Nordel

Annual Report 2002

Contents

Photos: Motives from Denmark, Finland, Iceland, Norway and Sweden, Thursday 2003.20.02

Photographers: Håkon Flank, Juhani Eskelinen, Jørgen Schytte, Hans Blomberg, Odd Stefan Thórisson, Martin Dyrløv, Trond Isaksen and others.

Nordel

Nordel is a body for co-operation between the transmission system operators (TSOs) in the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), whose primary objective is to create the conditions for, and to develop further, an efficient and harmonised Nordic electricity market, regardless of national borders.

Nordel also serves as a forum for contact and co-operation between the TSOs and representatives of the market players in the Nordic countries. In order to create the right conditions for the development of an efficient electricity market, it is important for the TSOs to meet with the market players for mutual exchange of views.
A Market Forum has been set up within the new Nordel organisation in order to pursue this dialogue.

Nordel's strategy has been formulated in the following vision:
Nordel shall:
- Act as one Nordic TSO and be the basis for a harmonised Nordic electricity market
- Be in the front rank in the development of the Nordic electricity market
- Be a strong force in the development of the European electricity market
- Have the ability to react quickly to challenges, make decisions and have a shared commitment to implementing them.

The Nordel vision results in a number of tasks in the following categories:
- System development and rules for network dimensioning, including co-ordination of grid investments and congestion management
- System operation, operational security, reliability of supply and exchange of information
- Principles of transmission pricing and pricing of ancillary services, including transit solutions
- International co-operation
- Maintaining and developing contacts with organisations and regulatory authorities in the power sector, particularly in the Nordic countries and Europe
- Preparing and disseminating neutral information about the Nordic electricity system and market.

Nordel's highest decision-making body is the Annual Meeting, whose participants are drawn from representatives of the TSOs. The Annual Meeting elects the chairman of the organisation for a term of two years. The chairmanship rotates between the Nordic countries. The chairman appoints Nordel's secretary and is responsible for the secretariat and for the related costs. The organisation has no separate budget.

Nordel's executive body is the Board, composed of one representative from each of the Nordic TSOs. The Board of Nordel makes initiatives and decisions on topical issues, and implements the decisions taken at Nordel's Annual Meeting. The Board is also responsible for the organisation's external information activities. In order to support the Nordel Board with its information activities, an Information Group has been established in Nordel.

Most of Nordel's work is carried out by committees and working groups. Nordel's Operations Committee, Planning Committee and Market Committee are made up of the leaders responsible for the corresponding sectors in the TSOs. The working groups are composed of technical specialists from the TSOs.

Key Figures 2002

		Nordel	Denmark	Finland	Iceland	Norway	Sweden
Population	mill	**24.3**	5.4	5.2	0.3	4.5	8.9
Total consumption	TWh	**397.1**	35.2	83.9	8.4	120.9	148.7
Maximum load [1)]	GW	**59.2**	6.1	11.6	1.0	17.3	23.3
Electricity generation	TWh	**391.6**	37.3	71.9	8.4	130.6	143.4
Breakdown of electricity generation:							
Hydropower	%	**55**	0	15	83	99	46
Nuclear Power	%	**22**	-	30	-	-	46
Other thermal power	%	**21**	87	55	0	1	8
Other renewable power	%	**2**	13	0	17	0	0

– = Data are nonexistent 0 = Less than 0,5 % 1) Measured 3rd Wednesday in January

The Nordic Electricity Market under Pressure

The Nordic electricity market was put under pressure in 2002. During the first half of the year, the water levels of the hydropower reservoirs were higher than normal. This surplus paved the way for intensive exports from the Nordic countries to the continent. The summer was dry, and the autumn did not bring any precipitation worth mentioning. It was evident during the late summer months that over a few months the Nordic electricity system had changed from a wet year situation to a dry year situation. The exports going from north to south changed around to imports from the continent for the rest of the year.

The water reservoirs emptied quickly – in particular in Western and Southern Norway. The spot market reacted with skyrocketing prices meaning that system prices averaged 7 or 8 times higher figures.

Several manufacturers made production cuts to be able to sell cheap electricity supply contracts at the high spot price. Also ordinary end consumers cut down on electricity consumption. Especially in those areas where the system price is directly and almost immediately reflected in the bills issued to the consumers. As a result of this, Norway saw a drop in consumption of about 10 per cent over a period of time.

This was probably the reason why the Nordic countries avoided new record high strains on the limited production capacity that would otherwise have constituted a powerful challenge to the common Nordic electricity system, as in particular Sweden had feared in advance.

The market development brought older power plants back into play after they had spent some years in the moth bag.

Nordic hydropower reservoirs, exactly as described in the first Grid Master Plan in a scenario for 2005. This plan was issued in April 2002.

The need to build new production capacity, remedy bottlenecks in the transmission network and set up new interconnections with the neighbouring areas is larger than ever before.

Nordel has launched its own cross-disciplinary process to analyse the events that took place in the Nordic and European electricity markets in 2002/2003. Some of the aspects to be analysed in this process are if the continental players on this market pay sufficient attention to the Nordic market, and if the interconnections with the neighbouring areas are exploited to the full from a market point of view. All three committees are involved in this work.

This gave both industry and ordinary consumers quite a scare and several sides urged for political intervention.

Nordel followed the general trend of the market with a worried frown, and paid particular attention to bottleneck situations and unequal price areas.

Basically, Nordel was of the opinion that the market forces should be able to deal with the situation – which proved right.

For the first time, the HVDC SwePol Link in the direction from Poland to Sweden was on full transfer capacity.

