Annual Report 2006

Nordel

Cover photo: Tuomo Kouti

Contents

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 of 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 adequacy of the transmission system,
- to enhance the efficient functioning of the electricity market.

Nordel exchanges continuously views with the authorities and the market players. This is important for the evolution of an efficient electricity market.

The most superior 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. Nordel has no budget of its own.

The Nordel Board consists of the chief executive officers of the TSOs. The Board initiates new projects, makes decisions relating to current matters, and executes the decisions made at Nordel's annual meeting.

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

Key figures for 2006

		Nordel	Denmark	Finland	Iceland	Norway	Sweden
Population	mill.	**24.8**	5.4	5.3	0.3	4.7	9.1
Total consumption	TWh	**405.4**	36.4	90.1	9.9	122.6	146.4
Maximum load[1]	GW	**66.8**	6.3	14.2	1.1	19.9	25.4
Electricity generation	TWh	**393.9**	43.3	78.6	9.9	121.7	140.3
Breakdown of electricity generation:							
Hydropower	%	**51**	0	14	73	98	44
Nuclear power	%	**22**	-	28	-	-	46
Other thermal power	%	**24**	86	58	0	1	9
Wind power	%	**3**	14	0	-	1	1
Geothermal power	%	**-**	-	-	27	-	-

[1] Measured 3rd Wednesday in January - = Data are non-existent 0 = Less than 0,5 %

Report of the Board

Nordel contributes to a well-functioning regional electricity market and a high security of supply

Lately, energy issues have been subject to a comprehensive debate in Europe. In January 2007, the European Commission communicated its objectives for the future European Energy Market Policy. The communication also includes work programmes. From the TSOs' point of view, the key issues in the communication are: operation of the grids towards a single European market, independent TSOs i.e. unbundling between grid and production, increased transparency of the market, and strengthened regulatory governance in European and regional issues.

The Nordic electricity market arrangements are in compliance with the communication. Unbundling of the ownership of the TSOs already exists in the Nordic countries. Despite the differences in national energy policies and legislation, Nordel has, through the years, developed common rules and procedures for the core tasks of system responsibility. Common economic benefits and a high security of supply in the Nordic power system have been the driving forces of the co-operation.

The Nordic Grid Code includes criteria for transmission system planning, rules for system operation, and minimum technical requirements for connecting power plants to the grid. The Nordic Grid Code leads to a coherent security of supply in the whole Nordic power system by defining the obligations of all parties. These combined with common Nordic market operations, implicit auctions of the cross-border flows between the Nordic countries, co-ordinated planning of outages in the transmission grid, and continuous exchange of real-time operational data ensure that the Nordic power system is already operated efficiently as a single regional market. Therefore, the Nordic electricity market has often been referred to as a forerunner and an example of a well-functioning regional electricity market.

Even though Nordel's work in facilitating the Nordic electricity market has been successful in many respects, there is still room for further development and harmonisation. The main topics on Nordel's agenda have been system responsibility and the role of the TSOs, transmission capacity management, planning and financing of Nordic grid investments, balance management, procurement and co-ordination of operational reserves, and management of peak load situations. In April 2006, Nordel submitted a report to the Nordic Council of Ministers summarising the status of the ongoing work on these issues.

Substantial investments in the Nordic grid and in interconnections to other markets

Congestions in the transmission grid can only be removed physically by means of investments. During the coming three years, the total grid investments will amount to 1.8 billion euros.

The five Nordic grid projects will be implemented by 2012. In addition, the Nordic market will be connected more strongly with the other markets. Estlink, a new 350 MW cable link between Estonia and Finland, was taken into commercial operation in January 2007. It connects the Baltic electricity market to the Nordic market for the first time. A new 700 MW interconnection from Norway to the Netherlands will be implemented by the end of 2007. A reinforcement of an existing 400 kV overhead line in Western Denmark will also increase the transmission capacity between Denmark and Germany by the end of 2009. These projects together with the development of market coupling between the Nordic market and Continental Europe will be important steps towards an internal European electricity market pursued by the EU.

Equal electricity price simultaneously in different Nordic regions indicates that there are no major congestions between these regions. After the implementation of the projected investments in 2012, the congested time in the Nordic grid is estimated to be more than half as short as now. This is an important step in enhancing the efficient functioning of the Nordic electricity market.

Common Nordic grid planning is a continuous procedure within Nordel and the next Nordic system development plan will be finalised during 2007.

First regional intra-day market to be implemented

Nordel recommended expanding the Elbas market also to Western Denmark and Norway. As a result of this, Nord Pool Spot introduced Elbas in Western Denmark in April 2007. In Norway, the introduction is waiting for the approval of authorities. Thereafter, the first regional intra-day market in the world will be a reality in the Nordic countries allowing the market players to adjust their balances within the operating day up to the gate closure, in particular after outages of power plants or deviations due to weather conditions.

In addition, Nordel proposed the application of a gate closure of one hour before the operating hour for all plans and transactions that have implications to the TSOs.

The introduction of the Nordic intra-day market together with the existing regional Elspot and regulating power markets create a combination of regional physical markets that allow the market players to trade continuously around the clock every day of the year until the gate closure.

Elbas has also been expanded to cover Nord Pool Spot's bidding area Kontek in September 2006 and all of Germany in January 2007. Even in these cases, the gate closure will be one hour before the operating hour. Coherent intra-day trading rules already cover a substantial part of the European electricity market.

Harmonised balance management - first step towards a Nordic retail market

After consultation with the market players, Nordel agreed on harmonised principles for balance management in 2007. This contributes to creating a level playing field for the market players and is a step towards a totally integrated balance service where all Nordic market players could be served over one counter, with one Nordic contract and one Nordic balance. With this, Nordic TSOs are also contributing to the creation of a Nordic retail market which is mainly a responsibility of Nordic Governments and regulators.

Harmonised guidelines for possible peak load arrangements

In 2007, Nordel agreed on a proposal for harmonised Nordic guidelines for possible peak load arrangements. The background for this is the authorities' concern that there may not always be sufficient commercial resources (generation capacity or demand flexibility) to meet the national peak demand. Peak load resources would be the last resort if market mechanisms fail. Typically, they are only needed for a few hours per year. Some countries have launched temporary centralised arrangements to secure the availability of peak load resources.

Nordel has previously stressed that the market is designed to solve the peak load problems. Any interventions in the market, like a possible peak load arrangement, should be avoided. The proposed guidelines aim at minimising the negative impacts on the market.

International co-operation with the TSO organisations

The Nordic TSOs have contributed actively to the international co-operation of the European TSOs within European Transmission System Operators (ETSO) and by maintaining contacts with the neighbouring TSO organisations. Within ETSO, the Nordic TSOs have contributed to the establishment of the European information platform, further development of the European Inter TSO Compensation for Transit (ITC), and market coupling issues among other things.

Presidency moved from Sweden to Finland

At the annual meeting of 2006, the Presidency of Nordel was moved to Fingrid for the next two years. Mr Juha Kekkonen, Executive Vice President of Fingrid Oyj, was elected President, and he held this position until 7 February 2007. Mr Jukka Ruusunen, President & CEO of Fingrid Oyj from 1 January 2007, serves as the President during the remaining period of Finnish Presidency.

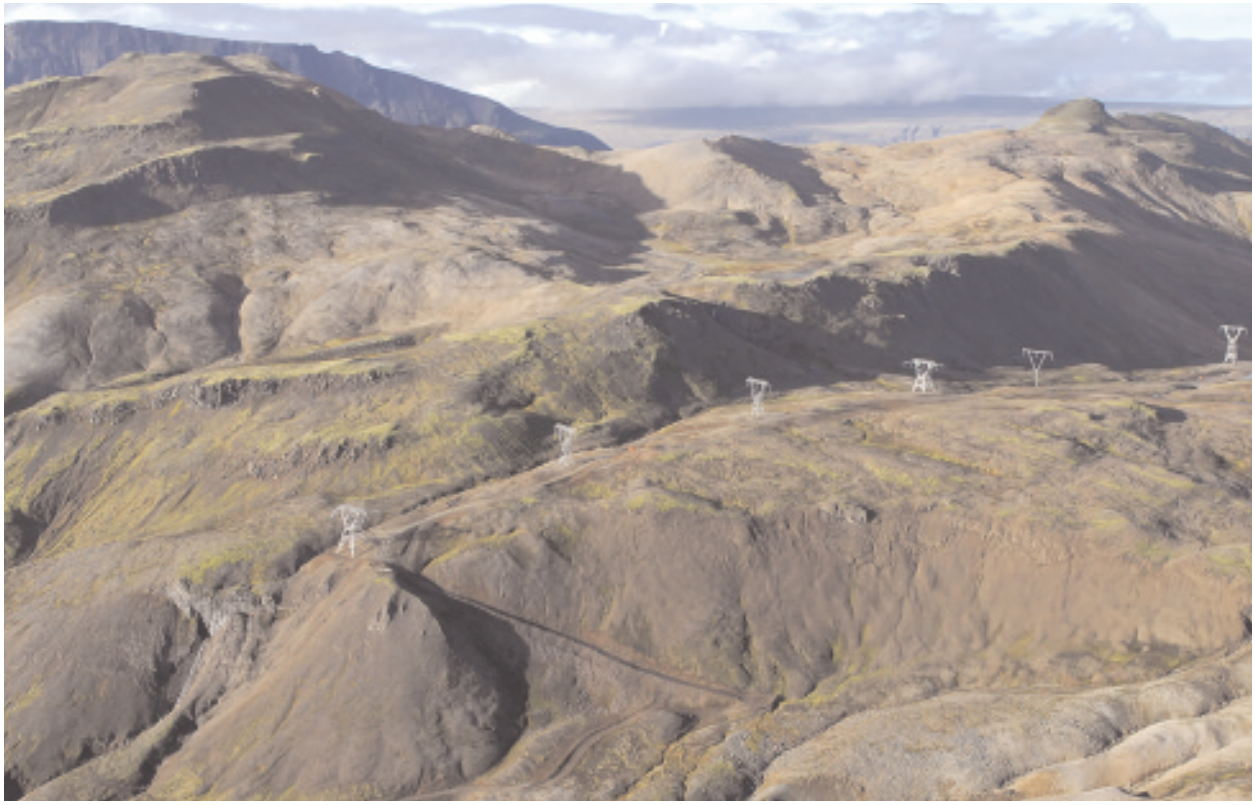
The members of the Board and the Chairmen of the Committees

