordel cooperation in transmission planning aims to develop the grid from a Nordic perspective taking into account both international aspects and environmental impact.

The previous Grid Master Plan released in 2004, resulted in a recommendation to build five major transmission projects. The cooperation has now taken another step when Nordel launched the 2008 Grid Master Plan. The plan was based on scenarios including a substantial increase in renewable energy generation. Together with the existing plans in each Nordic country, the investments in the Nordic main transmission grids will be doubled and reach a level of € 700 million/year.

In addition to the Nordic projects, Nordel recommends that studies be initiated to investigate further interconnections between the Nordic grid and neighbouring areas. As a consequence, the TSOs in the Baltic Sea region (BALTSO, Nordel and UCTE), have established a common modeling tool. The tool analyses the multi-regional market benefits from possible interconnectors between the involved areas. The results of the performed market studies are available at *www.nordel.org*.

Presidency moved from Finland to Norway

At the annual meeting of 2008, the Presidency of Nordel moved to Statnett. Odd Håkon Hoelsæter, President and CEO of Statnett was elected President. After more than 17 years, Hoelsæter left his position as President and CEO of Statnett at the end of January 2009. Auke Lont succeeded Odd Håkon Hoelsæter as President and CEO of Statnett, and from February 1, 2009, Auke Lont serves as the President for Nordel and the Norwegian Presidency until the last annual meeting in June 2009.

The members of the Board and the Chairmen of the Committees

Auke Lont,
Statnett SF
(President)

Peder Østermark Andreasen,
Energinet.dk
(Vice President)

Mikael Odenberg,
Svenska Kraftnät

Jukka Ruusunen,
Fingid Oyj

Thordur Gudmundsson,
Landsnet hf

Lene Sonne,
Energinet.dk
(Market Committee)

Mikael Engvall,
Svenska Kraftnät
(Operations Committee)

Jussi Jyrinsalo,
Fingrid Oyj
(Planning Comittee)

Outgoing Board member on 31 January 2008

Odd Håkon Hoelsæter
(Statnett SF)

Photo: Emil Thor

Electricity market

The Nordic electricity market in 2008

During spring and summer the prices of oil and coal rose to record-high levels causing the electricity price to rise as well. Even though the international financial crisis resulted in lower electricity prices at the end of the year, the average electricity prices in 2008 were still higher than in 2007.

The hydrological situation was the opposite. Due to high water levels in reservoirs at the beginning of 2008 and high inflow during 2008, hydro production was high during 2008.

Transmission capacity was restricted on some of the interconnections during 2008. The interconnection between Jutland and Norway, Skagerrak 3, was out of operation from August 2007 until July 4, 2008, diminishing the capacity by 50 %. In March 2008, failures on the subsea cables crossing the Oslo Fjord resulted in considerable restrictions on the transmission capacity from Norway to Sweden. Full capacity is expected in June 2009.

As a consequence of high hydro inflow and the considerable constraints on interconnections, prices were the same in the Nordic region for just 7 % of the time. There were long periods with large price differences: Lowest average price in Southern Norway was € 32,5/MWh, highest average price in Jutland was € 54,9/MWh.

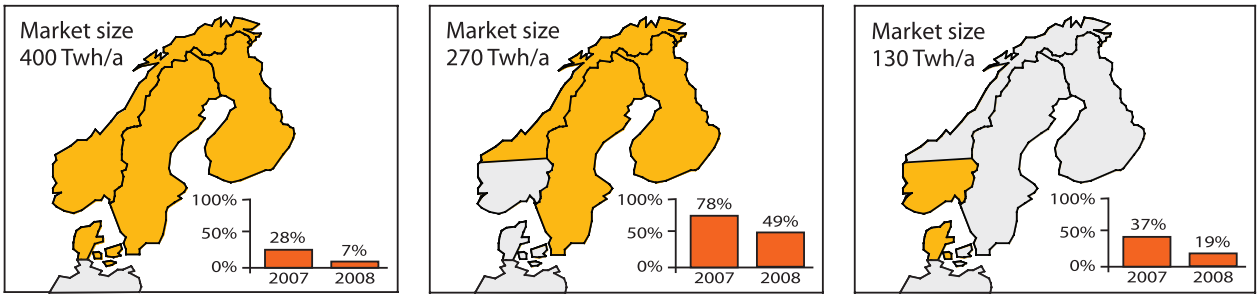

Figure 1. The Nordic integration in 2008 is illustrated by the duration of the same day-ahead price, percentage of hours, in different Nordic regions. The annual consumption of electricity (TWh/a) describes the size of the market in the corresponding region.

Market coupling improves integration

To obtain a competitive and efficient European electricity market, it is necessary to further integrate the markets in Europe. An efficient integration of markets improves competition, ensures security of supply, and improves the use of the existing infrastructure while also sending the right investment signals to generators and network operators.

To tackle the climate change, the ambitious renewable targets have to be met. This will be difficult without competitive integrated markets.

Common market structures and market coupling, allowing efficient use of cross border interconnectors, are prerequisites for integration. Part of the Nordel strategic action plan is therefore to promote market integration with neighbouring countries. Several market coupling projects have already been started:

- Implementation of market coupling between EEX and Nord Pool Spot. On September 29, 2008, Germany and Denmark were coupled through the EMCC solution (European Market Coupling Company), which is day-ahead implicit auctioning. EMCC experienced problems with flow and price calculations and market coupling was temporarily suspended in order to resolve these problems. EMCC will re-launch during the second quarter of 2009.
- Baltic cable. The Baltic cable between Sweden and Germany will become part of the EMCC solution in 2009.
- Price area Estlink. A co-project launched by Nord Pool Spot to integrate the Baltic power market into the Nordic power market. A share of the capacity at Estlink cable is to be made available to the market and will be sold through the Nord Pool Spot implicit auction. Based on the work of the project Nord Pool Spot continues to work on establishing the Estlink price area.
- NorNed market coupling. The NorNed cable between Norway and the Netherlands was made available to the market based on explicit auctioning of capacity on May 5, 2008. Statnett and TenneT, the Dutch transmission system operator, are working on establishing market coupling based on an implicit auction on NorNed as soon as possible.
- Establishment of a common market structure and market coupling with Central Western Europe (CWE). The CWE region has started a market coupling project covering the markets in Germany, France and Benelux. The market coupling is expected to start in March 2010.
  A common Nordic-CWE project is investigating the possibility of connecting the two market coupling projects.

In 2008, a study on regional market integration and the coupling of regional markets was carried out in cooperation between the Association of European Transmission System Operators (ETSO) and the Association of European Power Exchanges (EuroPex). The Study had a Nordic project leader and members from the Nordic TSOs. The final report "Development and Implementation of a Coordinated Model for Regional and Inter-Regional Congestion Management" was well received at the Florence Forum in November 2008 and the European Regulators Group for Electricity and Gas (ERGEG) was asked to establish a Project Coordination Group of experts. The task of the group is to develop a practical and achievable model to harmonise interregional and later EU-wide coordinated congestion management.

Explicit and Implicit auction - efficient market coupling

Explicit auction: transmission capacity on an interconnector is auctioned separately from the energy trade. This can lead to flow from a high price area to a low price area resulting in inefficient utilization of transmission capacity - especially when the area price differences are highly unpredictable.

Implicit auction/Market coupling: capacity and energy are auctioned simultaneously, ensuring optimal use of the transmission capacity since electricity always flows from the low price area to the high price area.

Implicit auction improves optimal hourly utilization of the cross border capacity between Denmark and Germany by an additional 20 % of all hours.

A transparent Nordic market

Transparent market information is an important strategic goal for Nordel. It is crucial that all market participants have access to the same market information and Nordel is therefore working towards being a forerunner in Europe on transparency.

Nordel will continue to implement the requirements issued by ERGEG's North European Electricity Regional Initiative. Nordel is committed to go beyond the official requirements and provide better and more accurate data to the market.
Nordel and Nord Pool Spot are working closely together on publishing information at *www.nordpoolspot.com* and on establishing user-friendly access based on the expectations of market players. New information is published on the website in 2009: balancing data,

Lempäälä Pirkanpylväs
Photo: Juhani Eskelinen

external connection data, wind power forecast, long term transmission capacity development, congestion income and real time state of Nordic power system.

Information on the Nordic market can also be found at *www.etsovista.org* - the European website developed and funded by ETSO.

Harmonisation of balance service and regulation market

Balance management is used by TSOs to physically balance the system in the hour of operation and to settle the imbalances after the hour of operation.

If the vision of a common Nordic end-user market is to be fulfilled, a harmonised Nordic balance management is required. Market participants need to have the same tools available and the same rules to follow.

During 2008 it has been one of Nordel's strategic actions to finalise and implement a Nordic harmonisation model. From January 1, 2009, the following principles became effective in the Nordic countries:

- One-price settlement for consumption imbalance and two-price settlement for production imbalance.
- A more harmonised cost basis for balance management and a common fee structure.
- Intra-day trading in all Nordic countries (Norway from March 4, 2009).
- A harmonised gate closure, of 45 minutes before the start of the operating hour, for submitting intra-day production plans and regulating bids. The same time will be applied for intra-day trade plans (except in Finland where 20 minutes will remain).

In Norway, the principles will be effective from September 2009, with the exception that small scale renewable power stations below 3 MW shall be settled as consumption.

Following the harmonisation of these agreed principles Nordic balance regulation is well harmonised even though some national differences still exist. Nordel has therefore investigated the remaining differences in the Nordic countries and published a report proposing further work to be carried out in 2009.

In the beginning of 2009, Nordel started up a limited common Nordic monitoring of the regulated power market as a supplement to national monitoring. The goal is to help evaluate the behaviour of the market players and to evaluate if the practical TSO operation corresponds to the defined principles. The common monitoring will be continuously developed and broadened in 2009.

Establishment of Elbas (intra-day market) in Norway

Norway joined the Elbas (intra-day market) on March 4, 2009. This enables cross-border intra-day trading between Norway and the other Nordic countries and Germany via the physical cables to Denmark and Sweden.

Congestion management

Investments in the Nordic region have risen to over € 600 million/year. However, not all congestion is reasonably handled by investments from a socioeconomic point of view. Instead common principles for efficient market-based handling of the existing interconnector capacity in the operational phase are of importance.