By the end of the first quarter of 2003 everything seemed to suggest that the Nordic electricity market has documented its sturdy ability to deal with highly difficult production situations and price developments. However, the lesson to learn from this is how dependent the system is on the water level of the

The challenge Nordel is facing is that to prevent the dry year situation from stretching into next year, the precipitation must reach a higher than average level for the 2003 summer months. The regulating bodies are not comfortable with this situation and have asked Nordel to prepare for the interventions that may be introduced.

Nordel's External Relations

Co-operation with Public Authorities and Market Players

Nordel and the regulators of the Nordic countries – now formally joined in FNER (Forum of Nordic Energy Regulators) – are forming steadily closer ties. A tightly woven and open co-operation between the transmission system operators (TSOs) in the Nordic countries and FNER in an atmosphere of mutual confidence is an essential condition to make the Nordic electricity market work in an efficient manner – as if there is only one TSO.

In 2002, Nordel and the Nordic Council of Ministers worked closer together in a joint effort to organise two conferences; one in October on the expanding electricity production and another in November on market power. Work continues with both issues in Nordel, the Nordic Council of Ministers and the national competition bodies.

The semi-annual event "Market Forum", which is an event shared with representatives of the market players of the Nordic countries, has not yet found its final form. Nordel's intention with Market Forum is to create a platform where the Nordic market players can co-ordinate their active efforts to influence the continued development of the Nordic electricity market.

The TSOs cannot deal with the task involved in continuing the development of the Nordic electricity market by themselves. Regulators, politicians, market players and Nordel need to target their efforts and work closely together. There is still quite a way to go, but much to Nordel's satisfaction several steps were taken in the right direction in 2002.

ETSO and Florence Forum

The Nordic TSOs have individual memberships of ETSO (the European Transmission System Operators Association), and technical experts from the Nordic TSOs participate in ETSO working groups.

Formally, "Florence Forum" has become the setting of the semi-annual discussions that the EU Commission, the regulators, representatives of the electricity industri and the TSOs engage in on the development of the European electricity market. The chairman of Nordel participates in these meetings. At the October 2002 meeting, Nordel presented the paper "Reliability Standards and System Operating Practices in Nordel".

Russia

In the spring, the Russian electricity company RAO UES of Russia got in touch with Nordel to discuss the possibility of working more closely together.

On behalf on Nordel Fingrid is now, together with RAO UES of Russia, in the process of conducting a technical analysis of the possibilities of making a synchronous coupling of the Russian and the Nordic AC systems. The outcome of this analysis is expected to be available in 2005.

Strategic Project

At the formal level, three committees have been set up to deal with the practical aspects of the Nordel co-operation work.

As a result of the review of the mandates of these three committees in 2002, they have been given a more dynamic and in several aspects more independent role within Nordel. These committees and their working groups have been given a professional impetus that keeps the Nordic region in the lead of the European development of the market.

In 2001, Nordel set up a number of strategic projects. 2002 saw the following results:

- Development of a Nordic grid master plan
  - The Planning Committee presented the “Nordic Grid Master Plan” in April.

- Rules governing bottleneck situations
  - In May, the Market Committee presented the report “Översyn av elspotindelningen och förutsättningarna för mothandel på den nordiska marknaden” on how to handle bottleneck situations.

- Funding of new interconnections
  - In September, a working group presented the report “Realisering af Missing Links i det nordiska kraftsystemet” on the introduction of new interconnections in the Nordic region.

- Harmonisation of tariffs
  - The tariffs of the HVDC grid were harmonised on January 1.
  - Sweden abolished the cross-border tariff to Denmark on March 1.

- Transit principles
  - The internal Nordel transit agreement took effect on January 1.
  - This agreement was supplemented with ETSO CBT (Cross Border Trade) from March 1.

- System operation
  - A common Nordic regulating power market took effect on September 1. This 2003 Annual Report offers an article specially written on this issue.

Together with the Nordic Council of Ministers, Nordel launched in autumn 2002 a new project looking into the possibilities of adding capacity to the Nordic electricity market. The findings of this project are expected to be available by the end of 2003.

The Development of the Nordic Electricity System

The dryyear situation experienced in 2002 made the governments in Norway, Sweden and Finland encourage, to a varying degree, the consumers to save energy. Although spot prices were high and the media gave the threatening energy situation considerable attention, the savings were limited. Allowing for the temperature correction, the consumption of the Nordic electricity market fell less than one per cent. Only the power intensive Norwegian industry demonstrated significant savings.

In 2002, the physical trading in electricity on the Nordic spot market exceeded EUR 3.31 billion (124 TWh).
The transactions were effected via Nord Pool Spot AS, which was separated from Nord Pool ASA on January 1, 2002. From July 1, 2002 the following are owners of the spot exchange: Svenska Kraftnät, Statnett, Fingrid and Nord Pool ASA with 20 per cent each. Eltra and Elkraft System have 10 per cent each.
Also Nord Pool's clearing house was extracted to form an independent company called Nord Pool Clearing ASA.

Transmission System Operation

Denmark: In May, the energy authorities issued an order on transmission system operations that lays down rules for the use of the transmission grid and the organisation of the electricity system.
Iceland: The restructuring of the Icelandic electricity supply industry suffers from a delay of one more year. The coming energy act will provide a clear distinction between the monopolistic activities (system operation, transmission and distribution) and production/trading.
Norway: In February the Norwegian Storting widely agreed on the continued role of Statnett as the transmission system operator owned by the Government. Statnett's responsibilities vis-á-vis the system were extended and clear definitions were provided. By year end Statnett owned 89% of the main grid.
• In May 2002, the guidelines on system operation were replaced with regulations produced by the Norwegian Water Resources and Energy Directorate.