From the left: Bo Krantz, *Svenska Kraftnät (Planning Committee)*, Per Sørensen, *Energinet.dk (Operations Committee)*, Bente Hagem, *Statnett SF (Market Committee)*, Peder Østermark Andreasen, *Energinet.dk*, Jukka Ruusunen, *Fingrid Oyj (President)*, Jan Magnusson, *Svenska Kraftnät*, Odd Håkon Hoelsæter, *Statnett SF (Vice President)*, Juha Kekkonen, *Fingrid Oyj (former President)*. Photo: Juhani Eskelinen

Thordur Gudmundsson, *Landsnet hf. (Board member, missing from the group photo)*

Outgoing Board member on 14 June 2006

Timo Toivonen, *Fingrid Oyj*



An eyebird view of one of Landsnet's 400 kV transmission lines in Eastern Iceland. Photo: Emil Thor

The electricity market

Hydrological variations and public debate characterised the electricity market

The Nordic electricity market was characterised by low levels in the water reservoirs due to a very dry spring and summer. At the beginning of the autumn, the hydrological situation was giving cause for concern. Rainfall during the latter part of the year together with a mild early winter facilitated the energy situation and the energy situation for the rest of the winter 2006/2007 was considered as almost normal.

The functioning of the electricity market continued to be subject to a public debate. The increase in the price of electricity in recent years was often linked with issues such as lack of competition, operation of the electricity exchange and emission trade mechanisms. Congestions and congestion management were also criticised. During the year, there have been discussions within Nordel on principles for market-based congestion management, but it has not yet been possible to reach full agreement on these.

Harmonisation of balance management

A Nordic retail market is regarded as a positive development of the electricity market both by authorities, market players and Nordel. It would contribute to increased competition, as the establishment of already active market players in different countries would be facilitated in the same way as that of newcomers.

To support this development and to create a level playing field for the wholesale market, Nordel agreed to harmonise the cost base, principles of calculation and pricing of the imbalances and a common fee structure, i.e. the main elements in the balance service provided by the TSOs.

The cost base of balancing will be defined according to equal principles. The same cost elements are included although absolute cost levels may vary between countries.

The calculation of imbalances will be based on two balances: one production balance and one consumption balance. The first one is settled according to a two-price system while the consumption balance is based on a one-price settlement.

An objective of a harmonised fee structure is that market players in a competitive situation pay the same fees for their imbalances. As these fees are not sufficient to cover the TSOs' all balancing costs, additional flat fees for producers and consumers are needed.

A consultation process has been carried out in all concerned countries. Implementation is foreseen at the beginning of 2009.

Nordic guidelines for possible peak load arrangements

EU directive 2003/54 empowers the Member States to introduce a tendering process or similar safeguarding measures to ensure security of supply. However, the tendering procedure should be the last resort if market mechanisms fail. If a country decides to launch such measures, guidelines for a harmonised transitional peak load arrangement have been proposed by Nordel to minimise the negative impacts on the market. The guidelines include common methods for the assessment of power system adequacy and relevant market design issues.

Implementing a peak load arrangement would be a national decision. However, any decision to launch a tendering process or other safeguarding measure should be based on consistent information and analysis. It should take into account the state of the whole Nordic system because different subsystems can support each other.

Nordel makes yearly assessments of the future power balances in the Nordic system and communicates the results to the stakeholders. Nordel considers extending the time horizon up to six years ahead. Advance information on future Nordic power balances will help the market players to react in due time.

Any centralised acquisition of peak load resources interferes with the market mechanisms. The arrangement should be transitory with a fixed expiring date. The arrangement should also be transparent in view of the type and volume of the resources, activation and pricing, financing of the arrangement and opt-out rules. The most critical issue for the market is the activation and pricing of the peak load resources. Nordel recommends activating the resources first in the commercial markets (Elspot, Elbas). All remaining available resources can thereafter be offered to the regulating power market. The resources should only be used after all the commercial bids have been activated.

Before implementing a tendering procedure, Nordel recommends consultation with the Nordic TSOs to evaluate how the peak load arrangement may affect the market. The proposed guidelines will be discussed with the authorities during 2007.

Market monitoring

An ad-hoc group has, through cases from the Nordic market, studied different market monitoring issues in the regulating power market and in connection with imbalances between areas. The focus of the work has been on information and information needs, but the study has also looked into what benefits further Nordic co-ordination in monitoring could bring.

The study showed that the TSOs have access to a lot of data and information. Sharing of market participants' specific information between the TSOs could, however, be problematic since this is regarded as confidential information. The work concluded that all suspected situations in the regulation power market, affecting the Nordic market, should be analysed to achieve a harmonised clarification to the market participants. The study also concluded that the value of more harmonised market monitoring would increase when the balancing mechanism is further harmonised.

Transparency of information to the market players

During 2006, the question of transparency became a much discussed issue, both in the Nordic countries and in the rest of Europe.

The Nordic countries have been ahead of the rest of Europe as regards transparency issues and have therefore only needed to make smaller adjustments so far. It is, however, the common opinion of the Nordic TSOs that there is still room for improvement.

The EU's congestion management guidelines entered into force in 2006. The guidelines also include transparency issues. Nordel has examined how to fulfil the requirements of the guidelines and has investigated whether there are other things to be done to improve the transparency of the information. Nordel has also commented on the proposed "Guidelines for Good Practice on Transparency" prepared by the European Group for Electricity and Gas (ER.GEG).

ETSO has also been working to enhance transparency and launched a European information system - called ETSOVista (www.etsovista.org) - in the autumn of 2006. ETSOVista displays key operational data. In the first stage, it will contain the physical flows per border, exchange schedules etc. More data will be added at a later stage. Nordel played an important role in the development of the system in co-operation with ETSO.

As a result of increased transparency, Nord Pool Spot is in the process of improving the information available on its website, for example about trading capacities and the possible causes for their limitations. The improved information is a precondition for implementing the future method for identifying congestions.

The vessel used in the repair of the submarine cable Fenno-Skan between Finland and Sweden can also operate in severe sea conditions. Photo: Tuomo Kouti

System responsibility and operation

The Nordic system came close to its limits in many ways

The Nordic electricity system did not suffer from any operational disturbances leading to major black-outs in 2006. However, it was a year when the synchronous Nordic system came close to its limits in many ways, for instance in connection with several faults and limitations on interconnections and in power plants and periods with critically low water levels in the reservoirs. All these events made it necessary to prepare measures for ensuring operational security.

Operational disturbances

Because of a fault in the only three-month-old transformer in Kristiansand in Norway, Skagerrak 3 was out of operation for almost the whole year. The reason for the long outage was that the transformer had to be transported to the factory for repair. As a result, the transfer capacity between Denmark and Norway was halved to 500 MW, negatively affecting both the electricity market and the power balance. However, a spare transformer put the capacity on the Skagerrak cables back to normal at the end of 2006, four months before the damaged transformer was repaired.

The Fenno-Skan link between Finland and Sweden was damaged in early December about 8 kilometres from the Finnish coast. The link was taken into operation again in the middle of February 2007.

The Kontek cable between Eastern Denmark and Germany was also disconnected due to a fault when it was hit by an anchor at the end of December. The connection was taken into operation again in the middle of March 2007.

A fault in the Forsmark nuclear power plant in Sweden in July led to a safety investigation of other similar nuclear power plants in Sweden. As a consequence, several units with a total capacity of approx. 3,000 MW were not in operation until the investigation was concluded and permission to restart was given after several months. Because of those investigations together with the annual maintenance check, approx. 4,000 MW of a total of 9,250 MW of nuclear capacity was out of operation for several weeks. Reduced production capability in the nuclear power plants combined with a dry year resulted in a higher price level in the spot market than expected.

Some situations threatening the security of supply occurred during the year. Especially important was the situation in Europe on 4 November when a fault in Northern Germany caused a power outage affecting 15 million consumers for several hours. No consumers were affected in Denmark, but the situation could well have escalated under unfavourable circumstances. Frequency control at the power plants and emergency power regulation on the HVDC links to Sweden and Norway were activated in the western part of Denmark. Situation analyses have revealed areas requiring improvements in the Danish electricity system, and the operational and emergency procedures are to be observed.

Frequency control

The frequency quality has decreased gradually over the years, one of the reasons being increased trade with Continental Europe and between the Nordic countries. However, the negative trend has been halted in the last couple of years because of the implementation of short-term measures in the form of operational actions. The development and implementation of long-term measures to improve the frequency quality are still a challenge for the future.

The common Nordic regulating power market contributes to frequency control in the synchronous Nordic system and Western Denmark. In January 2006, the common Nordic regulating power market became a reality when Western Denmark was integrated into the joint regulating collaboration.

As a first step, frequency control is maintained automatically through primary regulation. The next step is to use different arrangements for manual adjustment. Normal manual regulation is supplemented with quarterly (15 minutes) regulation, which is separated from the regulating power market.

As the power markets in the Nordic countries and Central Europe are developing and the number of interconnections between the Nordic countries and Europe is increasing, a need for extra focus on the operation of the cross-border exchange has arisen. Rapid and large exchanges in the exchange have given rise to important operational challenges.

Nordel has looked into how the introduction of ramping on the interconnections and new rules for quarterly regulations can aid frequency control. This demonstrated a need for further analysis of future measures. A package of 15 different possibilities has been set up, including ramping and quarterly regulations. The new measures include time-for-gate closure for trading and planning, the use of Load Frequency Control/Automatic Generation Control coupled with the HVDC exchange, and the use of system-protection schemes in connection with frequency deviations.

The repair work of the Fenno-Skan cable. Photo: Tuomo Kouti

Winter outlook 2006/2007

Before the winter period of 2006/2007, Nordel's assessment of the power balance of the Nordic system showed that the total power balance in the Nordic area for the coming winter would be better than that of last winter. This was mainly due to a higher total available generation capacity.