In order to manage the existing problems with congestion management in the Nordic area, the Nordic Council of Ministers has asked the Nordic TSOs to start a process of splitting the Nordic market into additional price areas and/or bidding areas.

In principle congestions should be handled where they are physically located. The Nordic TSOs have therefore, as commissioned by the national authorities, started national processes of establishing more potential price areas and/or bidding areas for bottlenecks which are not feasible to handle with counter-trade. The work is coordinated within Nordel.

Electricity market in Iceland

Landsnet is continuously improving the Grid Code for market needs and adapting EU regulations. New terms released in 2008 and early 2009 are among others terms on congestion management, interruptible transmission services and improved balance mechanism.

Further preparations for the establishment of an electronic trading platform for power exchange were carried out in close co-operation with NordPool Spot.
The conclusion was to base the Icelandic power market on the Elbas principle, and adding the possibility of a week-ahead market, an additional feature over and above the day-ahead principle used in Elbas.

The Icelandic market, which has been given the brand name ISBAS, was ready for launching in late 2008. However, due to the financial situation in Iceland and the subsequent fall of its stock market, Landsnet decided to postpone the opening of this market.

Global interest in utilising Iceland's green energy is considerable, and investors are considering new aluminium smelters, data centres and other energy intensive industries in the country. A continuous growth in power transmission is forecasted, and in 2009 the energy transmitted is expected to have increased by 100% since Landsnet was founded in 2005.

Icelandic sunset
Photo: Landsnet

The Fingrid Power System Control Centre
Photo: Juhani Eskelinen

System responsibility and operation

An operational review for 2008

During 2008 there were no major black-outs in the Nordic electricity system. However, limitations on interconnections and in power plants have been a challenge for the system operation during 2008.

In March, a fault occurred on one of the three subsea cables which cross the Oslo Fjord. Just a few weeks later another fault, independent of the first, was detected on a second subsea cable. With two of the three subsea cables out of order, the capacity between Norway and Sweden was substantially reduced. The fault-localization and repair were challenging due to the location of the cables and weather conditions, and have taken longer than expected. In late November one of the cables was back in operation and consequently the capacity could be increased except for periods with cold weather conditions. Full capacity is expected in June 2009.

At the end of 2008, several nuclear power plants in Sweden were out of operation. Two units with a total capacity of 2292 MW were taken out of operation due to problems with the control rods. The severity of the failure and difficulties in acquiring new control rods caused the start-up to be delayed until January 4, 2009.

Another unit (859 MW) was delayed as a result of an annual maintenance in October. The start-up was delayed until January 5, 2009.

With production out of operation and the uncertainty of when it could be back in use, combined with the restricted capacity from Norway, the power balance in Sweden had to be revised for the coming winter period. The production outages also affected the transmission capacity in cut 2 and cut 4 in Sweden during periods with colder weather.

The NorNed cable between Norway (Feda) and the Netherlands (Eemshaven) was put into operation on May 6. The cable will contribute to security of supply both in Norway and the Netherlands.

In Iceland, the year 2008 began with a period of several weather-related disturbances in the transmission system, which caused outages in power delivery to distribution companies and power-intensive industry.

The hydro station Sultartangi was out of operation most of the year due to failures in the station's step-up transformers. The aluminium smelter in eastern Iceland was fully operational after completing the start-up phase in April.

Two new generating units were put into operation in Hellisheidi geothermal power plant in the fall of 2008.

Frequency and balance control – a prioritised challenge

Maintaining the quality of the frequency in the synchronous Nordic system has been a challenge over the last years. Increased trade with Continental Europe and between the Nordic countries has led to larger variations in the hourly trade and therefore increased hourly changes in the power flow.

Nordel continued the work to develop new measures to improve the balance and frequency control of the synchronous Nordic power system during 2008. This is brought to a level which supports a secure operation with the current market solutions.

The planned (and some already implemented) actions comprise harmonised rules and principles, improved tools for planning and balancing, and training programs for personnel in the control rooms.

Actions to improve the control of daily operations can be separated into two sub-categories, operating plans and balancing tools.

Improved operating plans

Better operating plans imply a second level of plans (quarterly operating plans) which set out details and restrict the physical operation of the power system within the operating hour, in order to reduce the inherent imbalances of the current hourly plans. As a first step, a ramping restriction on all HVDC links has been implemented to lower the maximum changes in the power flow between the synchronous areas from one hour to the next.

In order to integrate and improve the operations planning among the Nordic TSOs, common rules for all BRPs (Balance Responsible Party) in the Nordic countries are necessary. In the beginning of 2009, harmonised rules for gate closure times for production plans and bids in the regulating power market were implemented. The plans have to be submitted to the TSOs no later than 45 minutes before the operating hour. The next step regarding production plans is to harmonise the level of details within the operational hour and activate measures to be better able to follow the physical operation. In a longer perspective Nordel will also start to investigate more closely a possible implementation of quarterly settlement.

Improved balancing tools

A set of better and new balancing tools on top of the quarterly operating plans is suggested. This set of tools shall offset the imbalances which remain during the operating hour even if sound operating plans are prepared and followed. They also increase the automatic reserves to provide a quicker and more optimal use of reserves compared with manual control. Examples of such actions under investigation are:

- System protection schemes on HVDC connections.
- Use of automatic generation control (AGC) such as
  - Load frequency control (LFC)
  - Load following.

Efficient use of the operational reserves will improve the operational security and enhance the efficiency of the integrated electricity market. Nordel is currently working with investigations on optimal volume of reserves and cost-effective market-based purchasing methods for both automatic and manual reserves.

Stable frequency crucial to the security of supply

In order to maintain a high level of security in an electric power system a continuous and momentary balance between production, consumption and exchanges is required. For the synchronous Nordic power system this is expressed through the criteria that the frequency has to be kept within the interval of 49,90-50,10 Hz. Primary reserves in the form of frequency controlled normal operations reserves (FNR) and frequency controlled disturbance reserves (FDR) are dimensioned for imbalances caused by stochastic variations of consumption and grid/production failures.

When the frequency is outside the allowed interval, the automatic reserves are temporarily activated as a first step. They have, however, to be replaced by other manually activated resources, e.g. bids on the regulating market or other manual reserves to be prepared for an increasing or new imbalance.

This means that if the frequency is below 49,90, remaining reserves may be below recommended volumes defined with regards to security reasons.

NOIS – A common Nordic tool for control rooms

In 2002, a pilot project for a common Nordic information system was implemented. The Nordic Operational Information System (NOIS) is a tool for the control rooms of the Nordic TSOs and supports the operational processes. In 2006, Nordel decided to develop the NOIS system to further improve the transparency of information and strengthen operational cooperation. The system supports the management of balance, capacity, reserves and planned outages. Furthermore, the system will have supportive functions for urgent operator alerts, reporting and statistics. The new NOIS-system has become operational during spring 2009.

Increased multi-regional cooperation

Within both Nordel and the Union for Coordination of Transmission of Electricity (UCTE) the operational cooperation between the TSOs has developed through many years. An important element in Nordel's strategic agenda is also a strengthened cooperation with the TSOs in the neighbouring North European regions.

Based on an initial status and overview prepared by Nordel in the first half of 2008, a working group on multiregional operational cooperation was formed in September 2008 between E.ON Netz, Energinet.dk, Fingrid, PSE-Operator, Statnett, Svenska Kraftnät, TenneT and VE Transmission.

Areas for possible harmonisation and development of the interoperability of the HVDC links between the partners i.e. NorNed, Skagerrak, KontiSkan, Kontek, Baltic Cable and SwePol Link have been identified. The focus is on issues of operational co-operation with respect to the grid- and system security. The work will be input to, and in respect of the development going on through ENTSO-E towards common rules for UCTE and Nordel.

Photo: Statnett

DC-loop – a good example of cooperation

A good example of the multi-regional cooperation is the so-called DC-loop flow, a procedure that makes it possible to move power around in a closed loop. This is made by simultaneously changing the scheduled exchanges on at least two HVDC links between Nordel and UCTE, accompanied by relevant modifications in scheduled exchanges within UCTE and Nordel. An example is shown below in Figure 2.

The clockwise DC loop flow makes it possible to relieve network constraints in AC (alternating current) systems in the areas located between the HVDC links.

The changes of exchange schedules do not lead to any change of generation level in any control area involved. This means that there is no need to increase or decrease any generation and thus there is no extra cost of generation.

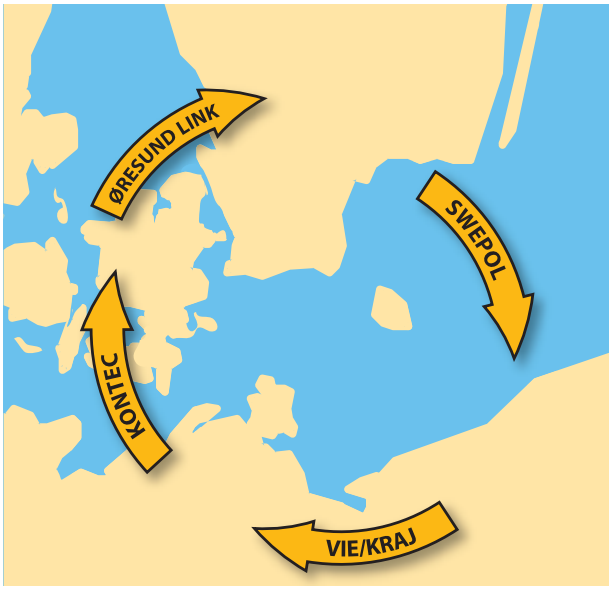

Figure 2. Illustration of DC-loop flow.

An example of how the DC-loop works

Example: In case of high wind conditions in northern Germany network constraints can occur on the Polish – German border. With the DC-loop, the physical flow from Germany to Poland can be decreased. This has actually occurred a few times since the agreement started and the DC-loop was successfully used to relieve the constraints.

Improved training programs

An improved common training programme for the staff in the Nordic control rooms for both normal and emergency situations has been launched. The programme is implemented on an annual basis and relates to both grid operations and balance control. The training sessions comprise both lectures and workshops. The participants also have an opportunity for simulator practice. The main topics for the training sessions are to understand the Nordic System Operation and handling of power shortages. The working group responsible for the training programs also prepares a yearly evaluation report.