Other Legislation

Denmark: In September, the Danish Government introduced a debate to change the Electricity Supply Act as part of the deregulation of the electricity supply industry. The following points are up for discussion: The capital of the electricity companies (size and appropriations), transfer of the proceeds from the sale of an electricity company to the state and the consumers, and how to secure the independence of the transmission system operators.
• The Danish Folketing adopted a new tariffing structure for wind turbines in December according to which the sale of wind generated electricity is transferred to the market while at the same time introducing a freeze of the price for new wind turbines at 0.36 DKK/kWh (market price plus variable subsidy). A balancing fee of 0.028 DKK/kWh is added to this figure.
Finland: In February 2003, the Finnish Parliament adopted a bill limiting the access of distribution network operators to impose fees on their electricity customers when they change suppliers. The bill also introduced extended consumer protection measures (such as damages for long-term interruptions of the electricity supply). According to the bill, the distribution network operators are now under stricter obligations to disclose information to the public, and the bill also extended the supervisory powers of the authorities.
Iceland: The minister accepted the building of the new hydropower plant (Karanhnju-verket) in the eastern part of Iceland. Believing that the environmental impact of the plant would be too negative, the State Planning Institute had previously turned down the project. The power plant will have a capacity of 690 MW. Service is scheduled to start in 2007 and the plant will be delivering energy to an aluminium smelter, which is to be built nearby. This smelter facility will be producing 322,000 tonnes a year.
• Together with Statnett and Statoil, Landsvirkjun is analysing the feasibility of constructing a cable interconnection between Iceland and the European continent.
Sweden: In March 2003, the Government decided to dismantle the Swedish nuclear power plants along the same lines as the Government and the nuclear industry in Germany have agreed on. The Swedish Government has appointed a chief negotiator who is to develop a plan for the restructuring of the Swedish energy system. The plan is to describe both how to phase out nuclear power and how to replace it.
• In May 2003, Sweden introduces a system for renewable energy certificates. The intention is that this will replace the subsidies that have been granted so far to renewable and local energy production. The target is to increase the renewable energy production by 10 TWh by 2010.

The Electricity Market

Denmark: On January 1, 2003 the Danish electricity market opened up to all electricity customers. This was the last step of the opening process that began in 1998 for customers consuming more than 100 GWh. In 2000, this threshold was lowered to 10 GWh and in 2001 to 1 GWh.
• On Sealand a grid protection has been introduced allowing better use of the Nordic transmission grid. The KONTEK interconnection is in service again after breakdowns in November 2002 and January 2003. The transit has been large for the German–Swedish interconnection.

• In view of the large need for transit capacity to Norway, part of the new 400 kV line between Aarhus and Aalborg was completed a couple of months ahead of schedule. This increased the transit capacity by 200 MW from mid-January 2003.
• Physically Western Denmark is part of the continental electricity system. This affects the pricing of the Western Danish spot area. In wet years, the price level is close to that of the Nordic region, whereas it is close to the German prices in dry periods. The capacity across the border to Germany is auctioned. Most of the time, the exchanges take place in agreement with the signals of the market. For 20 per cent of the time, however, exploitation of the capacity was not optimal in 2002. In 2003, Eltra will make attempts to create a framework that will allow better use of the capacity.
• Although coupling the Nordic electricity market and the German system produces a series of "interface difficulties", the relationship with E. ON Netz is sufficiently good and flexible to solve the difficulties that may arise.
Finland: In May, the Finnish Parliament (Eduskunta) approved the Government's in-principle decision to allow the privately owned Finnish electricity generation company Teollisuuden Voima (TVO) to build a nuclear power plant. No decisions have been made as to the size yet. This will be the fifth nuclear power plant in Finland.
• The authorities granted a building permit to a consortium that is planning a DC interconnection between Finland and Estonia.
Norway: There is considerable difference between the precipitation in Northern Norway and Southern Norway. While the hydropower reservoirs in the south emptied fast in December, the power plants in Northern Norway experienced a situation of net export. Normally, Norway is divided into two spot areas. However, the difficult electricity supply situation in Southern and Western Norway made it necessary to set up two more spot areas in December: The Western Norway and the North Western Norway.
Sweden: According to a review of the competitive situation published in January, the Swedish electricity market works well but there was some uncertainty related to the increased concentration of the market. It was determined that the energy authorities follow the evolution of the electricity market from January 2003.
• According to an energy review, which the Government submitted to the Riksdag in March 2003, the Government will introduce monthly readings for all electricity customers by July 1, 2009 at the latest.

System Operation

Norway: The Norwegian regulating power option market (RK-Option-Market), which Statnett set up in 2001 was further developed during 2002.
Sweden: As ordered by the Government, Svenska Kraftnät purchased in January 2002, as a temporary arrangement, a 500 MW power reserve to be used if periods of extreme cold weather arose. For the winter 2002-2003 they bought a reserve of about 450 MW. In future increases in generation capacity are to be secured by the market.