The assessment also showed that in one out of ten winters, Finland and Sweden would have a deficit of peak load capacity while Denmark and Norway would have a surplus. Despite this, the available Nordic generation capacity proved to be sufficient to cover the hourly peak demand also during these rare cold periods that may occur once in a decade.

Statistical method to analyse congestions

In order to increase the transparency of information available to the market players, Nordel has developed a statistical method for analysing congestions in the Nordic system having the largest impact on the market. In 2006, those congestions were identified on basis of the information from 2002-2006. The method will be developed further, and the next step is expected to be ready in 2007.

Co-ordinated Nordic operational reserves

A study was conducted whether a Nordic market-based approach for procuring operational reserves could be provided. Several potential future solutions regarding the frequency-controlled reserves were thoroughly investigated. However, Nordel decided to postpone the work and gather experience from the establishment of a market for automatic reserves in Norway which will be established in the autumn of 2007.

Increased operational co-operation between the Nordic countries

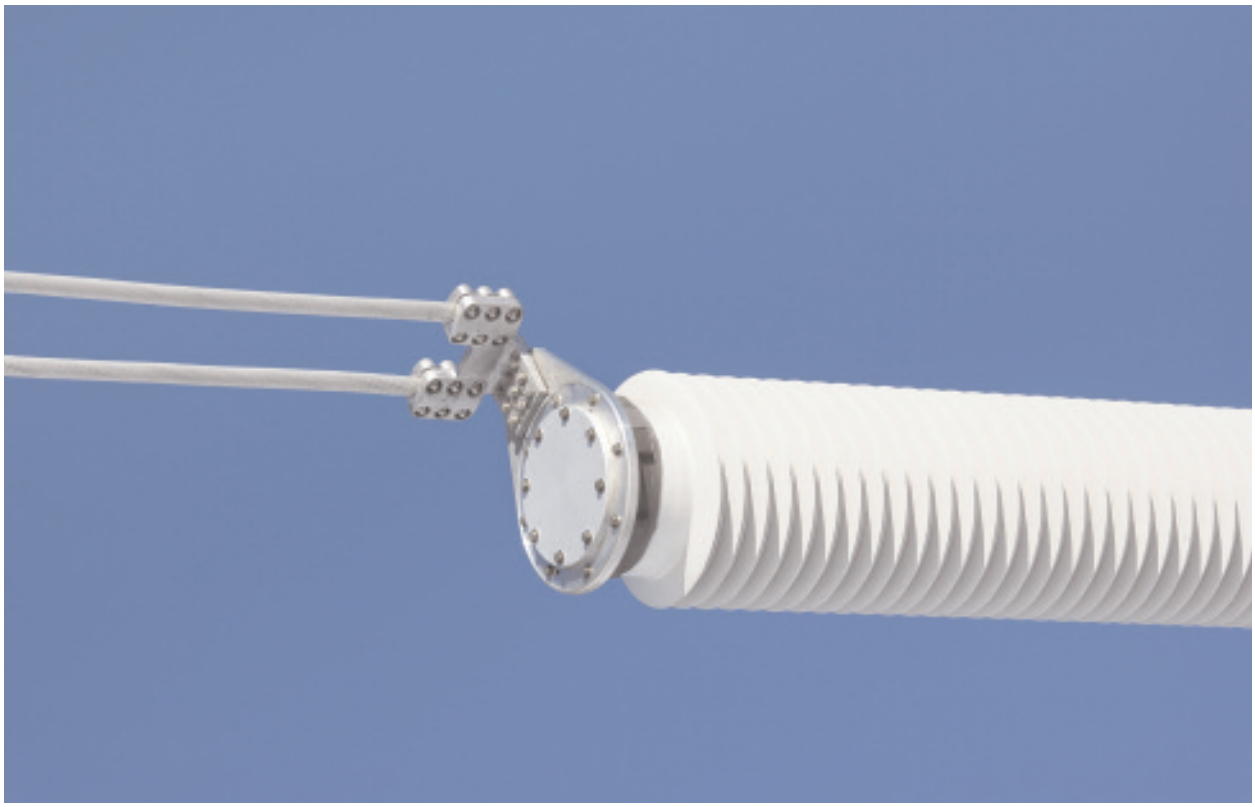
Close and well-functioning co-operation between the control centres has proved to be very important, especially during extensive operational interruptions like those that have been experienced worldwide in recent years. Nordel continuously endeavours to improve the co-operation which is described in the article "TSO co-operation to assure Nordic power system security" in this annual report.

Common R&D project Nordic Wide Area Measurement System

In 2006, the Nordic TSOs signed a contract where they agreed to develop and implement a Nordic Wide Area Measurement System (WAMS).

The goals of the project are to achieve a method for the real-time monitoring and control of inter-area power oscillations. Also a method for fast warning of possible poor or undamped oscillations should be demonstrated. The wide common data set also gives better feedback of the dynamic properties of the system.

The wind farm at Horns Rev on the western coast of Denmark. Photo: Jørgen Schytte



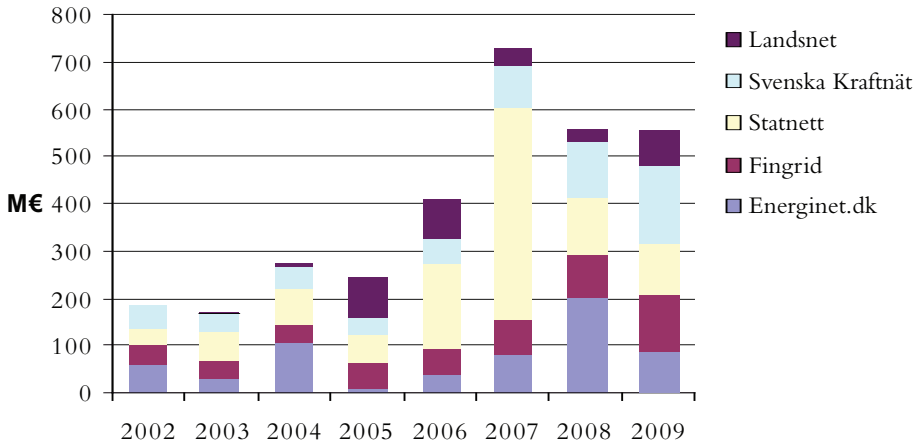
Several technical components specify the transmission capability in the power system. Photo: Trond Isaksen

Network development

Five Nordic transmission grid projects are in the pipeline

During the past five years, the Nordic grid investments have amounted to 1.3 billion euros in total. During the next three years, the investments will amount to 1.8 billion euros. The TSOs will invest more during the three coming years than they did during the past five years. This is partly due to five Nordic investment projects that are in the pipeline.

In June 2004, Nordel recommended the reinforcement of five cross-sections in the Nordic transmission grid. The purpose of the reinforcements is to improve the functioning of the market, to ensure acceptable security of supply and to facilitate more flexible power exchange between the Nordic countries. Further, there is a need to reinforce the transmission grid due to increased consumption in some areas and due to new plans for generating plants.



The investments in the five Nordic projects will amount to about 1 billion euros. The status of these projects is:

- The Fenno-Skan 2 project continued during the year by the drawing up of technical specifications and by choosing the cable route on the basis of a seabed study. Applications regarding the concession for the link were submitted to the authorities both in Finland and Sweden. The link is expected to go into service at the end of 2010.
- The line Nea-Järpströmmen will make the connection between Central Norway and Central Sweden stronger. For the Norwegian part of the line, the final permit from the authorities has been received. In December, applications were submitted regarding the concession for the Swedish part of the line. The line is expected to go into service in the autumn of 2009.
- In October, Svenska Kraftnät presented a pre-study for Sydlänken, the planned national grid line between Hallsberg and Hörby. The pre-study describes four alternative routes for the two technical alternatives studied, i.e. a 400 kV AC overhead line or an underground 300 kV DC cable. The line is expected to go into service in 2011.
- In the autumn of 2006, Energinet.dk launched an EU call for tenders relating to the main components of the Great Belt power link between Eastern and Western Denmark. The public authority process has not been completed. The new link is expected to be operational in 2010.
- Energinet.dk and Statnett have signed a letter of intent for a new HVDC link between Denmark and Norway, Skagerrak 4. The link will increase the capacity between the two countries from 1,000 MW to 1,600 MW. The bilateral studies have finished, and business cases are under preparation for the Boards of each company. The investment decision is scheduled for 2008/09 with commissioning in 2012.

Reinforcement of the cable between Denmark and Sweden

Another Nordic joint investment project is the new, modern HVDC link which replaces the old Konti-Skan 1 interconnection between Sweden and Western Denmark. It includes new converter stations both in Denmark and Sweden. The capacity has been increased from 270 to 380 MW. The reconstructed interconnection was put into trial operation in June and was taken into commercial operation in December.

The connection work with the existing Konti-Skan 2 will be finished in 2007. An improved and more modern system for supervision will also be installed.

Other interconnections

Finland - Estonia
In October, the trial period of the Estlink cable between Finland and Estonia began, and the cable was taken into commercial operation in January 2007. The length of the cable is 105 kilometres, 75 kilometres of which is sea cable, and the power capacity is 350 MW in both directions.

The cable is the first link between the Baltic countries and the Nordic electricity market. The operational responsibility alternates between Fingrid and Pöhivörk, the transmission grid operator in Estonia. The capacity is primary allocated by the owners but the objective is that it will subsequently be accessible to all market players in the future.

Norway - Netherlands
The NorNed cable is a joint venture project between Statnett and TenneT. The length of the cable will be 580 km, and it will have a capacity of 700 MW. The total cost of the cable is 485 million euros. The completion of the NorNed cable is planned to take place at the end of 2007. The cable capacity will be available for all market entrants through implicit auctioning. This requires a trading agreement that links the Nordic power market to the Dutch and European power markets. The trading mechanism is planned to be ready in the third quarter of 2007. It will also be possible to exchange ancillary services.

Denmark - Germany
To ensure a robust electricity system and an improved transmission capacity between Denmark and Germany, Energinet.dk is planning the reconstruction and expansion of an existing single-circuit 400 kV overhead line in Southern Jutland. The public authority process is in progress, and the new overhead line is expected to be ready for operation at the end of 2009.