Common principles for outage planning

The Nordic TSOs coordinate and plan the activities for operations and maintenance of the Nordic interconnected electric power system so that the power market is optimised with regard to the security of supply and the available transfer capacities to the market.

For several years the coordination and planning of the outages between the TSOs have been performed by a group called Nordel Outage Team. This concerns mostly the outages of the interconnections between the Nordic subsystems and with the neighbouring regions e.g. UCTE, Russia and Estonia. Outages at internal connections in the subsystems are also considered when they affect the cross-border capacities.

The practical accomplishment of the coordination and planning is now done according to common principles agreed upon between the TSOs and published on *www.nordpoolspot.com*.

Energinet.dk's new Control Centre Electricity at the headquarters in Fredericia
Photo: Palle Peter Skov

The transformer platform for the Horns Rev 2 offshore wind farm is sailed out
Photo: Bent Sørensen

Network development

Numerous new Nordic grid projects

The main driving forces pushing the grid development forward are security of supply, environmental commitments and European market integration.

There is increasing demand for even higher security of supply since society is becoming ever more dependent on electricity. The European commitments to the integration of renewables and reduction of CO_2 emissions by the year 2020, as well as other mechanisms, will lead to a substantial expansion of wind-power in particular in the system. This will again require greater transmission capacity. All this leads to urgently required reinforcements and must be seen in a wider regional context.

Investments in the Nordic grid have risen to over € 600 million /year, and will rise even higher in the future, which is shown in figure 3. This will lead to a significantly strengthened Nordic power grid.

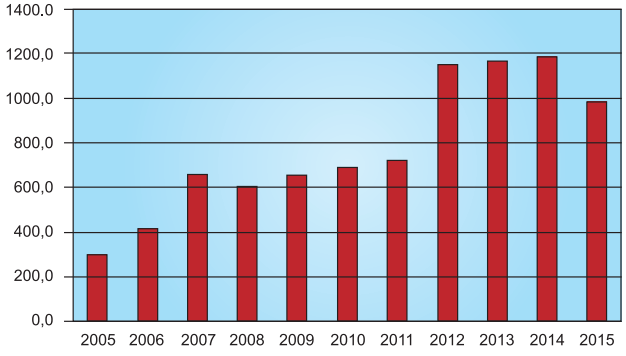

Figure 3: Nordic investments 2005-2015

Increased co-operation in grid planning

The successful Nordel cooperation in system planning aims to develop the Nordic grid by taking into account the international aspects and paying attention to environmental impacts. The main objective is to achieve continuous and coordinated Nordic planning between the TSOs and to identify the grid investment projects. This will ensure an efficient functioning of the integrated Nordic electricity market and the targeted level of adequacy in the Nordic power system.

The first Nordic Grid Master Plan was finished in 2002. In March 2008, Nordel published the third Nordic Grid Master Plan. The results of the analysis show that some internal Nordic reinforcements are highly beneficial. In October 2008 a planning seminar was held for stakeholders where the Nordic Grid Master Plan 2008 was presented, and stakeholders presented their views on the plan. The mentioned material is available at *www.nordel.org*.

A work plan and organisation for the grid planning for the Baltic Sea region was decided on November 2007. A market simulation model, used as a long-term planning tool, has also been extended to cover the Baltic region. The first multiregional plan with the Estonian, Latvian and Lithuanian Transmission System Cooperation Organization (BALTSO) and Poland was finalised on February 2009.

For the North Sea region work has been initiated between Statnett and Energinet.dk and the European Commission. It will be continued in the ENTSO-E North Sea planning region.

Strengthening internal Nordic connections

In June 2004, Nordel recommended the reinforcements of five cross-sections in the Nordic transmission grid. The purpose is to improve the effectiveness of the Nordic electricity market and increase the reliability of the system. The implementation of the Nordic Grid Master Plan 2004 is still in progress and is prioritised.

Based on the analysis performed in the Grid Master Plan 2008, Nordel recommended that the planning process be initiated by the TSOs involved, to reinforce the following internal Nordic grid areas (figure 4 below):

Sweden-Norway (South)
The South-West Link is a project under development, reinforcing the grid between southern and central parts of Sweden, complemented with a link to Norway. The suggested reinforcement is a 1200 MW HVDC connection between the southern part of Sweden and Norway, with an additional AC-line in Sweden. Additional capacity between Norway and Sweden will be 1200 MW at the highest.

Sweden-Norway (North-South axis)
A new 420 kV line Ørskog-Fardal will strengthen the Swedish/Norwegian north-south capacity and at the same time decrease potential capacity problems related to cross-section 2 in Sweden.

The Arctic region
A new 420 kV line Ofoten-Balsfjord–Hammerfest is recommended by Nordel to meet the needs of expected new petroleum-related activities and planned large wind-power projects.

Sweden-Finland
Fingrid and Svenska Kraftnät have started further studies on a new AC-line between northern Finland and northern Sweden.

Nordic Grid Master Plan 2008 also indicates other potential reinforcements, which require further analysis.

Possible external reinforcements

Norway-Netherlands
NorNed: A new HVDC link between Norway and the Netherlands was commissioned in May 2008. The link has a capacity of 700 MW.

Based on the analysis as well as other studies, Nordel also recommended that studies be initiated within the multiregional planning cooperation to investigate further HVDC interconnections between Nordel and neighbouring areas:

Norway-Germany
NORD.LINK (HVDC link between southern Norway and northern Germany): Statnett in Norway and E.ON Netz in Germany, are preparing a joint feasibility study. The result of the study is expected to form the basis for a decision of entering into a pre-licensing phase. The link has a capacity of 700 to 1400 MW.

NorGer (HVDC link between southern Norway and northern Germany): A consortium of investors in Norway and Germany has started the licensing process. The capacity of the link is from 700 to 1400 MW.

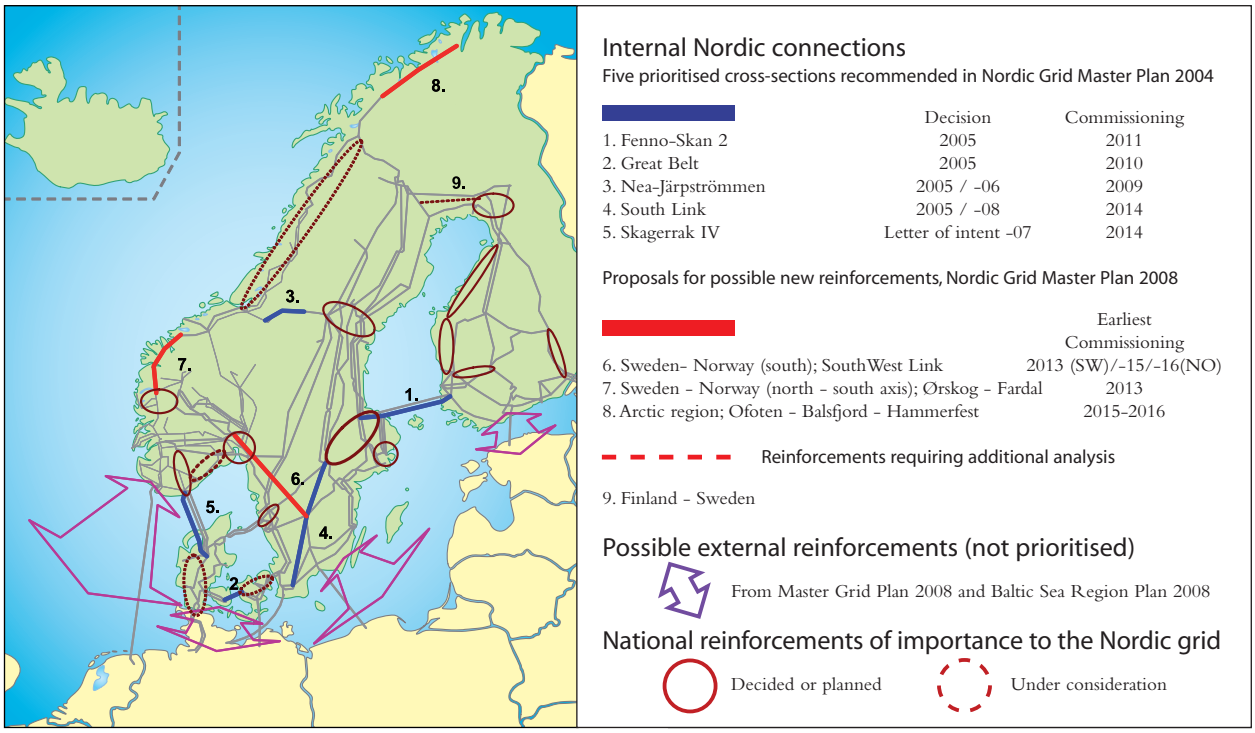

Figure 4: Possible external reinforcements

Denmark/Sweden-Germany
AC lines: Phase shifting transformers are planned to be installed by 2012 on the two 220 kV lines Jutland-Germany. This will increase the market capacity from 950/1500 MW to approximately 1500/2000 MW (import/export).

Kriegers Flak: Svenska Kraftnät, Vattenfall Europe Transmission and Energinet.dk are conducting a pre-feasibility study of a possible interconnection between the respective countries combining the offshore wind farm connections.

Denmark-Netherlands
Cobra: TenneT and Energinet.dk are performing a Business Case regarding a 600 MW HVDC link between the Netherlands and southwest Jutland.

Multi-regional planning cooperation with BALTSO and Poland
The first multiregional plan with BALTSO and Poland included a comparison of three alternative new interconnections from the Baltic area: towards Finland, Poland and Sweden. The market benefits of one or more new interconnections were calculated with a market simulation model. Based on the study the best market-based solution is to implement two interconnections: Finland-Estonia and Lithuania-Poland. However, taking into account the security of supply and market integration aspects, a set of three proposed interconnections, including Sweden and the Baltic countries, would probably be the best solution, but this will be studied further.

National reinforcements of importance to the Nordic grid

Denmark
By 2012, the existing 400 kV one system line Kassø-Askær-Tjele will be replaced by a two system line. This will facilitate the expected cabling of the 150 kV overhead lines in western Denmark and the increased transit due to the increased market capacity Germany-Denmark and the construction of Skagerrak 4.