Transmission

Denmark: A new 400 kV line in Northern Jutland is expected to be put into service in 2004. The line comprises three cabled stretches of about 14 km in all. The line will reduce the bottleneck difficulties encountered in Western Denmark.
• By Gørløse on Sealand a new 400 kV transformer substation has been commissioned as part of an extensive upgrading scheme of the transmission grid in the Copenhagen region.
Finland: A new 400 kV line between Russia and Finland was completed in November 2002. The new line increases the capacities between the countries with 400 MW.
The 23 km new 400 kV line between Keminmaa and Torneå Stålværk (Steel Plant) has been put into service.
Iceland: The Minister of Environment is expected to give his acceptance to build a 400 kV line from the power plants in Southern Iceland to the aluminium smelters in Western Iceland. This line is expected to be put into operation in 2005, initially for 220 kV.
Norway: Statnett wants to improve its safeguard against dry years by introducing new interconnections. The Norwegian TSO is working on the NordNed project – a 600 MW cable to The Netherlands – and the North Sea Interconnector (NSI) for 1,200 MW to the UK. Together with Danish Eltra, Statnett is also looking to expand the Skagerrak interconnection to Denmark with another 600 MW.
• The transfer capacity between Southern Norway and Sweden saw an increase of 200 MW in June. In July the capacity from the northern and central parts of Norway saw an increase of approx. 300 MW.

System Disturbances

Denmark: For almost three hours, one million consumers were without electricity on December 28, 2002 when the system suffered a fault in Western and Northern Jutland. First the 400 kV line between Kassø and Tjele was disconnected because of a communication fault. Immediately following that, a relay fault disconnected a 150 kV line between Aarhus and Tange, and this was at once followed by a cascade condition causing the line to disconnect. The Nordic electricity system experienced a frequency drop to 49.2 Hz.
Finland: On April 20, the 400 kV line Raumo–Olkiluoto suffered a breakdown and one of the units at the nuclear power plant disconnected.
On May 4 there were faults on both 400 kV lines between Yllikkälä and Vyborg. As a result of this, the HVDC interconnection to Russia also disconnected.
Sweden: In June the line Porjus–Vietas–Ritsem suffered a grid fault. The grid frequency dropped to below 49.5 Hz, but none of the customers were affected by the interruption. A grid fault on the line Lasele–Långbjørn–Gulsele caused interruptions of the power supply.

Events of the Year

January 1

Nordel transit agreement and harmonisation of grid tariffs take effect.

February 20

Eltra determines to upgrade and increase the capacity of Konti-Skan 1. The total capacity of the interconnection will then be 750 MW from 2005. Svenska Kraftnät adopted the upgrade of pole 1 in 2001.

March 1

The Nordic ETSO CBT scheme takes effect.

March 5

Nordel Market Forum in Helsinki, Finland.

April 30

The first Nordel Grid Master Plan is published.

May 15

Nordel arranges a press seminar in Copenhagen with many participants.

June 13

Nordel's Annual Meeting held at Rømø, Denmark. Georg Styrbro, Eltra takes over the presidency from Odd Håkon Hoelsæter, Statnett.

July 1

The ownership of Nord Pool Spot AS changes. Svenska Kraftnät, Statnett, Fingrid and Nord Pool ASA each own 20 per cent, whereas Eltra and Elkraft System own 10 per cent each.

Eltra concludes an agreement with E.ON Energie whereby a permanent German power reservation for 300 MW from Denmark to Germany cease to exist. This gives the market access to the entire capacity between Denmark and Western Germany.

September 1

The common Nordic regulating power market takes effect.

October 8-9

Electricity conference in Oslo, Norway organised by Nordel and the Nordic Council of Ministers.

October 22

Nordel Market Forum in Oslo, Norway.

November 6-7

Market power seminar in Bålsta Sweden, jointly organised by the Nordic Council of Ministers and Nordel.

Members of the Board of Nordel

Georg Styrbro
CEO, Eltra amba, Denmark (Chairman)
Photo: Nils Rosenvold

Jan Magnusson
Director General, Svenska Kraftnät, Sweden (Vice chairman)
Photo: Hans Blomberg

Flemming Wibroe
Senior Project Manager, Eltra amba, Denmark (Secretary)
Photo: Max Leo Arnesen

Bent Agerholm
Managing Director, and CEO, Elkraft System amba, Denmark
Photo: Martin Dyrløv

Timo Toivonen
President and CEO, Fingrid Oyj, Finland
Photo: Juhani Eskelinen

Fridrik Sophusson
Managing Director, Landsvirkjun, Iceland
Photo: Odd Stefan Thórisson

Odd Håkon Hoelsæter
President and CEO, Statnett SF, Norway
Photo: Trond Isaksen

The Planning Committee's Activities

Objectives and Responsibilities

The Planning Committee is responsible for technical matters of a long-term nature concerning the transmission system and the exchange of information in relation to the expansion of the electricity system. The committee works from a Nordic perspective, albeit having regard for necessary international angles of approach. The Planning Committee is composed of managers with planning functions in the transmission system operators (TSOs), and their job is to work together as a co-ordinated planning and management team.

The Planning Committee's Objectives are:

- To achieve continuous and co-ordinated Nordic planning between the TSOs, so that the best possible conditions can be provided for a smooth-functioning and effectively integrated Nordic electricity market;
- To initiate and support changes in the Nordic power system, which will enable satisfactory reliability of system supply through the effective utilisation of existing and new facilities;
- To be instrumental in developing the Nordic power system. When planning transmission facilities, impact assessments must integrate the need to preserve and protect the natural environment.

In order to achieve the above-mentioned objectives, the following means have been defined:

- In order to ensure important input values for analyses and development plans it is necessary to have a realistic and alternative view of the future. The Planning Committee will draw up future scenarios for the expansion of the Nordic power system with a time horizon of up to 20 years. In these scenarios key roles will be given to the long-term development of the environment, energy and power. Working with these basic scenarios, the Planning Committee can take the initiative to advance its objectives.
- Each year the Planning Committee will present prognoses for the future energy/power balance. Energy prognoses will focus on normal and dry years. Power prognoses will focus on normal maximum load and extreme maximum load.
  - Every second year the Planning Committee will present a summarised Nordic Grid Master Plan which primarily consists of projects that have an effect on the capacities between the Nordic TSOs. It will assist efficient grid development in order to support the integrated market based on a Nordic perspective. The plan will focus 5-10 years ahead, but where considered necessary will look up to 20 years into the future. Grid development plans from the individual TSOs and scenarios and prognoses for the long-term energy and power development will provide important input data.
  In addition planning criteria in the Nordic Grid Code will provide a framework for the plan.
- The Planning Committee shall continuously update the Nordic Grid Code and has overall responsibility for the continuous updating of recommendations for shared grid-dimensioning rules (planning criteria) for the TSOs and the Nordic main grid (Planning Code). These recommendations include technical, financial and environmental matters.