Nordic system development plan 2007

During 2007, the next system development plan within Nordel will be drawn up. As an important input for this work, three future scenarios have been developed. The scenarios describe different future situations in view of economic growth, climate policies, energy prices, etc.

The first scenario, which is the base scenario, prolongs current trends and reflects likely outcomes of existing plans, policies, support schemes for renewables etc. The global focus on climate is continued at a moderate level.

In the second scenario, called Climate & integration, the growth in world economy will exceed current expectations, and the resulting growth in the demand for oil, gas and coal will reduce capacity margins on the supply

side (production and transportation) and lift prices and volatility.

In the third scenario, called National focus, global economic growth will decline as compared to the base scenario even though the prices of oil and gas are higher in this scenario. The focus on the mitigation of CO_2 emissions is relatively high also in this scenario, but international co-operation is poorer.

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 2009/10 and energy balance for 2009 were the following:

- Both balances are better than the former estimate for 2008/09.
- The Nordic system is able to meet both energy and power demand in average conditions without imports.
- The Nordic generation capacity is able to meet the peak power demand also in cold conditions (once in ten years).
- In "low inflow" conditions, imports are needed.
- Some areas in Norway can be exposed to a risk of rationing or other measures in case of extremely low inflow.

Nordic Wind Integration Study

The outlined trends of the energy policies indicate that the installed wind power capacity will increase substantially in the Nordic countries in the near future, especially in Sweden and Norway. The trend in wind power has therefore been estimated and the consequences of this trend have been studied in the European Wind Integration Study (EWIS). EWIS is a joint investigation initiated by ETSO and supported by the EU. The first part of the study focused on the year 2008 and was finished at the end of 2006. All synchronous areas in Europe (Nordel, TSOI, UCTE and UKTSOA) have been involved in the work.

The results of the Nordic part of the first phase of the study have been released in a Nordel report which can be downloaded from its website.

Nordic Grid Code 2007

The Nordic Grid Code forms the basis for the Nordic TSO co-operation. The purpose of the Grid Code is to achieve uniform and co-ordinated Nordic operation and planning between the TSOs in order to establish favourable conditions for the development of a well-functioning and effectively integrated Nordic electricity market. An essential objective of the Grid Code is to set a common basis for satisfactory operational reliability and quality of supply in the coherent Nordic electric power system.

The Grid Code governs technical co-operation between the TSOs in the interconnected Nordic countries. It concerns the operation and planning of the electric power system of the TSOs and the market participants' access to the grid. The Grid Code lays down fundamental common requirements and procedures that govern the operation and development of the electric power system.

The Grid Code is made up of:

- Concise introduction to the Nordic power system and general provisions for co-operation
- Planning Code
- Operational Code (System Operation Agreement)
- Connection Code
- Data Exchange Code (Data Exchange Agreement)

The Operational Code and the Data Exchange Code are binding agreements. The Planning Code and the Connection Code are rules that should be observed. They correspond to Nordel's recommendations in these areas.

The Grid Code will be a starting point for the harmonisation of national rules, with minimum requirements for technical properties that influence the operation of the interconnected Nordic electric power system. The Grid Code must, however, be subordinate to the national rules in the various Nordic countries.

As a new Nordel recommendation, this document includes the Nordel Connection Code for Wind Turbines. Other parts of the Connection Code have been updated according to the latest developments in the national requirements and rules.

Co-ordination between the Planning Code and the Operational Code has been improved by developing the formulation of the criteria scheme in planning to better correspond to the operational states. The Nordic Grid Code 2007 will replace the Nordic Grid Code 2004.

The complete Grid Code can be downloaded from Nordel's website at www.nordel.org.

The transmission grid in the Nordic countries

Events in the individual countries

Denmark

In 2006, two important steps were taken towards improving integration into the German electricity market. Energinet.dk, Nord Pool Spot, the German power exchange and the two TSOs in Northern Germany agreed on establishing a market coupling between the Nordic and the German power exchanges. The market coupling is expected to become operative in the fourth quarter of 2007. Furthermore, in September, the Elbas market opened for electricity trade close to the operating hour on the Kontek Link between Eastern Denmark and Germany.

Eastern Denmark implemented the daily market for manual regulating power reserves on 1 July, with Western Denmark following suit on 1 February 2007. The portfolio for the reserves will consist of long-term contracts using a starting incentive for new suppliers, mid-term contracts covering the supply of a basic amount of the reserves, and a daily supply covering the variable part of the reserves.

A large part of Denmark was hit by an ice storm on 19 and 20 January. The ice settled on overhead lines in the transmission and distribution systems. The result was galloping lines, and consequently, occasional outages and consumer interruptions. There was an estimated 140,000 cut-offs, some of which affected consumers more than once for shorter periods of time.

At the end of the year, weather conditions caused a critical production surplus in Western Denmark. Large amounts of wind resulted in wind turbines contributing to large amounts of power, and since Northern Germany was experiencing similar conditions, it was not possible to export the surplus. Almost all measures in the emergency plan for critical power surplus were implemented, and in the end distributed power plants and wind turbines were disconnected.

Since the foundation of a single national TSO for electricity and gas in Denmark in October 2005, Energinet.dk has worked towards combining the two existing control centres for electricity to a single centre. This means that the two existing control centres in Eastern and Western Denmark are presently undergoing a harmonisation and strategy process in preparation for the relocation in 2008.

Energinet.dk is in the process of planning the power connections for two new offshore wind farms with a capacity of 200 MW each at Horns Rev in Western Jutland and Rødsand south of Lolland, respectively. The offshore wind farms and the power connections are expected to be operational in 2009.

Finland

Several law proposals were made in Finland in 2006. These included facilitating the network access of small-scale power plants, securing the production of condensing power plants which are under a threat of being closed down, and supporting peat condensing power by means of a feed-in tariff. The implementation of the latter two has been assigned to Fingrid.

The amendment of the Finnish Electricity Market Act concerning the harmonisation of transmission fees for production was passed in October. The purpose of the amendment is to facilitate the access of small-scale electricity production to electricity distribution networks. The amendment aims to promote local combined heat and power production as well as the use of biomass fuels and renewable energy sources.

The Power Reserve Act, which secures the security of supply of electricity and ensures that condensing power capacity, which is under a threat of being closed down, will be kept in readiness for use, came into force on 15 December 2006 and will stay in force until 28 February 2011. According to the act, Fingrid has to maintain the related arrangement. Agreements have been made between Fingrid and owners of power plants from the beginning of 2007. These agreements include approx. 600 MW of condensing power capacity. In the winter period, the plants are kept in a starting readiness of a maximum of 12 hours.

The act on the feed-in tariff which supports peat condensing power was passed by Parliament in January 2007, and the act will become effective as of 2008.

During a cold period at the beginning of the year, a peak load record, 14,860 MW, was reached in Finland on 20 January 2006. At the same time, the imports from Russia were limited at a short notice due to a strained situation and cold weather in the St Petersburg region. Fingrid informed the market about a strained power situation for the first time ever. However, the operational situation did not lead to a power shortage situation or interruptions in the electricity supply.

A new peak load record, around 14,900 MW, was reached on 7 February 2007.

With the exception of a disturbance where a helicopter with a fertilizer spreader got entangled in the 110 kV line between Imatra and Juva in South-Eastern Finland in August causing large damage, no major disturbances occurred in the Finnish grid and the operational reliability was good. The total number of disturbances was below average.

Much of network development in 2006 focused on the implementation of grid reinforcements required by the Olkiluoto 3 nuclear power unit which is being con-

structed. No new 400 kV transmission lines were completed in Finland during the year. Two new 110 kV lines with a total length of 42 km were finalised. A new 400 kV switching substation was built in Huittinen in South-Western Finland. Two new 400/110 kV transformers were commissioned in 2006, one at Tammisto near Helsinki and the other in Vuolijoki in Eastern Finland.

There has been an increasing interest in constructing new transmission connections from Russia. One example of these is the sea cable planned from Sosnovyi Bor to Finland, which attracted much media publicity. The Finnish Ministry of Trade and Industry processed the matter in December and rejected the related application. Experiences during 2006 showed that the situation in the St Petersburg region, due to economic growth in Russia, can restrict the electricity exports. This must be taken into account when assessing the availability of the imports to the Nordic countries and its impact on the system security.

Iceland

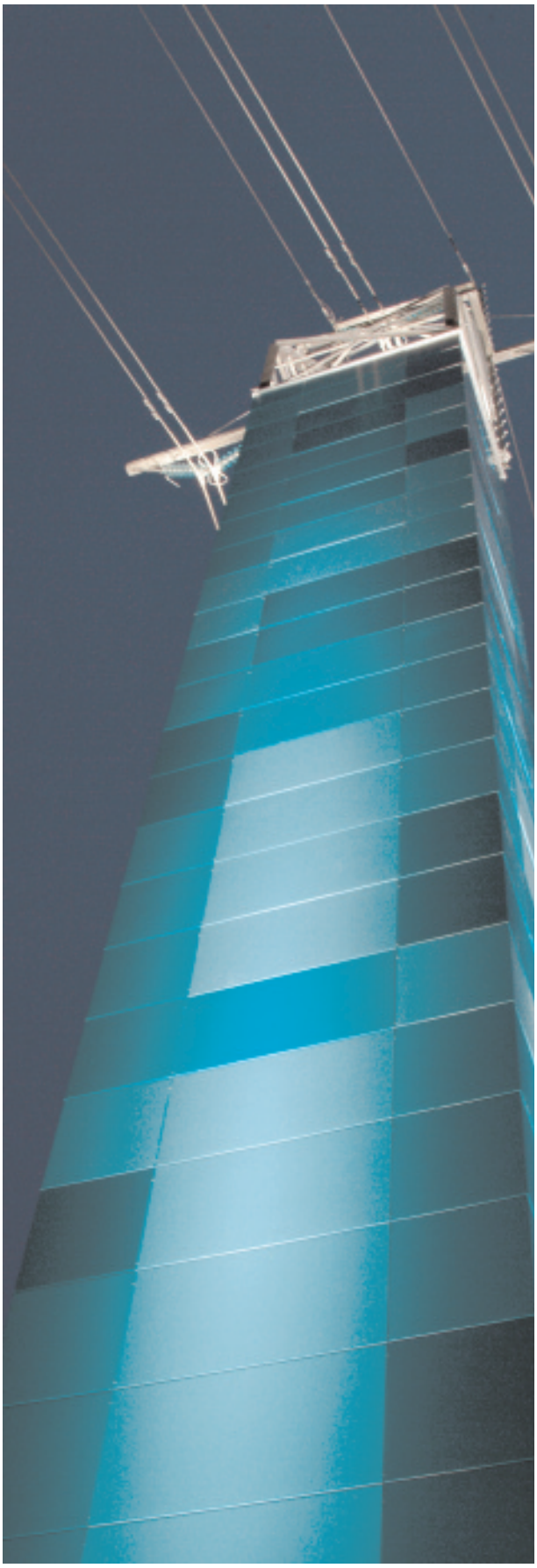
The energy market in Iceland became fully open as of 1 January 2006 but its first opening phase was at the beginning of 2005. Competition is very limited with only six producers participating in the market with Landsvirkjun being the dominant player. The first steps in the preparation of evaluating the establishment of an electricity spot market in Iceland were carried out with the intent of starting the market in 2008. That preparation work was done in co-operation with Nord Pool.