Finland
In 2008, a new 400 kV line Ulvila-Kangasala was put into operation. The line strengthens the Finnish west coast cross-section to fully utilize the upcoming Fenno-Skan 2 HVDC link. It is also necessary due to the coming Olkiluoto 3 power plant.

There are several projects going on to improve the transmission capacity in the northern interconnections. A new Petäjäskoski-Keminmaa 400 kV line and series compensation of the existing 400 kV Petäjäskoski-Pyhänselkä and Pirttikoski-Pikkarala lines are proceeding, and expected to be commissioned in 2009.

There will be a SVC (Static Var Compensator) put into operation in 2009 in the Kangasala 400 kV station in Mid-Finland. The main purpose will be to dampen the system wide oscillations after a fault in the system.

Norway
There are several plans throughout Norway to upgrade and expand the transmission grid. In southern Norway the new 400 kV line Kristiansand-Holen, is under construction and will be commissioned in 2009. The line is important for the interconnectors to the Continent. Also the 400 kV line Nea-Järpströmmen, and voltage upgrading to 400 kV of Nea-Klæbu, will be commissioned in 2009.

Several investments are under planning and expected to be commissioned in the near future:
- New 400 kV line Sima-Samnanger (to maintain security of supply in western Norway)
- Improved transmission within Mid-Norway and between Mid-Norway and North-Norway (to meet petroleum-related consumption and additional wind power)
- An extensive upgrading of existing 300 kV lines to 400 kV in the southern part of Norway

Sweden
Studies that examine how to reinforce the grid between northern and central Sweden are underway. This part of the grid will be important for the integration of wind power in the Nordic system, since the bulk of the Swedish hydropower is located in the northern part of Sweden. It is also expected that large amounts of wind power will be connected in this area.

Other reinforcements under investigation are the need to strengthen the grid in the areas around the nuclear power plants, which are all increasing their electrical power output.

Iceland
The system plan 2008 presented, among other projects, the building of a new 220 kV line between Blanda hydropower plant and Rangárvellir substation in the northern part of Iceland. The project of strengthening the transmission system from the geothermal power plants on Hellisheidi, east of Reykjavik, to the Reykjanes peninsula, was presented. At the end of 2008 Landsnet decided to build a new 132 kV underground cable connection to the geothermal power plant Nesjavellir in south-western Iceland.

Landsnet continued the preparation and planning of all necessary transmission system works in conjunction with two future aluminium plants, one in Helguvík near Keflavik airport and the other one in Bakki near Húsavík in north-eastern Iceland.

European Wind Integration Study (EWIS-2)

The European Wind Integration Study (EWIS) is an initiative established by the TSO associations of the European transmission system operators in collaboration with the European Commission. Energinet.dk is a member of the consortium and other Nordic TSOs have co-operation agreements with Energinet.dk to participate and provide information on Nordic level to the study.

Annual Power and Energy balances

Estimated power and simulated energy balances for the Nordic area three years into the future are prepared annually. The conclusions of the latest power balance for 2012/2013 and energy balance for 2012 were the following:

Energy balance 2012
The Nordic electricity system is able to meet the estimated consumption and the corresponding typical power demand pattern in average conditions even without imports. In low inflow conditions the Nordic power system needs to import from neighbouring countries. Some areas in Norway can be exposed to a risk of rationing in case of extremely low precipitation.

Power balance and security of supply 2012/13
The Nordic power system is sufficient enough to handle peak demand situations even in very cold conditions (a cold year winter, every ten years).
All the Nordic countries fulfil the criteria decided by Nordel for security of supply.

Nordel also participated in providing data for the ten-year Power System Adequacy Report, published by ETSO.

An advanced aerodynamic lift
Photo: Lena Wretman-Berglund

The Nordic transmission grid

Important events during 2008

5 January
Strained power balance situation due to a production trip in Finland and production problems in northern Norway.

23 January
The EU Commission proposed an energy and climate package. A political agreement on the package was reached in December 2008.

1 March
Mikael Odenberg was appointed as new Director General of Svenska Kraftnät.

13 March
Nordic Grid Master Plan 2008 was published.

20 March and 17 April
There were separate cable failures in the cables in the Oslofjord Röd-Hasle and Sylling- Tegneby. As a consequence of these failures the trading capacity between Norway and Sweden at Hasle was substantially reduced during the rest of 2008.

31 March
Energinet.dk started the construction of the Great Belt Power Link, which will connect eastern and western Denmark.

17 April
The Swedish government granted licence for Fenno-Skan 2.

6 May
NorNed, the HVDC connection between Norway and the Netherlands was put into commercial operation.

8 June
Nordel held its annual meeting at Losby in Norway.

17 June
Statnett and Energinet.dk decided to expand the interconnection between Norway and Denmark with an extra cable.

4 July
Skagerrak 3 between Denmark and Norway was recommissioned after a breakdown of a transformer in August 2007.

1 September
Energinet.dk merged the control of the East Danish and the West Danish power systems in a new common control centre.

28 September
Market coupling between the Nordic countries and Germany took effect but was suspended temporarily after a few days. A relaunch is planned in the second quarter of 2009.

28 - 30 September
Nordic Council of Ministers. The Nordic Energy ministers gave the Nordic TSOs a commission to analyse the effect of introducing more price or bid-areas in the Nordic system.

15 and 21 October
Two nuclear power units (of total 2292 MW) were taken out of the grid due to failure in control rod clusters. Both units were back in production in the first days of January 2009.

21-23 October
The largest training sessions ever for crisis management of the power supply in Sweden took place in Åsbro in Sweden.

23 October
Nordel Grid Planning Seminar was held for stakeholders in Copenhagen.

4 November
A politic agreement is made on the principles for the future expansion of the main power system in Denmark - using cables instead of overhead lines.

6 November
The Finnish Government approved a new climate and energy strategy for Finland.

10 November
The Ministry of Employment and Economy of Finland set up a workgroup with responsibility for making suggestions about feed-in tariffs for renewable energy by the summer of 2009.

13 November
The European Commission published EU's second Strategic Energy Review. The Review proposed an Energy Security and Solidarity Action Plan to secure sustainable energy supplies in the EU and to look at the challenges that Europe will face between 2020 and 2050.

15 November
Reykjavik Energy's Geothermal Power Plant in Hellisheidi east of Reykjavik was enlarged by 90 MW.

19 December
The European TSOs established the new organisation ENTSO-E.

Ringerike substation, Norway
Photo: Trond Isaksen

From Nordel to ENTSO-E

Nordel - playing a part in Europe

Europe has to meet the climate change, ensure security of supply and obtain a truly competitive and efficient European electricity market. Consequently, there will be substantial investments both in production capacity and grid development in the coming years. A prerequisite for efficient operation and investments is closer cooperation between regions. TSOs are key players in obtaining efficient planning of infrastructure development and efficient use of resources and technologies between regions.

The Nordic transmission system operators (TSOs) have a long tradition of cooperation within Nordel. This has resulted in the development of a common Nordic wholesale market with a common power exchange Nord Pool, close operational cooperation and common grid planning.

Nordel has been and is still working actively in order to have a closer European cooperation. Following the first directive on common rules for the internal market in electricity that came into force in 1999, the common association ETSO was founded to cope with the new tasks. Nordel's President at the time, Odd Håkon Hoelsæter, former President and CEO of Statnett, was the first president of ETSO.

In September 2007 the European Commission launched the third legislative package with the aim of establishing a truly competitive energy market. The package included among others the proposal:
To promote cross-border collaboration and investment by establishing a new European Network for Transmission System Operators.

The presidents of Nordel, UCTE, ETSO, UKTSOA, ATSOI and BALTSO decided early in 2008 to start the process of establishing this new organisation (ENTSO-E) instead of waiting for the third liberalisation package to be adopted and come into force.

ENTSO-E:	European Network of Transmission System Operators
UCTE:	Union for the Co-ordination of Transmission of Electricity
ETSO:	Association of European Transmission System Operators
UKTSOA:	UK TSO association
ATSOI:	Association of TSOs in Ireland
BALTSO:	Organisation for the Baltic TSOs

This article describes how the future Nordic cooperation will be organised within the new organisation.

A long tradition of cooperation

Nordel was founded in 1963 as an advisory and recommendatory organisation aiming to promote mainly Nordic cooperation in the field of production, distribution and consumption of electric energy.

Nordel's organisation has changed over time with the developments taking place in the electricity sector in the Nordic countries, and the entire process culminated at the Nordel Annual Meeting in June 2000. Here the organisation adopted new by-laws, thereby formalising Nordel's changed status as an organisation only for the TSOs in the Nordic countries.

Iceland is not connected to the Nordic transmission grid but participates in the Nordel collaboration. The Icelandic TSO, Landsnet, started its operations in 2005.

Important results reached by Nordel as a TSO organisation

In the beginning, the Nordic countries cooperated mainly on operational and planning issues. From 2000 market issues became a permanent issue as well. The fact that Nordel is cooperating at these three different levels has been one of Nordels strong points.
Over the years, Nordel has worked towards establishing the best possible conditions for the development of a well functioning and effectively integrated Nordic electricity market by harmonising where possible and otherwise coordinating between the Nordic TSOs.

To create the best conditions it is necessary to look at all aspects, meaning both the planning of the system, the operation of the system and the market rules - which is what the organisational structure of Nordel has allowed for.

Common grid planning - unique in Europe
The planning process of Nordel has proceeded in the direction of integrated Nordic cooperation concerning grid reinforcements and expansions. The "Planning Code" (recommendation and part of the Nordic Grid Code) describes common Nordic requirements, frameworks, procedures and criteria for joint planning.

Nordic Grid Master Plans
In 2002 Nordel published its first Nordic Grid Master Plan, which identified cross-sections in the Nordic grid, where reinforcements could be relevant. In 2004 the second Grid Master Plan was published including proposals for grid reinforcements in five prioritised cross-sections. The 2008 Grid Master Plan recommends the Nordic TSOs to invest in a number of new projects and also recommends that several studies are initiated to investigate further interconnections between the Nordic area and the neighbouring countries.