An important factor here is that the criteria maintain satisfactory system reliability, quality of supply and underpin the development of an efficient power market. The Planning Committee also has overall responsibility for compiling and updating common system oriented requirements for the future connection of production, transmission and consumer facilities to the grid (Connection Code).

- The Planning Committee shall ensure the gathering, updating and application of shared grid, consumption and production data. Planning tools are the responsibility of each TSO but Nordel plays a coordinating role in relation to the TSOs choosing tools that facilitate their work.

The Planning Committee's Activities

The Planning Committee is organised with two working groups, the Grid Group and the Balance Group.

The tasks of these two groups are organised so that the working groups do most of the actual analyses and surveys, while the Planning Committee functions as a natural steering group for the work that is carried out.

The Grid Group deals primarily with grid-related matters, while the Balance Group deals primarily with matters relating to energy and power balance. The most important tasks in 2002 were:

The Nordic Grid Master Plan 2002

The Nordic Grid Master Plan 2002 is the first common grid master plan and was completed and published in April 2002. The plan was drawn up by the Planning Committee in close cooperation with its two working groups, the Grid Group and the Balance Group.

The plan draws together political and legal frameworks and describes the current situation for the Nordic market with regard both to energy and power balances, the strengthening of the power system that will be ongoing until 2005, and the market trends that are being observed. It also describes expected development of the Nordel system up until 2010 and points to challenges with regard to safeguarding reliability of supply for both energy and power in relation to cold winter days as well as to dry years.

On the basis of the various assessments, priorities will be set in terms of which cross-sections Nordel should focus on in order to effect strengthening if possible.

Based on analyses carried out and market and operational experience Nordel is using the Nordic Grid Master Plan to give the following cross-sections priority in terms of capacity expansion:

- HVDC interconnector Denmark West-Norway South
- HVDC interconnector Norway South-Denmark East or Sweden Central
- HVDC interconnector Denmark West-Sweden Central
- Hasle corridor between Norway East and Sweden Central
- Transmission capacity Sweden Central-Norway Central
- Capacity on the internal corridor between Central and South Sweden.

In addition high utility values have been realised on northbound transmissions with the expansion of the Øresund interconnector between Denmark East and Sweden South. Analyses of the interconnectors between Finland and Sweden have been found to be necessary depending on the development of production capacity in Finland and import potential from Russia.

Prioritised cross-sections

In order to further the work of the Nordic Grid Master Plan 2002 an ad hoc group "Prioritised cross-sections" was formed, in which the cross-sections in the Nordic Grid Master Plan 2002 are to be looked at more closely. The aim is to analyse whether alternative strengthening measures have positive or negative socio-economic effects and shall form the basis for future decisions concerning such measures within Nordel's area.

The group has updated the assumptions used for estimates from the Nordic Grid Master Plan and calculated revised utility values for the prioritised cross-sections. The results are based on an updated "Samkjoeringsmodell" from the Balance Group and the assumptions and frameworks used for the work are described. The Nordic Grid Master Plan 2002 forms the basis here but other frameworks are important for work with the prioritised cross-sections, for example work in Nordel to ensure adequate power in a well-functioning electricity market (market committee), and criteria to assess utility values of the prioritised cross-sections (the ad hoc group "Missing link").

The group has described in detail the trade terms and theory related to the expansion of the transmission capacity and the theory behind the socio-economic cost/benefit analysis. It has also determined the most relevant strengthening alternatives and started calculating investment costs.

The results of the socio-economic analyses are expected in June 2003.

Power Balance for the coming Winter and Three-year Period

Power balances for the three-year period up until 2005

The continuous work on reporting the three-year balances to Nordel's annual meeting is carried out each year and was changed somewhat last year. In June, and with support from the Balance Group, the Planning Committee reported prognoses for power and energy for 2005 and statistical data from 2001.

Power balances for the three-year period 2002-2003

Together with the Operative Group, the Balance Group reported the power balances for the Nordic region as a whole and for each Nordic country separately. The prognoses take into account maximum consumption in connection with the extreme cold which hits us every tenth year, called the ten-year winter. The Planning Committee has also helped generate prognoses for energy balances for the winter January-April 2003. These studies came as a result of the dry-year situation that has occurred since autumn 2002.

Project: Input data for power balances

The Balance Group is working on a report that describes and explains important problems and input data used in the power balance studies. The aim of the report is ensure the quality of the groundwork. The following problems are looked at:

- Consumers' sensitivity to price
- The availability of nuclear and wind power generation
- The possibility of power imports from neighbouring countries outside Nordel
- The power reserve requirement in the Nordic power system.

Nordic Grid Code

The Grid Group has assessed the possibility of establishing a joint Nordic Grid Code (regulation collection) and has laid down the foundations for this ad hoc group, which is currently carrying out the work. The Grid Group has described the aim of a Nordic Grid Code and discussed each party's obligations under such a system. The Grid Group has also proposed a timetable for consultations and the implementation of a Nordic Grid Code. The code will consist of three main elements:

1. Operational Code
2. Connection Code
3. Planning Code

The Nordic Grid Code will be drawn up taking into account national regulations and laws. The main responsibility for the development of a Nordic Grid Code has been assigned to the Planning Committee. The Planning Committee has set up an ad hoc group to present proposals for the Nordic Grid Code around the beginning of 2004.