Two geothermal power plants were taken into operation during the year: one 100 MW plant owned by Sudurnes Regional Heating (HS) and one 90 MW plant owned by Reykjavik Energy (OR). Both these power plants deliver energy to the extension of the aluminium plant in Grundartangi north of Reykjavik.

The construction of the 690 MW hydropower plant at Karahnjukar in Eastern Iceland progressed during the year. The plant will deliver energy to an aluminium plant in Reydarfjordur in Eastern Iceland with a capacity of 320,000 tonnes per annum. Both the power plant and the aluminium plant will become operational in the first half of 2007.

There is still considerable interest in further investments in new aluminium plants in Iceland and in enlarging the capacity of the existing plants.

2006 was Landsnet's second year as the Icelandic Transmission System Operator, being responsible for the operation of all transmission facilities of 66 kV and higher. Landsnet's major shareholder is Landsvirkjun with Iceland State Electricity and Westfjord Power Company as minority shareholders.



A landscape transmission tower in Nummela in Southern Finland, design by Jorma Valkama. Photo: Juhani Eskelinen

No serious system disturbances occurred in the Icelandic grid during the year. Two transmission line failures, however, occurred on the west coast, both related to salt pollution and heavy wind.

During the year, the construction work of two 50 km long 400 kV transmission lines in Eastern Iceland progressed. The lines connect the power plant at Karahnjukar and the aluminium plant in Reydarfjordur.

In January, a 119 km long 420 kV line was taken into operation in the south-west between the hydropower stations in the Thjorsa river and the Brennimelur substation feeding the aluminium plant at Grundartangi north of Reykjavik.

A new 220 kV substation connecting Reykjavik Energy's 90 MW geothermal plant to the grid was energised.

The construction of a 220/132 kV substation in the east connecting the 690 MW Karahnjukar plant to the grid progressed well.

Norway

For a whole week in January, a storm (Narve) hit the northern part of Norway. The wind gusts were well above hurricane force. The temperature was down to -20 °C, with a new peak load record of 1,550 MW reached in Northern Norway north of Narvik. The storm caused several outages in Northern Norway. As a consequence, loads had to be disconnected to prevent a blackout. At most, about 250 MW were disrupted, with a total of 300 MWh not supplied for about 1.5 hour. The connection between Northern Norway and Sweden was also interrupted several times during that week.

As part of Statnett's measures to handle very strained energy (i.e. dry year) situations, Statnett made two important steps in 2006. In early autumn 2006, Statnett asked for tenders in options/rights to reduce electricity consumption among power intensive industries in the period of weeks 3 to 22. Statnett agreed on a total volume of 0.9 TWh. Due to the energy situation during the winter of 2006/07, Statnett did not need to exercise the options.

Statnett has decided to invest in 300 MW of reserve power in Central Norway. 150 MW at Tjeldbergodden will be ready for operation in January 2008. Another 150 MW will be ready for operation later in 2008 and will be localised at Nyhamna in Aukra. Reserve power will only be utilised in case of severely constrained power situations where there is a high risk of running out of water in the water reservoirs. Statnett needs concession and approvals from the authorities to install and start the installations.

During 2006, Statnett commissioned lines, cables and transformer stations at the amount of 1.2 million euros in Central Norway. The investments will contribute to secured power supply in Central Norway. The investments are also a result of increased demand from the onshore gas facility unit processing gas from the Ormen Lange field. Concluding this investment, Statnett has since 2004 commissioned construction projects for about 250 million euros to maintain the security of supply in Central Norway.

Statnett has decided to strengthen the transmission lines in the southern part of Norway. The new line is called Evje–Holen and will, among other things, contribute to an optimal utilisation of the HVDC links to the continent. The final permit from the Norwegian authorities is expected in 2007.

From 2007, Statnett reduced the interval between each calculation of marginal losses from 8 weeks to 1 week. Weekly calculations will reduce the deviation between real and calculated power flow, which in turn contributes to better and more correct signals to the market players regarding their use of the main grid.

Sweden

The beginning of March was the coldest for 25 years and the operational situation was strained. Electricity prices on the spot market were high, peaking at approx. 0.14 euros/kWh. At the same time, the transfer capacity was reduced as the Fenno-Skan link was shut down for maintenance. To safeguard network operation, other planned line work was interrupted.

In April, Svenska Kraftnät submitted a report to the Government concerning how the peak load resources can be resolved after the winter of 2007/08 when the interim law expires, giving Svenska Kraftnät the responsibility for the resources. It is planned that the market players themselves, through Swedenergy, will assume the responsibility for maintaining peak load resources. For the winter period of 2006/2007, the peak load resources are 1,989 MW in total. Of this, 564 MW consists of agreements with industries to reduce their consumption during power shortages and the rest consists of agreements with production facilities which are not normally commercially available.

During the last decade, there has been a moderate level of investments in the Swedish transmission grid. The focus has mainly been on administrating and operating the existing system. The situation is now changing into a phase of more restructuring and system extension which leads to a higher level of investments. The annual rate of investments during the coming years will be more than doubled. The purpose of the investments is to improve the system reliability and effectiveness of the electricity market.

In 2004, Svenska Kraftnät was commissioned by the Swedish Government to investigate and outline the future transmission system in the Stockholm area. The result of this work will now be implemented gradually continuing until 2016. As a first step, Svenska Kraftnät has decided to build a new 400 kV link through the city and to build four 220 kV underground cable links in the Stockholm area.

Similar to the Stockholm project, Svenska Kraftnät has decided to restructure and improve the transmission system close to the city of Uppsala. One 220 kV substation will be built and redundancy will increase by the establishment of a new transformer in the central area.

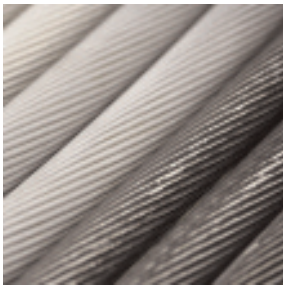


Photo: Emil Thor, Håkan Flank, Trond Isaksen

Important events during 2006

1 January
The electricity market in Iceland was fully opened.

16 January
The storm Narve caused several outages in Northern Norway.

20 January
A new peak load record was reached in Finland, 14,860 MW.

23 January
One of the transformers connecting the Skagerrak cables in Kristiansand went out of order.

4 February
The Security of Supply directive was passed by the EU Parliament.

16 February
Landsnet and Nord Pool Spot AS signed a Letter of Intent expressing their interest in opening a spot market for electricity trade in Iceland.

8 March
A green paper on the European Energy Policy was released by the EU.

6 June
The Ministry of Industry gave a positive signal to Landsnet's interest in opening a market for electricity trade in Iceland.

13 June
Nordel held its annual meeting at Fiskebäckskil north of Gothenburg in Sweden.

1 July
The EU's gas supply directive came into force. According to it, the system responsible authority has to draw up a plan for safeguarding the supply of natural gas within the framework of system responsibility.

25 July
As a consequence of a fault at the Forsmark nuclear power plant, several nuclear reactors were stopped by the Swedish Nuclear Power Inspectorate.

8 October
Large parts of Gothenburg were hit by a major power outage.

4 November
A major power failure affected about 15 million consumers in Continental Europe for several hours.

15 November
The Danish Competition Board of Appeal ruled that Elsam has abused its dominant position in the Danish electricity market.

20 November
Based on the power situation, a new Elspot area was created in Central Norway.

30 November
A spare transformer was put into operation and the capacity on the Skagerrak cables was back to normal.

1 December
The EU's Congestion Management Guidelines came into force.

2 December
The DC interconnector Fenno-Skan between Sweden and Finland was taken out of service after sustaining damage.

15 December
The Power Reserve Act came into force in Finland.

18 December
Statnett's Board decided to invest in 300 MW of reserve power.

19 December
The Finnish Ministry of Trade and Industry rejected the application to build a cross-border cable from Russia.

22 December
The modernised Konti-Skan 1 DC interconnector was taken into operation.

31 December
The Kontek Link between Eastern Denmark and Germany failed when it was damaged by a ship's anchor.

Photo: Håkan Flank, Juhani Eskelinen

The Operations Forum 2006 was held at Växholm, a small town north-east of Stockholm. Photo: Per Åge Johannessen

TSO co-operation to assure Nordic power system security

The Nordic power system consists of four national power systems controlled by the Transmission System Operators (TSO). A well-functioning co-operation between the national control centres is an important element in our 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.

Experiences from large disturbances world-wide have shown that insufficient co-operation between control centres and lack of knowledge of the power system situation in the neighbouring areas have been reasons for some disturbances. These factors may also lead to longer restoration times. It has also been experienced that personnel did not have the contractual rights or were not aware of the possible measures which could be used to ease the strained situation.