Nordic scenarios
The grid master plans are all done from a Nordic perspective and are based on Nordic scenarios for transmission grid planning and power system simulations. Nordel has well established common modelling tools and common data sets which are used to analyse the Nordic area and to create Nordic scenarios. When studying the transmission needs in each scenario, a market simulation tool is used. The market benefits are evaluated concerning the whole region, not only on the national level.

The collection of data regarding the grid, consumption and production is very important for creating the best possible basis for system analyses and therefore the Nordic TSOs have entered into the binding agreement "Data Exchange Code". The Data Exchange Code applies to the grid model and multi area power market simulator established jointly between the TSOs in Nordel.

Power and Energy balances
Apart from the grid master Plans, the common Nordic planning also leads to other important publications. Each year, before the winter period, Nordel assesses and publishes the power and energy balance of the Nordic system. This assessment evaluates the sufficiency of generation capacity and the water reservoir levels plus the need and possibility of imports from outside Nordel. As a follow-up, the power balance for the peak load situation during the past winter is also published.

Each year at the Nordel Annual Meeting, Nordel releases power and energy balances for three years ahead. Every second year, balances ten years ahead are also reported. The balances are simulated and estimated from predictions regarding electricity consumption development, investments in new generating capacity and changes in interconnections.

One single system
For many years the Nordic countries have had very close operational cooperation. The subsystems of Norway, Sweden, Finland and eastern Denmark are synchronously interconnected, forming the so called synchronous system. The subsystem of western Denmark is connected to Norway and Sweden using DC interconnectors. The synchronous system and the subsystem of western Denmark jointly constitute the interconnected Nordic power system.

System Operation Agreement
Principles, rules and guidance for the operation of the interconnected Nordic power system have been agreed upon in the binding "System Operation Agreement". The overall aim is to set up and describe the framework for the operation of the Nordic power system as a single system. The agreement has for several years been the basis for the operational cooperation between the Nordic TSOs.

Connections
Photo: Katrin Seuss

Nordic training group
Well-functioning cooperation between the national control centres is an important element in Nordel's ambition to operate the interconnected Nordic system like a single system, in order to maintain a high system security and a fast restoration of the system in case of disturbances.

Efficient information exchange between control centres and trained personnel are prerequisites for the well-functioning cooperation. Nordel has therefore organized a Nordic training group, which is responsible for the planning and execution of training sessions. Part of the objective is to achieve a common understanding of rules and regulations, how the subsystems interact, and the differences between them.

Nordic outage group
The system operation agreement states that where possible, operational outages shall be coordinated. The Nordic TSOs have therefore established a Nordel Outage Team that coordinates and plans activities for operations and maintenance. The impact on the power system and the power market is thereby optimized in relation to the security of supply and the available transfer capacities to the market. The team shares information and coordinates this within their respective subsystems but also bilaterally with the partners in the neighbouring areas.

NOIS - a common TSO tool for balance management
A common "Nordic Operational Information System" (NOIS) established by the Nordic TSOs has contributed to the optimal use of the Nordic transmission system and resources. In 2009 a new NOIS will be commissioned giving the Nordic TSOs a common tool for balance management of the synchronous Nordel system, daily transmission capacity management of relevant interconnectors, reserve management, outage management and operator alerts between the TSOs.

The effective cooperation between the TSOs provides the technical prerequisites for trading in power on an open electricity market.

A borderless Nordic market
From the mid-1990s the electricity sector in the Nordic countries changed into a common market and so did Nordel's focus on market issues. The goal became to create a borderless Nordic market for the market players, thereby improving the market's efficiency and functionality.

Nord Pool - establishing a common day-ahead market
A very important step taken by the Nordic TSOs has been the establishment of the Nord Pool power exchange. The market participants benefit from a common Nordic wholesale electricity market consisting of a day-ahead market, an intra-day market and a regulating power market. In these markets, power can be traded 24 hours a day throughout the year. The Nordic electricity market has in many respects been a model market in a European context.

Common regulating power market and harmonisation
The common regulating power market was established in 2002 when Nordel introduced new principles for the distribution of regulating power to balance the production and consumption of electricity. From then on, the regulating power of the total Nordic power system has been better exploited and was as such an essential step on the road to harmonising the conditions for the market players on the Nordic electricity market.

Nordel has continued to work towards harmonisation. Further principles were agreed upon in Nordel and took effect from January 2009. The new principles are mainly for balance settlement but also balance regulation. A harmonised market-based balance management is important for an efficient common Nordic market and is one of the preconditions for a future common Nordic retail market.

Common monitoring and transparency
Following this harmonisation, the Nordic TSOs have established a first level of common monitoring of the regulating power market and balance settlement of market players. The common monitoring is a supplement to national monitoring and has been established to help evaluate the harmonised market design.

Harmonising market conditions for all market participants include harmonising the available market and data information, making sure that all participants receive the same information at the same time. Nordic market transparency is well organised and market participants can find information on *www.nordpoolspot.com*.

Common market guidelines
Nordel seeks to agree and implement rules or guidelines that create the best conditions for an efficient electricity market. An example is the Nordel guidelines for implementation of transitional peak load arrangements. An EU directive empowers Member States, as a last resort, to introduce safeguarding measures in order to ensure security of supply. If such measures are applied, Nordel has agreed on guidelines to minimise the negative impact on the market.

Time to look outside the region

Further development of the Nordic region
As described in this article the long history of cooperation within Nordel has created many important results on both operational, planning and market levels. As a result, the Nordic market is now well harmonised. For the Nordic area to develop even further, it is time to look outside the region and work towards establishing a better coordination, integration and harmonisation. This will first of all be within new enlarged regional groups and between regional groups but also on a pan-European level. (figure 5)

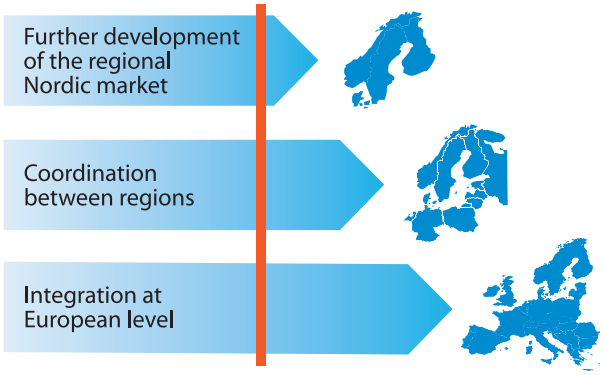

Figure 5: Development possibilities in Europe

The number of physical interconnections between the Nordic region and neighbouring countries are increasing. New interconnections integrate the Nordic power system even more closely with the neighbouring electricity markets and bring about growing needs for planning coordination, information exchange and operational co-operation.

The Nordic TSOs are already part of several European market coupling projects. A wider regional cooperation ensures that the projects are coordinated and working towards common and compatible goals.

Challenges to be tackled at a European level
Major challenges such as climate change, security of supply and a truly competitive and efficient European electricity market will influence the future power system. These challenges have to be tackled at a European level in order to really make a difference.

The Nordic view is to deal with these challenges by establishing a formalised binding European cooperation. Owing to the many years of cooperation the Nordic TSOs have the basis to contribute their experience and knowledge into the European discussions.

Maintenance carried out in Western Norway
Photo: Statnett

Agency for Cooperation of Energy Regulators
When the European Commission adopted the third legislative package in September 2007, it not only included the proposal to establish a new European Network for Transmission System Operators for electricity (ENTSO-E). The package also included a proposal to strengthen the powers of the regulatory authorities by establishing the Agency for the Cooperation of Energy Regulators (ACER).

TSO cooperation on a European level is a necessary counterpart to ACER in dealing with the European challenges.

Founding of ENTSO-E and dissolving existing organisations

In the beginning of 2008, the presidents of the existing regional TSO organisations decided to start the process of establishing ENTSO-E. Following this decision the CEOs of the European TSOs met in June 2008 to sign the Declaration of Intent to create ENTSO-E. Signing the declaration sent an important message to the EU-commission and other stakeholders that the TSOs were committed to creating a new association, willing to cooperate and willing to take on the responsibility to enhance the development towards a well functioning internal electricity market.

By signing the declaration, the CEOs also committed themselves to initiate procedures to wind-up their respective associations completely as soon as possible after the formal establishment of ENTSO-E. This was an important decision. For ENTSO-E to be a success it is necessary that the TSOs concentrate their efforts on cooperation within one common organisation.

ENTSO-E was founded on December 19, 2008. Daniel Dobbeni, CEO of the Belgian TSO ELIA was elected the first president and Jukka Ruusunen, President and CEO, Fingrid Oyj was elected vice president.

As the third legislative package has not come into force yet ENTSO-E has been established as a voluntary association. It is recognised that EU's legislation on Internal Electricity Market may be amended in the near future and may require changes to the governance rules of ENTSO-E.

Cooperation within the new structure

The ENTSO-E structure is quite similar to the Nordel structure with three permanent committees working on market, planning and operational issues (figure 6). This is an advantage for the Nordic TSOs, as it is a well-known approach to cooperation and is a recognition by the other European TSOs that this Nordic model is efficient.

The Nordic TSOs are all individual members of ENTSO-E and have representatives in the General Assembly, the three committees, the legal & regulatory group and in the relevant regional groups. As Iceland is not connected to the European grid, Landsnet will mainly have an observer status in selected committees and participate in events as appropriate from time to time. Landsnet will also seek semi-active participation within a North European regional group under the Market Committee.