Data Exchange Agreement between TSOs

The Planning Committee's Grid Group has drawn up proposals for an agreement between the TSOs in Nordel on shared access to data, and the use and confidentiality of data. The agreement is a prerequisite for the use of the shared Nordic grid data set and the balance data set for carrying out system analyses, also in connection with Nordic grid master plans.

Compilation of shared Set of Data

In connection with the Planning Committee's activities, it is important to have a good basic set of data to facilitate the various analyses. This is perhaps particularly so where the preparation of the Nordic Grid Master Plan is concerned, but for other activities it is also important to create a shared understanding of analysis results. The Planning Committee has therefore charged the working groups with preparing the necessary data models, which will cover the market areas for Nordel as well as important neighbouring areas.

The Grid Group has prepared a PSS/E grid data set for the Nordic power system. Operational and planning models have been prepared based on the probable developments and trends, production expansion, grid strengthening, etc.

The operational models cover load flow and dynamic analyses in peak and off-peak situations for 2001/2002, while the planning models cover load flow analyses in the years 2005 and 2010. The planning models are adapted to the conditions in the Nordic Grid Master Plan. With support from Powel, the Balance Group is preparing a power balance model for 2005 and 2010, which will constitute references for various system studies.

As early as the beginning of 2003 the models will be used in the "cost/benefit analysis of prioritised cross-sections in the Nordic power system" project. The database built up in the "Samkjoeringsmodell" will taken further with an improved representation of the transmission grid in the Nordic region. This is achieved by integrating the "Samkjoeringsmodell" with the grid model and the integrated model will be called the Consolidated Model. In 2002 the Balance Group prepared a report describing the various data models used in the different power system studies. The report is called The Balance Group's data set.

The Operations Committee's Activities

Goals and Tasks

The Operations Committee is responsible for short-term issues concerning the joint operation of the various subsystems in the interconnected Nordic transmission system and for defining a technical and market-focused framework for grid operation.

The Operations Committee co-ordinates operational co-operation between the Nordic TSOs and aims to promote the ideal utilisation of the Nordic electricity transmission system as per market needs, taking into account the agreed technical quality and operational reliability.

The Committee's work focuses on system operation issues which concern the utilisation of the grid, operational reliablity as well as congestion and balance management. The Nordic system operation agreement constitutes the formal foundation for this co-operation.

Operational Matters

Power and energy situation

In recent years, the Nordel area has been highly dependant on imports of electricity from the surrounding areas in order to cover the electricity need during situations of high loads. In 2002, there were no problems as far as the power situation was concerned, and a balance between electricity production and consumption was maintained in all situations. There was no need to use the fast disturbance reserves for balance reasons.

The power balance during the period of 2002/2003 again shows a narrow margin when also considering the anticipated imports. Both Sweden and Norway show a deficit in their balances. Through increased import capacity from Russia, Finland has a relatively strong power balance, and Finland is expected to be able to export electricity to Sweden. The import capacity from Russia into Finland grew by 400 MW at the beginning of 2003. Both Western and Eastern Denmark have a small surplus, which will increase further as a result of imports from Germany, whereby electricity can be exported to Norway and Sweden.

High prices of electricity, low levels of water reservoirs and commitment to avoid rationing during the latter part of the winter were topical issues in the autumn. The Nordic electricity market was put to a real test as a result of the summer which only gave little rain and as a result of the early and cold autumn. Following the high prices of electricity, thermal power plants which had not been used for some time were restarted. The Nordic transmission grid was occasionally very loaded because of the exceptional operational situation. The energy situation and trend in water reservoirs especially in Norway was poorer than during the previous dry period of 1996/1997. The energy situation in Norway led to the electricity market being split into four elspot areas at the end of the year.

Operational disturbance situations

The Nordic power system was subject to a few major operational disturbance situations in 2002. On July 10, there was a serious disturbance which started as a phase-ground failure when a tree fell on the 400 kV line between Tegneby and Hasle. The disturbance spread farther as a result of incorrectly installed ground current protection at Hasle. This caused unselective disconnections on many other lines connected to Hasle, leading to grid isolation and a frequency of 49.20 Hz. The grid isolation had a major impact on the availability of reserves. The disturbance caused relatively few problems in Norway, but the voltage level sank considerably in Southern Sweden, and transmissions at intersection 2 grew significantly. There was more concern over voltage collapse than over frequency decrease. The HVDC connections with emergency power regulation possibility had a decisive role in the disturbance not leading to a major failure in the entire power system.

Another major disturbance took place in the morning of November 12 in Sweden. This was caused by ground contact at the Porjus substation, and it led to the disconnection of all lines leading to the substation. As a result of fluctuation and instability in the power system, some other lines were also disconnected, such as Rösspåga – Ajaure, which meant that Northern Norway ended up in isolated operation with a production surplus and a frequency of just over 53 Hz. Frequency in the other parts of the system sank to 49.45 Hz. The total loss of production in the Nordic countries was approx. 2,000 MW. The high production loss combined with load-up in the morning resulted in a permanent frequency of 49.75 Hz which lasted for approx. 40 minutes.