After deregulation and opening of the Nordic electricity market, closer co-operation between the Nordic TSOs has been developed. It is important that the TSOs have multilateral agreements and principles, efficient information exchange between the control centres as well as skilled and trained personnel. The Nordic TSOs work continuously on those topics in order to ensure the Nordic power system security and a well-functioning market. This article summarises the current status of the work within Nordel.

Common framework for power system operation

The four Nordic TSOs are jointly responsible for power system security. Therefore, common instructions, principles and rules for power system operation are needed.

A common understanding of the terms and definitions used is essential for the co-operation between the operators because the subsystems are very different and there is no common language. The Scandinavian languages are related, but different. Finnish originates from a totally different language group.

Common criteria and rules are cornerstones for the operation of the interconnected Nordic power system. The criteria and rules cover

- the common operational security standards,
- the balance regulating standards and
- the handling of power shortages.

The procedures for the exchange of operational information facilitate joint operation. The information exchange covers

- operational plans,
- operational performance and
- operational follow-up.

Technical information about the subsystems is also a prerequisite for proper joint operation. This covers

- the general structure of the subsystems,
- the system protection within and between the subsystems and
- the procurement of system services within each subsystem.

Management of the individual cross-border links within the Nordic power system and to areas outside the Nordic system need to be defined in bilateral agreements between the TSOs. In addition, practical guidance in some operational areas, like in power shortage management, is needed.

All the above-mentioned principles, rules and guidance have been agreed upon in the System Operation Agreement, which has for several years been the basis for the operational co-operation between the Nordic TSOs. The System Operation Agreement is now included, as a binding Operational Code, in the Nordic Grid Code. The overall aim is to set up and describe a framework for the operation of the Nordic power system as a single system.

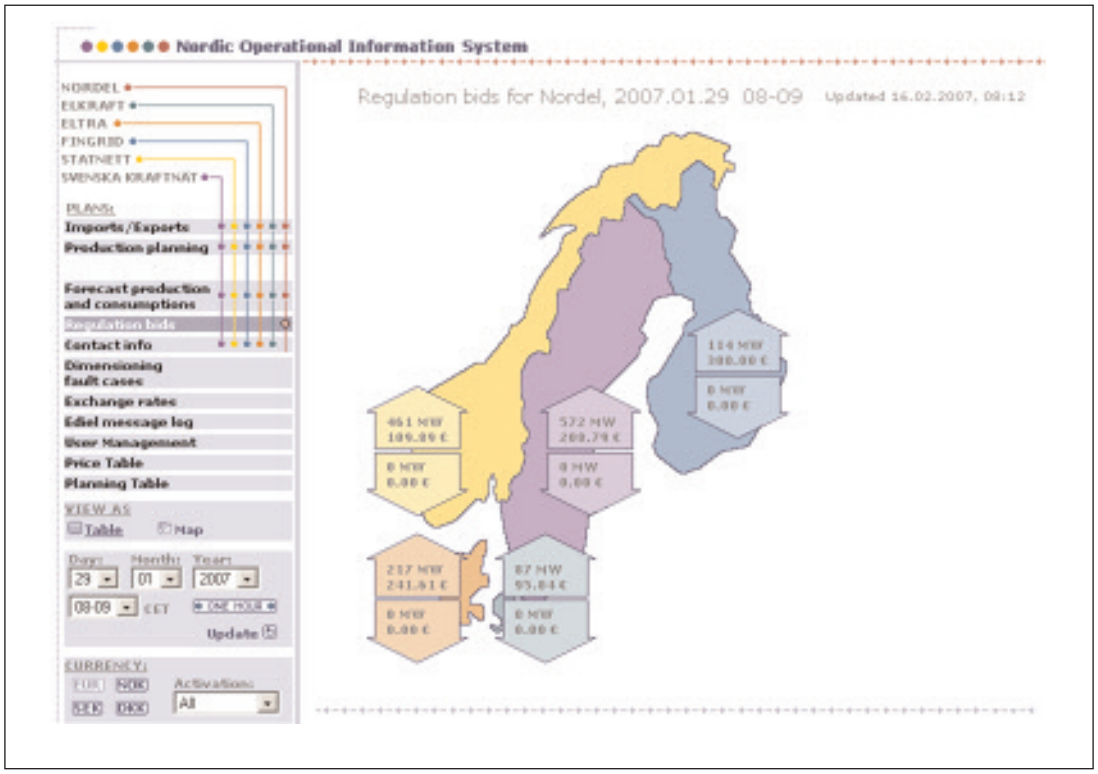
Common information systems

In the late 1990s, during the undergoing changes in the Nordic energy market with heavy consequences for the operation of the Nordic power system, the idea of a joint project and of a common operational information system was brought up for the first time. This system was seen as a necessary prerequisite for improved co-operation in the Nordic power system. New competitive IT possibilities and a strong will to exploit the benefits of the experiences and know-how of the four TSOs resulted in a Nordel decision on a common system and a joint project.

The main goal of the Nordic TSOs was that the common information system should contribute to an optimal use of the Nordic transmission system and resources, but also the security issues were kept in strong focus. The ambition was:

- to present a common picture of the actual operational situation
- to achieve a better operational co-ordination
- to develop the operational planning and balance and reserve management.

The Nordic Operational Information System (NOIS) pilot was taken into operation during 2002 and was a prerequisite for the final implementation of the "Common Nordic Regulating Power Market". The NOIS pilot has given important experiences and input to the planning and design of the new NOIS, which will be commissioned at the beginning of 2008. The pilot is a web-based system located physically at Fingrid.



Regulation volumes and prices in the NOIS pilot system.

Development of Nordic Operation Information System

A pre-study for the new NOIS was carried out in 2004. In November 2006, the contract with the supplier was signed together with agreements between Energinet.dk, Fingrid, Statnett and Svenska Kraftnät on cost sharing, maintenance and placement of the system. The system will be hosted by Energinet.dk in Jutland.
The system will be a common tool for the four Nordic TSOs in tasks related to

- balance management of the synchronous Nordel system
- daily transmission capacity management of relevant interconnections
- reserve management
- outage management
- operator alerts between the TSOs.

Also Urgent Market Messages (UMM) to Nord Pool Spot will be a part of the support functions in NOIS.

The new features in NOIS will promote the continuing development of operational co-operation between the TSOs and will be of great help in enhancing the common understanding and competence of the operators.

The new NOIS will help the TSOs' operational planning and control centre organizations to fulfil operational security requirements in the whole Nordic system and to use available system resources in an optimal way. It will give guidance in the short and long term to maintain frequency quality and at the same time to maintain an adequate amount of reserves. Especially when there are bottlenecks, NOIS will support the operators and show which resources should be used.

In disturbance situations, the demands on the NOIS usability, displays, and navigation are very high. It is important to give a good overall picture of the Nordic power system to the four national control centres.

Capacity and outage management features will give support to define and publish the cross-border capacities in a co-ordinated manner and to schedule outages within time periods which will have a minimum impact on the market.

In further development, NOIS can be a great help in data exchange with the TSOs in the Union for the Co-ordination of Transmission of Electricity (UCTE) system. For example, the large amount of wind power in Northern Europe and forthcoming investments in wind power also in the Nordic countries will increase the need for balance regulation possibilities. In this area, good planning tools are crucial and part of the NOIS delivery.

During the NOIS project, it has been very clear that the Nordic team spirit gives great opportunities in sharing expertise and experiences and also gives important input and development to the daily work processes in the national control centres.

In the long run, NOIS will reduce the required investments in the TSOs' own information systems, but the most important goal is nevertheless to improve the co-operation between the TSOs.

Information exchange with other systems

Traditionally, real-time measurements from neighbouring systems, e.g. status indications and power measurements from the substations behind the borders, have been exchanged. It is, however, very important to increase the exchange of real time data and develop this area as well. This may comprise power measurements in system boundaries and internal constraints as well as production, load and reserves, which all can for instance be presented on identical displays in the control systems, e.g. map pictures.

Operational planning information including transmission capacities and measured physical flows in the Nordic power system are also exchanged. Some of this information is also published on Nord Pool Spot's web pages and on the recently introduced information system of European Transmission System Operators, ETSOVista.

Nordic training of operations personnel

All of the Nordic TSOs share a common responsibility to educate and train their own personnel to be able to manage all kinds of operational conditions. The common Nordic power market has led to an extensive harmonisation and integration of Nordic system operation. As the complexity of the Nordic power system and Nordic power market increases, so does the need for common activities in the field of training and education.

In order to continue and formalise the co-operation in the training and education of control room operators, a Nordic training group was established in 2006. The group consists of a representative from each TSO. It is responsible for the planning and execution of training sessions and courses.

Part of the objective is to achieve a common understanding of rules and regulations, how the subsystems interact, and of the differences between them. Well-functioning co-operation and working environment between the national control centres should also be created.

The common activities of training and educating operational personnel can be divided into five main areas:

- visits to the other national control centres to learn and observe their procedures
- annual operational seminar "Operations Forum" with representatives from all the TSOs

- simulator training on the "Aristo" simulator of Svenska Kraftnät
- off-simulator training with focus on interpretation and use of different rules and regulations
- courses on subjects relevant to all Nordic TSOs.

Training and education are intended to cover normal operating conditions as well as strained operating conditions, containing subjects from congestion management, interruptions, frequency disturbances, capacity deficit to the pricing of balance power. The training sessions are largely based on roleplay. An environment and interaction between the participants as close as possible to the real experience should therefore be created.

Aristo is a real-time dynamic power system simulator developed by Svenska Kraftnät. This is an essential tool in creating realistic and complex training sessions for demonstrating both dynamic phenomena as well as the mutual influence between the different subsystems.

Bilateral training sessions with focus on specific cross-border challenges have also been carried out. As the Aristo model is under continuous development and updating, it will soon cover the entire Nordic power system. This will give the opportunity to further develop simulator training, both bilateral and joint sessions including all Nordic TSOs.

In addition to learning about the dynamics of the power system, such training gives the operators a better understanding of how other national control centres work during different situations and interruptions. Every year common rules and regulations are being thoroughly examined at the annual operational seminar "Operations Forum" and through paper-training sessions. Due to this common education and training, the operators have a better understanding of each others' operational challenges and how they can be solved.