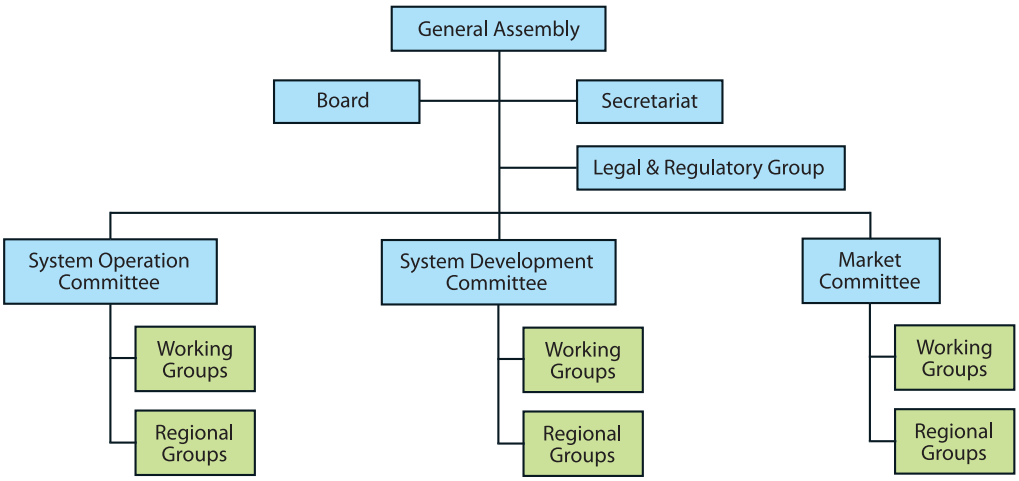

Figure 6: The ENTSO-E structure

The leading body of ENTSO-E is the *General Assembly*, where all members of ENTSO-E are represented. The General Assembly is responsible for decisions concerning the functioning of the Association; for network codes; common network operational tools and research plans and for the ten year network development plans.

The *Board* coordinates the work of and between the Committees and the Legal & Regulatory Group; prepares the agenda for the Assembly meetings; follow-up and executes decisions of the Assembly and coordinates the overall representation of the Association. The Board is not a decision-making body.

The *secretariat* is permanent and is situated in Brussels, unlike the Nordel secretariat, which has rotated every two years between the Nordic TSOs. The ENTSO-E secretariat is larger and has more tasks - one being to provide secretarial assistance to the ENTSO-E committees and functional groups.

The regional groups have been designed differently under the different committees. This is in line with the Nordic view on further cooperation, because the relevant partners on market issues are not necessarily the same relevant partners on planning and/or operational issues. By not having the same structure it is possible to optimise the work done under each committee.

The Market Committee

The scope of the Market Committee is to enhance the integration of the European electricity markets. The committee deals with market design from the perspective of TSOs, integrating the views of market participants and all stakeholders and taking account of long-term, day-ahead, intra-day and balancing markets.

Initially eight regional groups, corresponding to the groups established under the ERGEG regional initiative, were envisaged. This grouping was, however, not the optimal division in the context of ENTSO-E. Instead, it has been decided that regional groups can be established on initiative of the TSOs following a positive decision of the Market Committee and the Assembly.

The Nordic TSOs are working towards establishing a regional group with relevant TSOs from Central West Europe and another regional group with TSOs from Poland and the Baltic countries.

Design towers in Eastern Iceland
Photo: Emil Thor

The direct current cable for the Great Belt Power Link is placed underground. Photo: Heidi Lundsgaard

The System Development Committee

The scope of the ENTSO-E System Development Committee is to coordinate, at a pan European level, the network development and planning activities undertaken by TSOs at both regional and national level. One of the tasks will be to manage the information gathering, production, publication and ongoing review of the ENTSO-E 10 Year Network Development Statement.

A number of regional groups known as Network Development Areas (NDA) have been established for the purpose of coordinating network development and planning activities between the TSOs involved (figure 7).

All the Nordic TSOs are part of the Network Development Area "Baltic Sea". Norway and Denmark are also part of the "North Sea" area.

Figure 7: The System development committee - regional structure

North Sea:
Republic of Ireland, Northern Ireland, Great Britain, Norway, Denmark, Germany, the Netherlands, Belgium, France, Luxemburg.

Baltic Sea:
Estonia, Latvia, Lithuania, Poland, Germany, Sweden, Finland, Denmark, Norway.

Continental South West:
France, Spain, Portugal.

Continental South East:
Italy, Slovenia, Hungary, Croatia, Romania, Bulgaria, Bosnia-Herzegovina, Republic of Serbia, Montenegro, Former Yugoslav Republic of Macedonia, Greece.

Continental Central South:
France, Germany, Switzerland, Italy, Austria, Slovenia.

Continental Central East:
Germany, Czech Republic, Slovak Republic, Austria, Poland, Hungary, Slovenia, Croatia.

The System Operation Committee
The scope of the System Operations Committee is to ensure a high standard of operability, reliability and security of the European electricity transmission systems within a framework of transparency and liberalised energy markets.

The Committee provides proposals for harmonisation of operational standards on a pan-European level and ensures coordination and cooperation between the regions, in order to investigate and develop multiregional operational solutions and support.

The different regions correspond to the synchronous areas (figure 8). This was deemed very important in order for the association to maintain system security. The organisation of the regions has therefore been included in the articles of association.

The current Nordic operational cooperation corresponds to the new Nordic Regional Group in ENTSO-E. The Nordic TSOs will also be part of a multiregional voluntary group "Northern Europe".

The future of the Nordic area
With the establishment of ENTSO-E the future Nordic cooperation will take place within a European organisation. This does not imply that cooperation on a Nordic level will come to an end. Focus will still be on the development of the Nordic market as well as coordination within the new regional groups, between regions and the development of the European market.

All tasks and responsibilities in Nordel are transferred to the relevant regional groups within ENTSO-E. Nordic stakeholders will still be heard when issues concerning the Nordic electricity market are being discussed and the Nordic TSOs will continue their contact with the Nordic regulators and the Nordic Council of Ministers.

Author: Lene Egeberg-Gjelstrup, secretary of the Nordel Market Committee, Energinet.dk.

RG Continental Europe
Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Czech Republic, Croatia, Denmark (West), France, FYROM, Germany, Greece, Hungary, Italy, Luxemburg, Montenegro, the Netherlands, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain and Switzerland

RG Nordic
Denmark (East), Finland, Norway and Sweden

RG Baltic
Estonia, Latvia and Lithuania

RG UK
Great Britain

RG Ireland
Ireland and Great Britain

RG Northern Europe (voluntary)
Denmark, Norway, Sweden, Finland, the Netherlands, Poland and Germany (corresponding members)

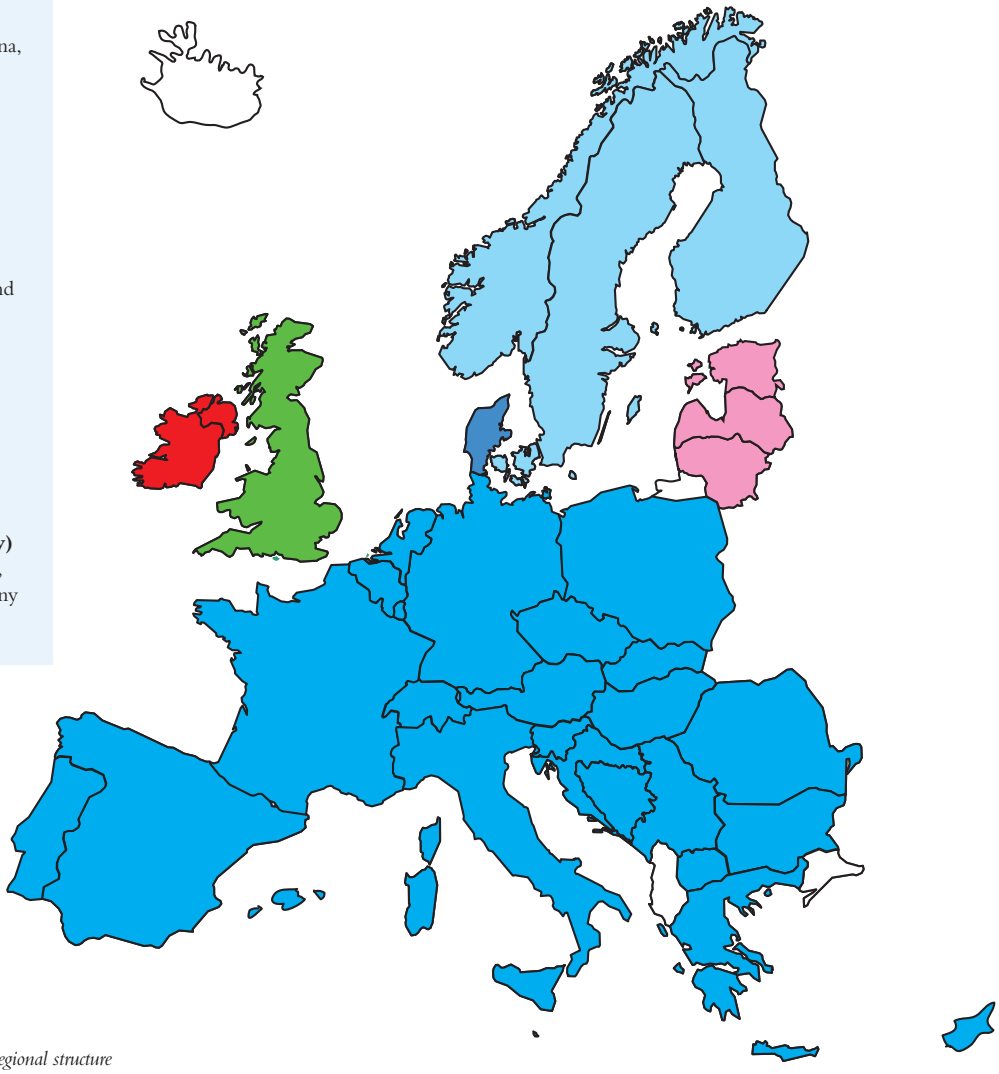

Figure 8: The System operation committee - regional structure

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Annual statistics is available at
www.nordel.org

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Agata Persson, Svenska Kraftnät

Sources

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Finnish Energy Industries
Icelandic National Energy Authority
Nordel
Nord Pool
Norwegian Water Resources and Energy Directorate
OECD (Organisation for Economic Co-operation and Development)
Statistics Denmark
Statistics Iceland
Statistics Sweden
Swedenergy

Definitions, units and symbols

Combined heat and power generation (CHP)
Generation at a steam power plant where some of the energy of the steam is used for electricity generation and some for another purpose, e.g. for district heating or as process steam for the industry.

Condensing power
Generation at a conventional steam power plant where the energy of the steam is used solely for electricity generation and where the steam is condensed to water after the turbine.

Electricity generation (net electricity generation)
The electrical energy generated by the power plants, excluding the plants' own consumption.