Other Activities

System operation agreement

After a revision of the Nordic System Operation Agreement, the revised agreement came effective on May 2, 2002. Further development of the agreement towards a Nordic Grid Code (Operational Code) is being carried out by the operative working group for power system operation. The entire system operation agreement has been translated into English and can be viewed at Nordel's Internet pages at www.nordel.org

Balance management
A new model for balance management within the synchronised Nordic power system was introduced on September 1. In line with the model, the power system is controlled as a single system starting from the quality requirements concerning frequency and time deviation. Determination of the regulating power prices and balance power prices between the Nordic elspot areas is co-ordinated, with the goal being equal prices in the various subsystems. Balance control must be carried out so that control takes place in that subsystem which has the lowest costs for regulation within the framework of available transmission capacity.

The objective is that the entire Nordic power system makes up a common regulating power market so that Western Denmark, which belongs to another synchronised area, is implemented, too.

NOIS, Nordic Operational Information System
NOIS, the new information system, enabled the application of the new balance regulation principles. A pilot version of the web-based information system for the exchange of operational information between the Nordic TSOs was taken into use in the autumn. NOIS primarily serves as a tool in Nordic balance regulation. NOIS contains a Nordic regulation list with regulation bids from all areas, and regulation can be carried out in price order on the basis of the list. The pilot version will provide experiences of issues such as information, usability and technical options for future development.

Primary control
In primary control, too, closer co-operation between the TSOs was achieved during 2002. Primary response transactions between Norway, Finland and Sweden were launched, and development work towards a more dynamic market continues.

Transmission capacity
The trial arrangement for counter trading during planned outages on cross-border connections, which was introduced in 2001, was assessed in 2002 in view of future solutions for maintaining normal elspot capacity during outages. The operative working group for power system operation has worked with various models, and it presented a suggestion to the Operations Committee in early 2003.

The meeting of the Board of Directors in February 2003 decided not to introduce this suggestion yet, but it will be included in the Market Committee's subsequent work concerning the general principles of counter trading.

Information technology
The Nordic data transmission network was interconnected via Electronic Highway. This means that there is now an integrated data transmission network between Nordel and the other parts of the ETSO area.

IT security has been analysed by the NORCON working group, intending to enhance the importance of IT security, achieve an understanding in security matters between the TSOs, define potential security risks as well as to monitor the consequences.

International co-operation
The annual meeting with the corresponding organisation within UCTE, Operations and Security, was held in Cologne in November.

The Market Committee's Activities

Objective and Tasks

The goals of the Market Committee are:

- to contribute towards creating a borderless Nordic market for the market players, thereby augmenting the market's efficiency and functionality,
- to contribute towards the rules of play in Europe being formulated in such a way as to promote a positive market trend and an efficient interplay with the Nordic market.

Operations during the Year

Below, you will find an outline of the work conducted by the Market Committee during the year.

Nordic transit power solution

Ahead of 2002, the grid operators of Nordel agreed upon terms and conditions for compensating one another for loss expenses caused by transit power. This loss compensation was the first step towards a fully-developed mechanism for transit compensation which also takes into account the need for subsidies to cover infrastructure costs caused by transit power. The work of developing such a system was prioritized during 2002. The investigation was carried out with the aim of enabling introduction of the developed payment system for transit power during the first half of 2003.

Nordic ETSO CBT

Within the European Transmission System Operators Association (ETSO), work has also been done on developing a renewed system for transit power compensation which, besides providing compensation for losses caused by transit power, also provides compensation for investment. The stopgap solution in force during 2002 has, with certain modifications, been extended to 2003 pending the approval of a new compensation solution by the European regulators. The fund of €200m for 2002, constituting the framework within which the system operators compensated one another, has been increased to €240m for 2003. At the same time, the floating charge for planned exports was reduced by 50 percent to €0.5/MWh. Belgium, France, Italy, Luxembourg, the Netherlands, Portugal, Switzerland, Spain, Germany and Austria were part of the system. In 2003, Slovenia and the Czech Republic also joined.

The Nordic area is connected as a peripheral sector via Denmark and Sweden. The UK, Ireland and Greece are correspondingly considered to be peripheral countries and continue to pay, like Nordel, €1/MWh for planned exports to continental Europe. During 2002, the system operators of Norway, Finland and Denmark socialized the charge, but have also correspondingly invoiced €1/MWh for exports from the continent. Sweden has not taken part, but intends to from May 1, 2003, following the decision of the Swedish Parliament to implement a planned legislative amendment enabling Swedish participation in European and Nordic transit arrangements that include compensation for investment.

Dominant market position

Against the backdrop of the positive response from previous work on the issue of market leverage, a collaboration project was started up during the year in respect of the dominant market position between Nordel and competition and regulatory authorities as well as the ministries of the Nordic countries. Within the framework of this project, issues particularly regarding relevant markets on the Nordic electricity market were studied, regarding market concentration and potential indicators of an all too dominant market position, as well as what is meant by the abuse of a dominant position and how economic theory can be used to demonstrate this to be the case. These issues were the object of a seminar and workshop held in Bålsta in November 2002.

A report with a summary and conclusions from the three projects and the workshop can be found on Nordel's website. One result of this collaboration is that the authorities and ministries concerned have created a joint platform for discussing the issue of a dominant market position on the Nordic electricity market. Fundamental values have been arrived at regarding how the electricity market works and what possibilities the various parties have for being able, in advance, to reduce the risk of abusing a dominant position.

The power issue

Deregulation of the electricity markets of the Nordic countries has brought with it increased cost-consciousness among the electricity market players. This has contributed, among other things, to a more cost-effective utilization of resources and to unviable production plants being closed down. With a reduced production capacity and a demand for power that continues to rise, there thus exists a certain risk that situations might arise when there is insufficient production capacity to meet the rising demand.