For an operator on duty in one of the national control centres, the fellow Nordic operators are your closest colleagues. There is a close relationship especially between the Swedish and Norwegian national control centres due to the common responsibility for frequency quality in the Nordic system. This calls for a continuous

Kenneth Walve (on the left) from Svenska Kraftnät has been a central person when it comes to exercises and simulations in the power system simulator Aristo. Photo: Håkan Flank

effort to maintain and develop a friendly and well-functioning work environment. The common activities in the field of training and education are the most important areas for operators to meet face to face.

The common knowledge and understanding of the integrated Nordic power system combined with the close collaboration between the national control centres secures the quality of decision-making and problem-solving during both normal and strained operating conditions.

Future challenges

To operate the Nordic power system as a single system is a challenge and needs continuous development of common processes and tools. The operational contracts and principles are updated regularly to assure that the prerequisites of managing power system security are in full force.

Common IT systems will give all TSO control centres the same possibilities to have an overall view of the Nordel system to be able to make correct decisions when needed. The new NOIS will improve the existing information exchange between control centres and will help to enhance operational co-operation. Real-time data exchange between control centres is very important. Further actions are still needed to have a full real-time picture of the Nordic power system in all four control centres.

The training of the personnel working in the control centres is crucial in order to have a common understanding of system phenomena and principles of the Nordic power system. Common training session have been started in 2006. The participants have responded with positive feedback. The training will continue according to an annual training programme prepared by the Nordic training group. In the future, common training sessions will also be organised with the TSOs in the interconnected neighbouring areas outside Nordel.

New interconnections in the future will integrate the Nordic power system more closely together with the neighbouring electricity markets. The need for information exchange and co-operation with the respective TSOs will increase. Accordingly, the number of different native languages used in the control centres will also increase creating a potential source for misinterpretations. This is one future challenge for the common training.

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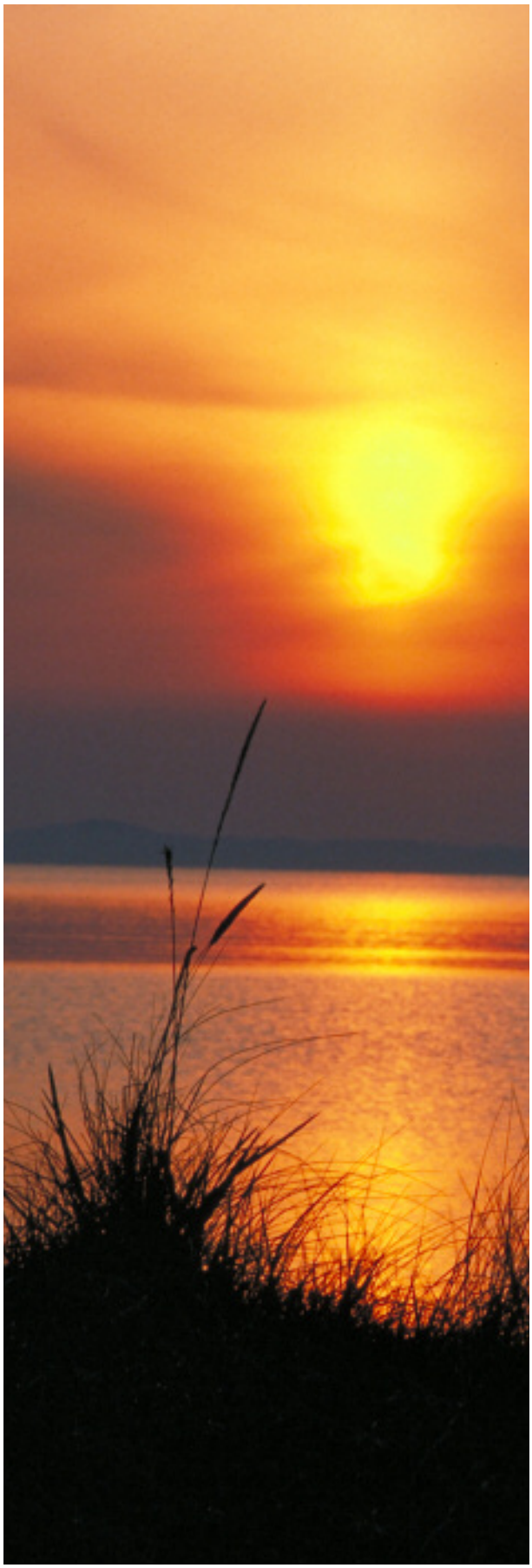

A view of Santakari in front of Rauma, Finland. Photo: Tuomo Kouti

Statistics

Annual statistics is available at
www.nordel.org

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Definitions, units and symbols

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

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

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

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.

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.

Total consumption
The sum of electricity generation and net imports.

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.

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

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

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

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

Losses
Losses in the transmission and distribution networks.

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.

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

Sources
Danish Energy Association
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

Electricity generation

S5 Electricity generation 2006, GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total generation	43 328	78 590	9 925	121 715[2]	140 314	**393 872**
Nuclear power	-	21 982	-	-	64 984	**86 966**
Other thermal power	37 198	45 119	5	1 123	13 167	**96 612**
- Condensing power		17 547	-	0	778	**18 325**
- CHP, district heating	35 433[1]	14 505	-	113	6 912	**56 963**
- CHP, industry	1 762	13 064	-	561	5 464	**20 851**
- Gas turbines, etc.	3	3	5	449	13	**473**
Hydro power	23	11 342	7 289	119 919	61 176	**199 749**
Wind power	6 107	147	-	673	987	**7 914**
Geothermal power	-	-	2 631	-	-	**2 631**
Total generation 2005	34 353	67 497	8 679	137 948[2]	154 609	**403 086**
Change compared to 2005	26.1%	16.4%	14.4%	-11.8%	-9.2%	**-2.3%**

[1] Includes condensing production.
[2] Gross production.

Electricity consumption

S9 Electricity consumption 2006, GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total consumption	36 392	90 111	9 925	122 572	146 366	**405 366**
Occasional power to electric boilers	-	56	171	3 513	1 312	**5 052**
Gross consumption	36 392	90 055	9 754	119 059	145 054	**400 314**
Gross temp corrected consumption	*36 520*	*90 683*	*9 656*	*123 018*	*146 923*	***406 800***
Losses	2 092	3 398	469	9 280	11 260	**26 499**
Pumped storage power	0	-	0	540	50	**590**
Net consumption [1]	34 300	86 657	9 285	109 239	133 744	**373 225**
- housing	9 800	20 900	934	35 503	40 100	**107 237**
- industry (incl. energy sector)	10 100	50 163	6 905	48 393	59 900	**175 461**
- trade and services (incl. transport)	11 400	14 694	963	23 703	27 300	**78 060**
- other (incl. agriculture)	3 000	900	434	1 640	6 444	**12 418**
Total consumption 2005	35 723	84 511	8 679	125 908	147 217	**402 038**
Change compared to 2005, %	1.9 %	6.5 %	14.4 %	-2.6 %	-0.6 %	**0.8 %**
Population (million)	5.4	5.3	0.3	4.7	9.1	**24.8**
Gross consumption per capita, kWh	6 693	17 112	31 772	25 549	20 421	**16 168**

[1] Estimated net consumption.

System load

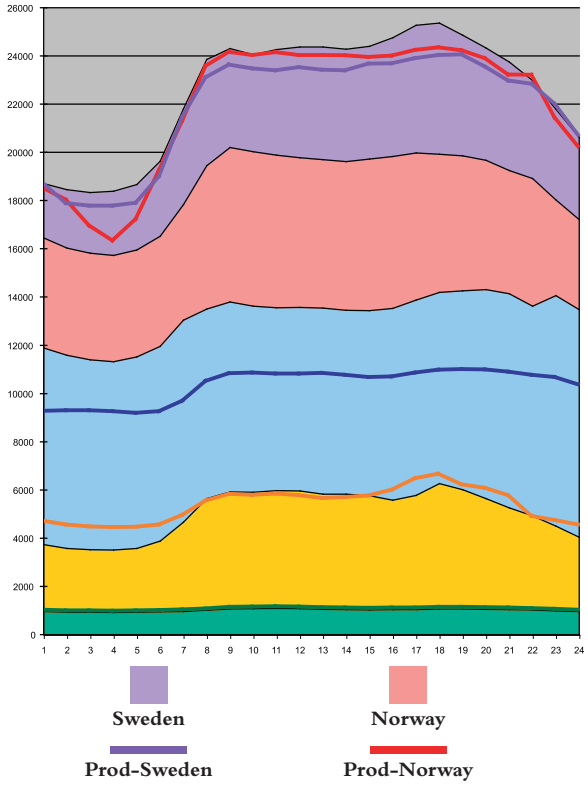
S13 Maximum system load in 2006

	Simultaneous maximum[1] 20 January 8:00-9:00 MWh/h	Maximum system load in each country MWh/h	Date/time
Denmark	5 965	6 423	24 Jan 17:00 - 18:00
Finland	14 863	14 863	20 Jan 08:00 - 09:00
Iceland	N.A.	1 337	18 Dec 11:00 - 12:00
Norway	21 368	21 575	06 March 08:00 - 09:00
Sweden	25 743	26 200	21 Feb 18:00 - 19:00
Nordel	**67 939**		

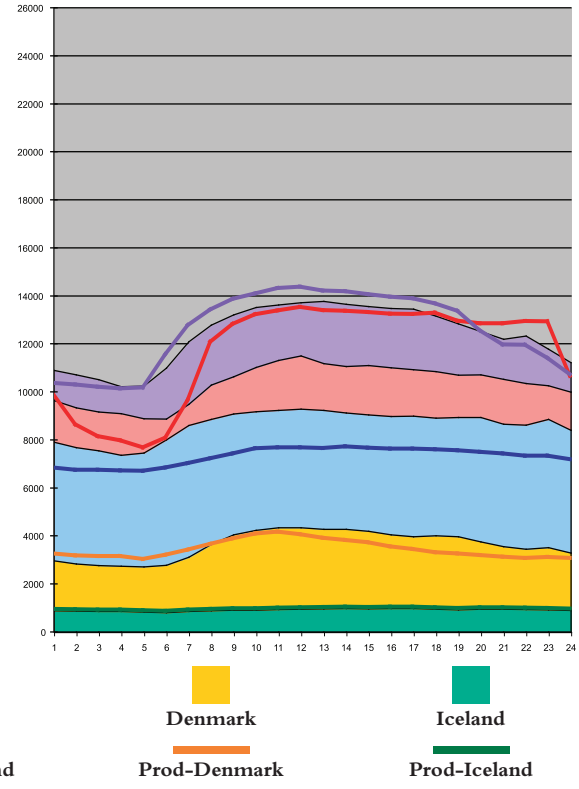
[1] In the interconnected Nordic power system.