Exchange of electricity
The physical exchange of electricity between the countries.

Gross consumption
The total consumption minus occasional power to electric boilers.

Gross temperature corrected consumption
Gross consumption corrected to correspond normal yearly temperature variations.

Installed capacity (net capacity)
The rated capacity of the power plants excluding the power plant's own consumption of electricity (exclusive heat production).

Losses
Losses in the transmission and distribution networks.

Net consumption
The sum of the electricity delivered to the end users.

Occasional power to electric boilers
The supply of electricity to electric boilers for the generation of steam or hot water, which may alternatively be generated using oil or some other fuel.

Pumped storage power
The electricity used for pumping water up to a reservoir for electricity generation later on.

Total consumption
The sum of electricity generation and net imports.

Transmission capacity
The power that a high voltage line can transmit under normal conditions, taking into account limitations that may be imposed on the rated capacity.

Units and symbols

kW	kilowatt
MW	megawatt = 1,000 kW
GW	gigawatt = 1,000 MW
kWh	kilowatt-hour = 3,600 kJ
MWh	megawatt-hour = 1,000 kWh
GWh	gigawatt-hour = 1,000 MWh
TWh	terawatt-hour = 1,000 GWh
~	Alternating current (AC)
=	Direct current (DC)
–	Data are non-existent
..	Data are too uncertain
0	Less than 0.5 of the unit given

Calculation of the electricity consumption

Electricity generation
\+ Imports
\- Exports

= Total consumption
\- Occasional power to electric boilers

= Gross consumption
\- Losses, pumped storage power etc.

= Net consumption

Electricity generation

S5 Electricity generation 2008, GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total generation	34 648	74 137	16 468	142 727 [2]	146 021	**414 001**
Nuclear power	-	22 038	-	-	61 266	**83 304**
Other thermal power	27 644	34 948	3	1 147	14 331	**78 073**
- Condensing power	11 718	8 203	-		840	**20 761**
- CHP, district heating	14 034 [1]	14 659	-	119	7 209	**36 021**
- CHP, industry	1 879	12 080	-	596	6 256	**20 811**
- Gas turbines, etc.	14	6	3	432	26	**481**
Hydro power	27	16 889	12 427	140 663	68 429	**238 435**
Wind power	6 977	262	-	917	1 995	**10 151**
Geothermal power	-	-	4 038	-	-	**4 038**
Total generation 2007	37 025	77 817	11 976	137 387 [2]	144 708	**408 913**
Change compared to 2007	-6,4%	-4,7%	37,5%	3,9%	0,9%	**1,2%**

[1] Includes condensing power generation.
[2] Gross electricity generation: net electricity generation + power plant's own electricity consumption.

Electricity consumption

S9 Electricity consumption 2008, GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total consumption	36 102	87 047	16 604	128 851	144 059	**412 663**
Occasional power to electric boilers	-	0	181	4 312	1 333	**5 826**
Gross consumption	36 102	87 047	16 423	124 539	142 726	**406 837**
Temperature corrected gross consumption	35 425	88 780	16 067	128 405	145 747	**414 424**
Grid losses	2 324	3 050	946	10 501	10 989	**27 810**
Pumped storage power	0	-	-	1 384	28	**1 412**
Net consumption [1]	33 778	83 997	15 477	112 654	131 709	**377 615**
- housing	9 837	21 558	856	36 501	38 800	**107 552**
- industry (incl. energy sector)	9 517	44 314	13 035	49 568	59 200	**175 634**
- trade and services (incl. transport)	11 084	16 889	1 029	24 935	27 700	**81 637**
- other (incl. agriculture)	3 341	1 236	557	1 650	6 009	**12 793**
Total consumption 2007	36 111	90 680	11 976	127 352	146 023	**412 142**
Change compared to 2007	0.0 %	-4.0 %	38.6 %	1.2 %	-1.3 %	**0.1 %**
Population[2] (million)	5.5	5.3	0.3	4.8	9.3	**25.2**
Gross consumption per capita, kWh	6 564	16 424	51 483	25 946	15 413	**16 158**

[1] Estimated net consumption.
[2] At the end of the year.

System load

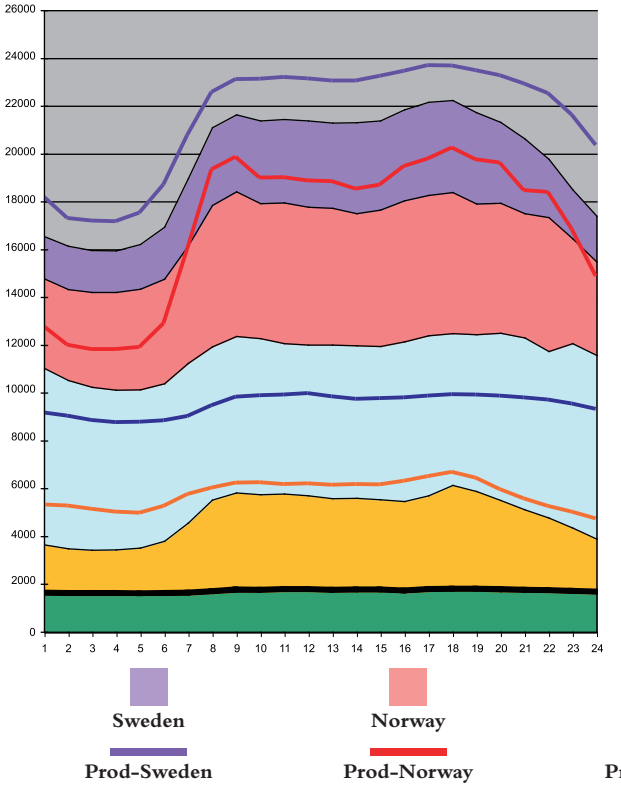
S13 Maximum system load in 2008

	Simultaneous maximum[1)] 3 January 17:00-18:00 (CET) MWh/h	Maximum system load in each country MWh/h	Date/time (local time)
Denmark	6 231	6 408	03 Jan 18:00-19:00
Finland	12 815	13 770	04 Jan 17:00-18:00
Iceland	N.A.	2 060	18 Dec 19:00-20:00
Norway	20 459	21 589	14 Feb 09:00-10:00
Sweden	23 580	24 500	23 Jan 17:00-18:00
Nordel	63 085		

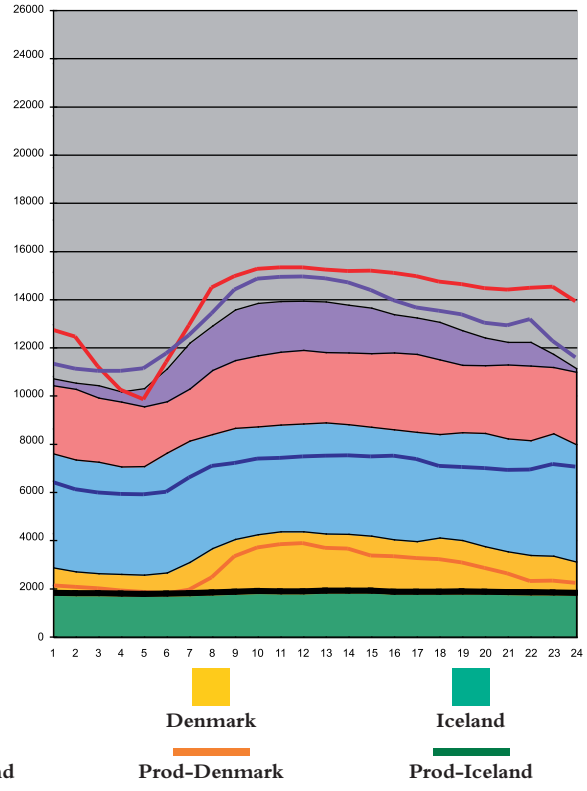
[1)] In the interconnected Nordic power system.

System load 3rd Wednesday in January and in July 2008

Average 24-hour consumption and production 3rd Wednesday in January (2008-01-16) MWh/h



Average 24-hour consumption and production 3rd Wednesday in July (2008-07-16) MWh/h



Maximum system load 3rd Wednesday in January and in July 2008

	3rd Wednesday in Jan 2008 17:00 - 18:00 - MWh/h	3rd Wednesday in July 2008 12:00 - 13:00 - MWh/h
Denmark	6 135	4 284
Finland	12 487	8 884
Iceland	1 715	1 822
Norway	18 390	11 813
Sweden	22 240	13 901
Nordel	60 967	40 705

All hours are local time.

Interconnections

S14 Existing interconnections between the Nordel countries 2008

Countries/Stations	Rated voltage kV	Transmission capacity as per design rules[1] MW		Total length of line km	Of which cable km
Denmark - Norway		**From Denmark**	**To Denmark**		
Tjele - Kristiansand	250/350=	1 000	1 000	240/pole	127/pole
Denmark - Sweden		**From Sweden**	**To Sweden**		
Teglstrupgård - Mörarp 1 and 2	132~	1 350	1 750	23	10
Gørløsegård - Söderåsen	400~			70	8
Hovegård - Söderåsen	400~			91	8
Hasle (Bornholm) - Borrby	60~	60	60	48	43
Vester Hassing - Lindome 1 and 2	2x285=	740	680	149/pole	87/pole
Finland - Norway		**From Finland**	**To Finland**		
Ivalo - Varangerbotn	220~	100	100	228	-
Finland - Sweden		**From Sweden**	**To Sweden**		
Ossauskoski - Kalix	220~	1 600[2]	1 200[2]	93	-
Petäjäskoski - Letsi	400~			230	-
Keminmaa - Svartbyn	400~			134	-
Raumo - Forsmark	400=	550	550	233	200
Tingsbacka (Åland) - Senneby	110~	80	80	81	60
Norway - Sweden		**From Sweden**	**To Sweden**		
Sildvik - Tornehamn	132~	1 000[4]	1 300[3,4]	39	-
Ofoten - Ritsem	400~			58	-
Røssåga - Ajaure	220~			117	-
Nea - Järpströmmen	275~			100	-
Linnvasselv, transformator	220/66~	50	50	-	-
Lutufallet - Höljes	132~	40	20	18	-
Eidskog - Charlottenberg	132~	100	100	13	-
Hasle - Borgvik	400~	2 200[4]	2 150[4,5]	106	-
Halden - Skogssäter	400~			135	-

[1] Maximum permissible transmission.

[2] In certain situations, the transmission capacity can be lower than the limit given here.

[3] Thermal limit. Stability problems and generation in nearby power plants may lower the limit.

[4] The transmission capacity can in certain situations be lower, owing to bottlenecks in the Norwegian and Swedish network.

[5] Requires a network protection system during operation (production disconnection).

Interconnections

S15 Existing interconnections between the Nordel countries and other countries 2008

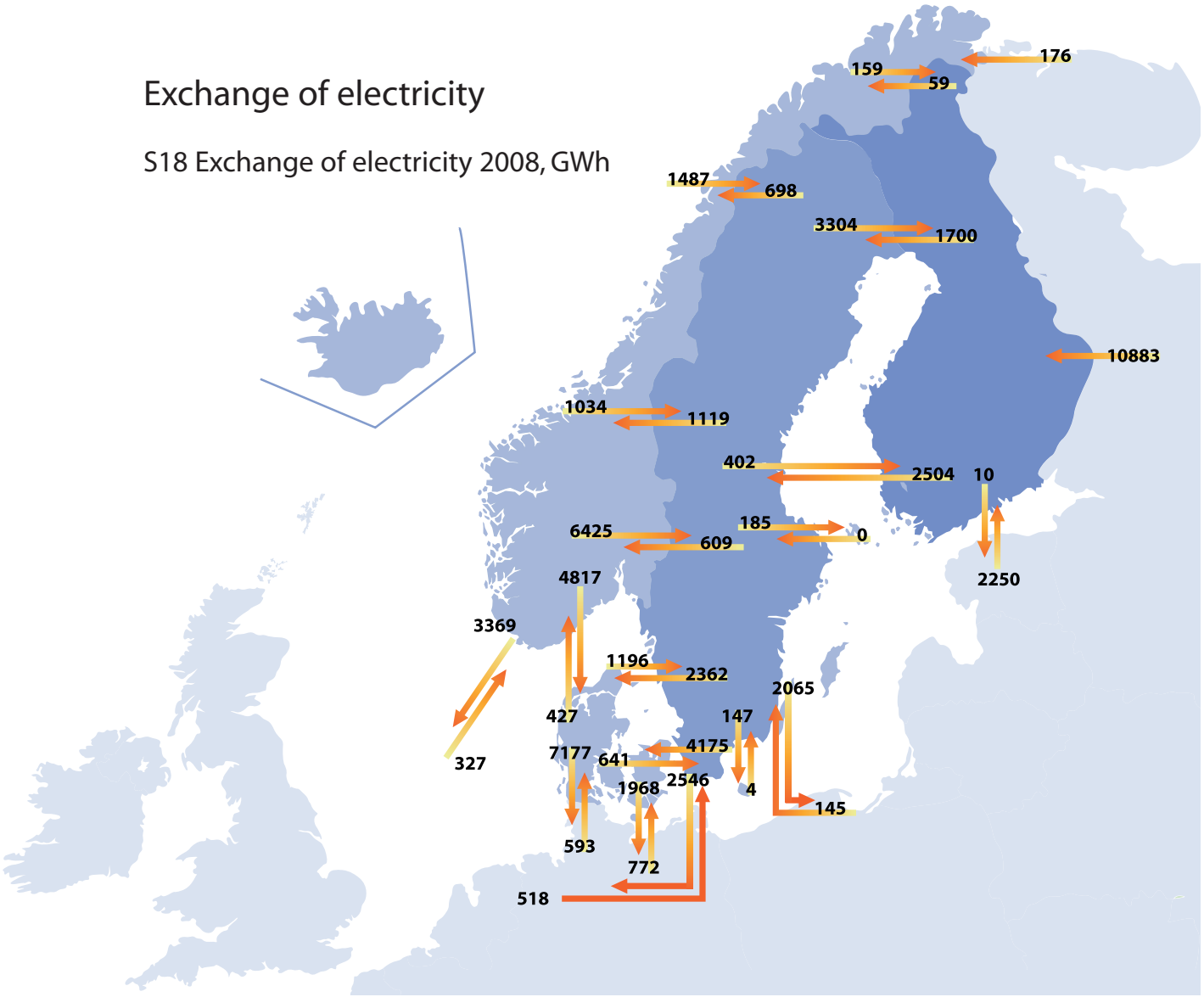
Countries/Stations	Rated voltage kV	Transmission capacity MW		Total length of line km	Of which cable km
Denmark - Germany		**From Nordel**	**To Nordel**		
Kassø - Audorf	2 x 400~	1500	950	107	-
Kassø - Flensburg	220~			40	-
Ensted - Flensburg	220~			34	-
Ensted - Flensburg	150~	150	150	26	5
Bjæverskov - Rostock	400=	600	600	166	166
Finland - Russia		**From Nordel**	**To Nordel**		
Imatra - GES 10	110~	-	100	20	-
Yllikkälä - Viborg [2]	2 x 400~	-	1400	2 x 67	-
Kymi - Viborg [2]	400~			132	-
Nellimö - Kaitakoski	110~	-	60	50	-
Finland - Estonia		**From Nordel**	**To Nordel**		
Espoo - Harku	150=	350	350	105	105
Norway - Russia		**From Nordel**	**To Nordel**		
Kirkenes - Boris Gleb	154~	50	50	10	-
Norway - Netherlands		**From Nordel**	**To Nordel**		
	450=	700	700	580	580
Sweden - Germany		**From Nordel**	**To Nordel**		
Västra Kärrstorp - Herrenwyk	450=	600 [1]	600 [1]	269	257
Sweden - Poland		**From Nordel**	**To Nordel**		
Stärnö - Slupsk	450=	600	600	256	256

[1] The transmission capacity is currently limited to 460 MW from Nordel and 390 MW to Nordel due to limitaion in the German network.

[2] Back to Back HVDC (+85 kV =) in Viborg and synchronous operation of NWPP power plant.

Exchange of electricity

S18 Exchange of electricity 2008, GWh



S19 Exchange of electricity 2008, GWh

From: To:	Denmark	Finland	Norway	Sweden	Other countries[1]	∑ From
Denmark	-	-	427	1 841	9 145	**11 413**
Finland	-	-	59	4 204	10	**4 273**
Norway	4 817	159	-	8 946	3369	**17 291**
Sweden	6 684	3 891	2 426	-	4 611	**17 612**
Other countries [1]	1 365	13 133	503	663	-	**15 664**
∑ To	**12 866**	**17 183**	**3 415**	**15 654**	**17 135**	**66 253**
					Nordel	
Total to	12 866	17 183	3 415	15 654	**49 118**	
Total from	11 413	4 273	17 291	17 612	**50 589**	
Net imports	1 453	12 910	-13 876	-1 958	**-1 471**	
Net imports/total consumption	4.0 %	14.8 %	-10.8 %	-1.4 %	**-0.4 %**	

[1] Russia, Estonia, Germany, Poland, Netherlands.

Icelandic nature. Photo: Emil Thor

Construction work at the Meisa mountain in Norway. Photo: Børje Heikkinen

Photo: Päivi Bourdon

Jyväskylä. Photo: Risto Jutila

Photo: Katrin Seuss

Photo: Trond Isaksen

Photo: Emil Thor

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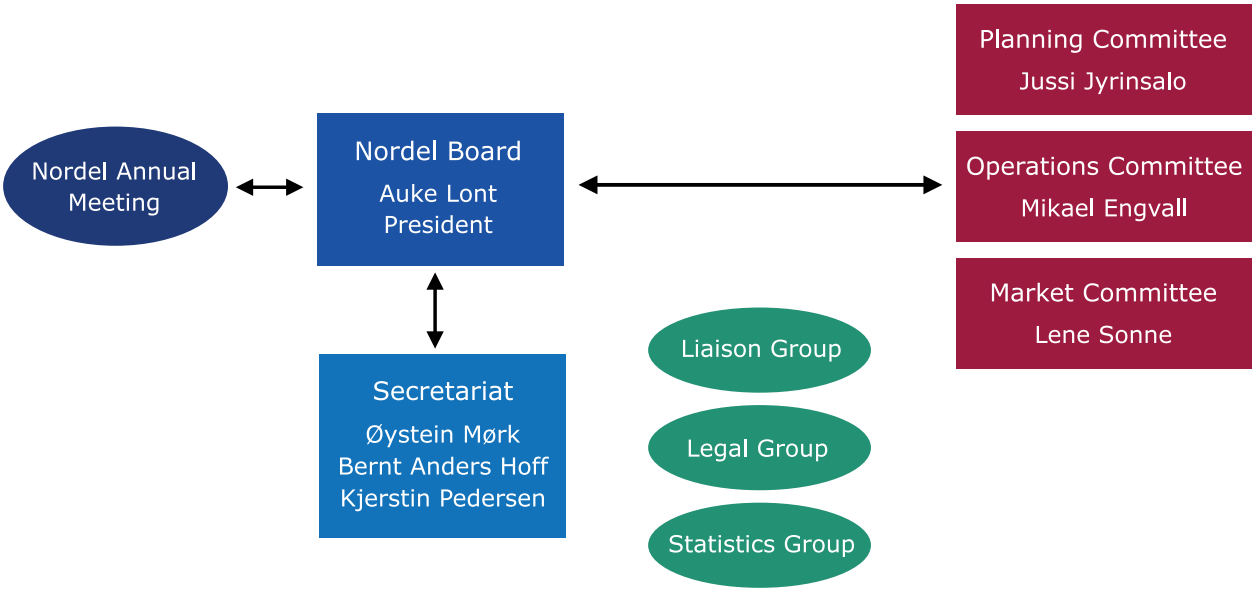

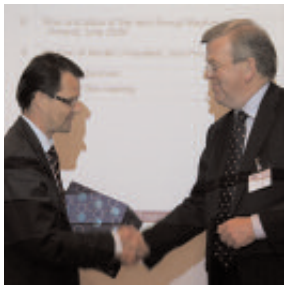

Nordel's Annual meeting 2008 was held at Losby Gods in Norway. The meeting was preceded by a boat trip on lake Mjøsa.
Photo: Gro Berglund / Bernt Anders Hoff

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