System load 3rd Wednesday in January and in July 2006

Average 24-hour consumption and production 3rd Wednesday in January (2006-01-18) MWh/h



Average 24-hour consumption and production 3rd Wednesday in July (2006-07-19) MWh/h



Maximum system load 3rd Wednesday in January and in July 2006

	3rd Wednesday in Jan 2006 17:00 - 18:00 - MWh/h	3rd Wednesday in July 2006 12:00 - 13:00 - MWh/h
Denmark	6 257	4 269
Finland	14 189	9 226
Iceland	1 056	962
Norway	19 918	11 183
Sweden	25 361	13 767
Nordel	66 781	39 408

All hours are local time.

Interconnections

S14 Existing interconnections between the Nordel countries 2006

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 1, 2 and 3	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 - Stenkullen	250= [6]	290	270	176	88
Vester Hassing - Lindome 1 and 2	2 x 285= [7]	740	740	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~	2 150 [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).

[6] Stenkullen decommissioned in August.

[7] The Lindome 1 utilising right from 1 July.

Interconnections

S15 Existing interconnections between the Nordel countries and other countries 2006

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~	1200	800[3]	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					
Espoo - Harku	150=	350	350	105	105
Norway - Russia		**From Nordel**	**To Nordel**		
Kirkenes - Boris Gleb	154~	50	50	10	-
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

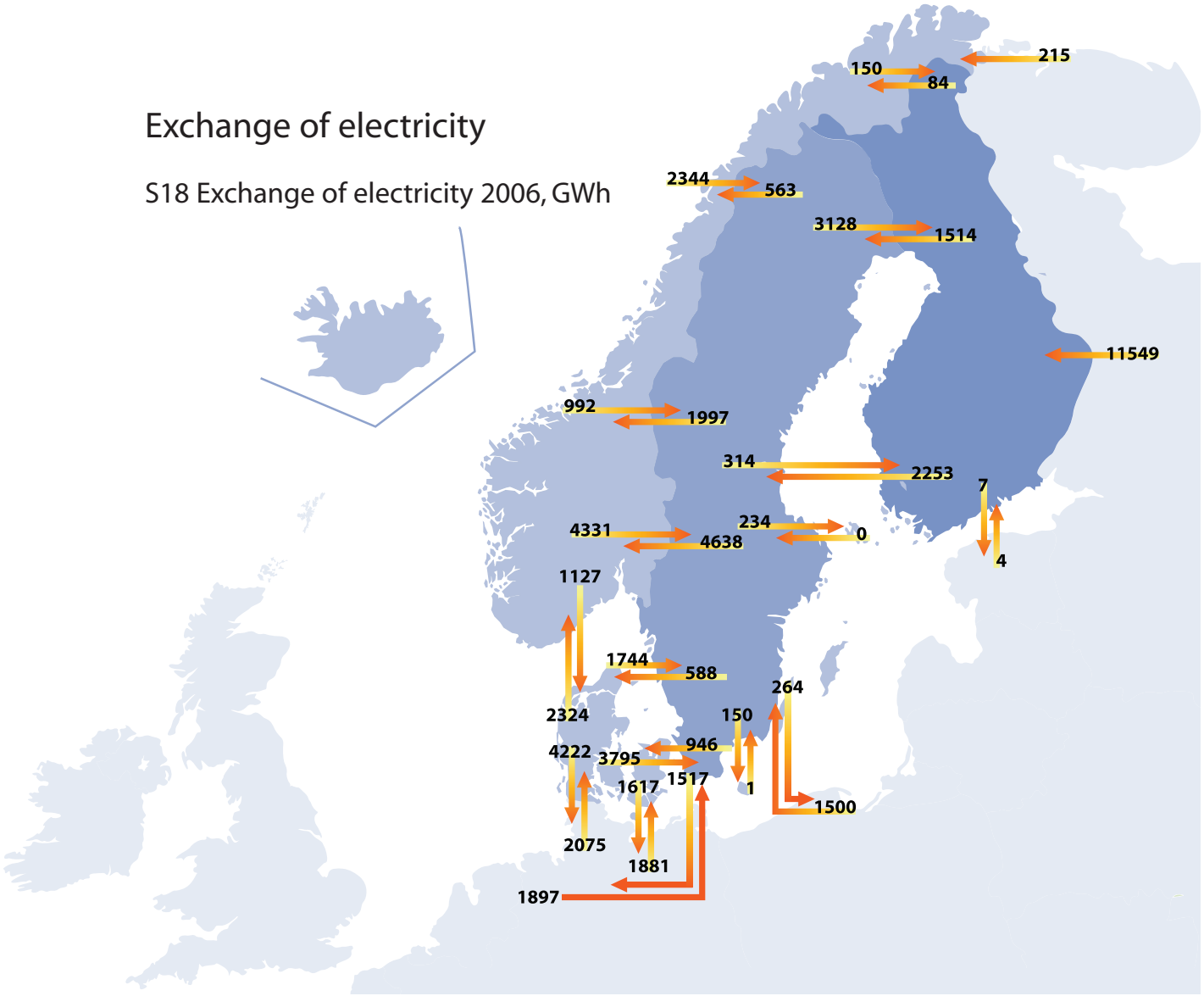
[1] The transmission capacity is currently limited to 460 MW from Nordel and 390 MW to Nordel due to limitaion in the German network.

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

[3] The transmission capacity to the north is limited to 800 MW due to internal restrictions in Denmark West.

Exchange of electricity

S18 Exchange of electricity 2006, GWh



S19 Exchange of electricity 2006, GWh

From: To:	Denmark	Finland	Norway	Sweden	Other countries[1]	∑ From
Denmark	-	-	2 324	5 540	5 839	**13 703**
Finland	-	-	84	3 767	7	**3 858**
Norway	1 127	150	-	7 667	-	**8 944**
Sweden	1 684	3 676	7 178	-	1 781	**14 319**
Other countries [1]	3 956	11 553	215	3 397	-	**19 121**
∑ To	**6 767**	**15 379**	**9 801**	**20 371**	**7 627**	**59 945**
					Nordel	
Total to	6 767	15 379	9 801	20 371	**52 318**	
Total from	13 703	3 858	8 944	14 319	**40 824**	
Net imports	-6 936	11 521	857	6 052	**11 494**	
Net imports/total consumption	-19.1 %	12.8 %	8.6 %	4.9 %	**2.8 %**	

[1] Russia, Estonia, Germany, Poland.

A double 400 kV line west of Stockholm, Sweden. Photo: Håkan Flank

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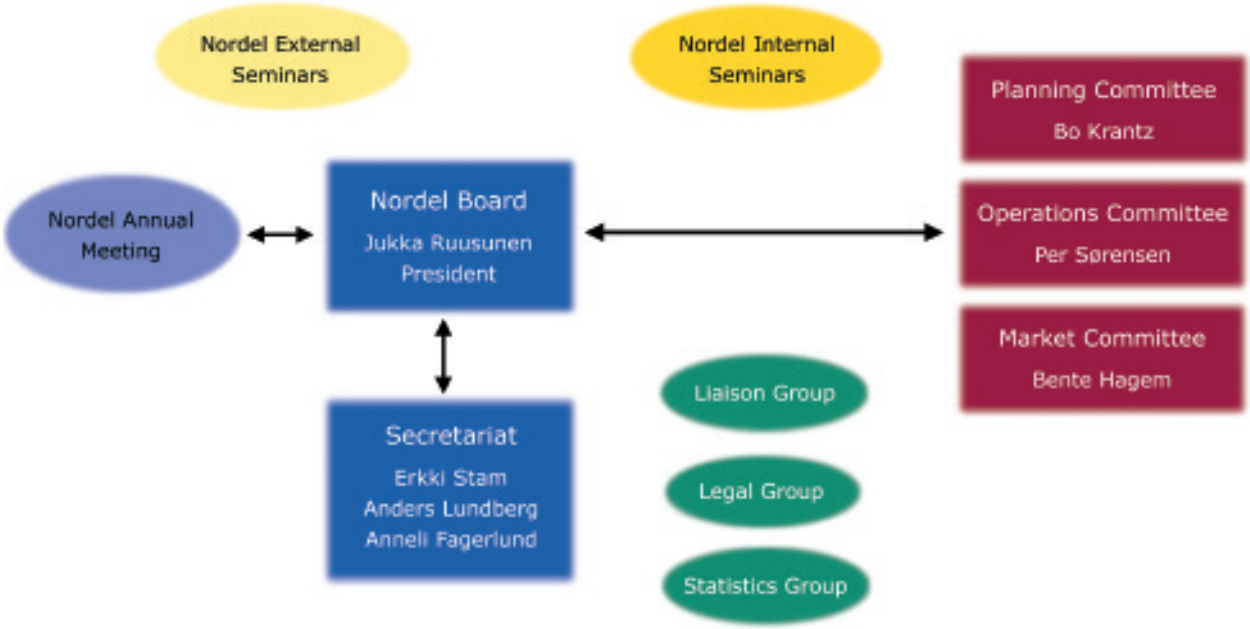

Nordel's annual meeting 2006 was held in Fiskebäckskil, north of Gothenburg in Sweden. Here a view of the hotel Gullmarsstrand and the small idyllic village of Fiskebäckskil. Watercolour: Irene Klee

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At the annual meeting of 2006, the secretariat was moved to Fingrid for the next two years. From the left Anders Lundberg and Erkki Stam. Photo: Eija Eskelinen

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