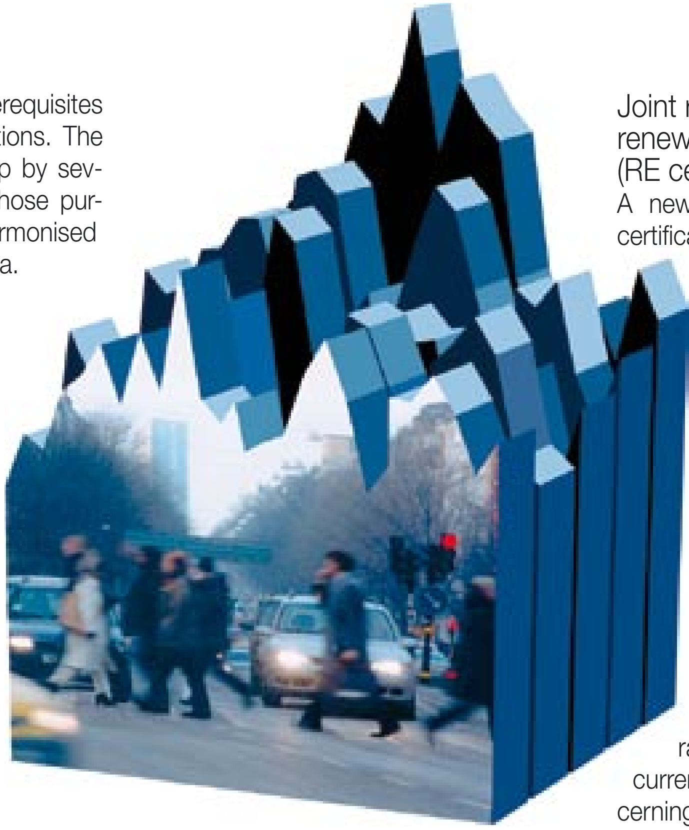
Nordel is working with this problem on several levels. In the Nordic system development plan, for instance, the Nordic energy and capacity balances are calculated in the short and long-term. In October 2002, Nordel, together with the Nordic Council of Ministers' electricity group, arranged a seminar for the transmission system operators and the involved authorities in the Nordic area concerning the power problem on the Nordic electricity market with the intention of producing the prerequisites for creating harmonised solutions. The seminar has been followed up by several projects within Nordel whose purpose has been to develop harmonised solutions within the Nordic area.

Review of the division into pricing areas

Work which started during 2002 with the purpose of investigating the prerequisites for implementing a division of the electricity spot areas which traces the physical bottlenecks, without taking national boundaries into consideration, was concluded during the year. The inquiry proposed that bottlenecks be managed using a combination of division into electricity spot areas and increased counter trade for some bottlenecks, up to a certain financial limit.

The standpoints of the referral bodies diverged, which is why Nordel did not consider it possible to divide Sweden into several electricity spot areas, as proposed by the inquiry. In order to shed light upon and look into the possibilities of joint rules for bottleneck management with regard to increased counter trade, another piece of work was commenced upon during the year.

The purpose of this work is to analyse the prerequisites for increased counter trade and to look into what consequences such a solution could entail in terms of, among other things, increased costs, as well as what effects there might be on competition. (The capacity issue is another area for the project, alongside the issue of counter trade).



Harmonisation of balance settlement in the Nordic area

Work which aims to evaluate the possibilities of a harmonised balance service (a harmonised model for pricing and settling balance power) was commenced upon during the year. This work focuses on analysing what the criteria would be for introducing a Nordic balance service based upon the various models being applied today. The study, which is to be concluded in March 2003, also aims to answer the question of what can be harmonised in the various systems of rules if a Nordic balance service model is not deemed possible.

Ahead of this project, s survey was made of the systems of rules for balance settlement in each respective country, and this can be found on Nordel's website.

Joint rules for trading in renewable energy certificates (RE certificates)

A new market for trading in energy certificates is becoming established, both nationally and within the framework of international collaboration.

The latter primarily takes place within the framework of RECS (Renewable Energy Certificate System). To meet the growing market, joint Nordic IT support has been developed for issuing and accounting purposes. During the year, work continued on analysing the function of RECS from a Nordic perspective and the transmission system operators' role, taking into account current political developments concerning renewable energy.

Even if volumes are still limited, it is the Market Committee's assessment that energy certificates will have the potential to be a new business sector of importance to the players, and that the system operators will have a function in the context.

International collaboration

The Market Committee has a co-ordinated role in the work done within the Nordic area vis-à-vis ETSO in issues concerning the long-term development of systems of rules and market conditions and has, during the year, continued to follow developments within ETSO by means of, among other things, being represented on ETSO's steering committee and work groups. Over and above this, Nordel has collaborated across national boundaries within the framework of the European collaboration project the Renewable Energy Certificates System (RECS).

Common Balance Management in the Nordic Countries

In September 2002, Nordel introduced new principles for the distribution of regulating power to balance the production and consumption of electricity. According to these new principles, the regulating power of the total Nordic power system will be exploited better and imbalances between the countries will be settled according to common rules. Imbalances are settled according to principles that vary from one country to the other, but work is ongoing to examine how these principles can be harmonised. The latest draft of the EU strategy report on the development of the electricity market introduces the common regulating power market as one of the ways to prevent abuse of market power.

In its latest annual reports, Nordel has published a number of articles about the Nordic deregulation and introduction of market solutions in the power system. In 1999, we described the basic conditions and structures of the electricity market. In 2000, we described how we handle grid constraints in the power system, and in 2001, we described transit solutions in the Nordic power system. In continuation of these articles, this article describes the contents and significance of effective market-based balance management.

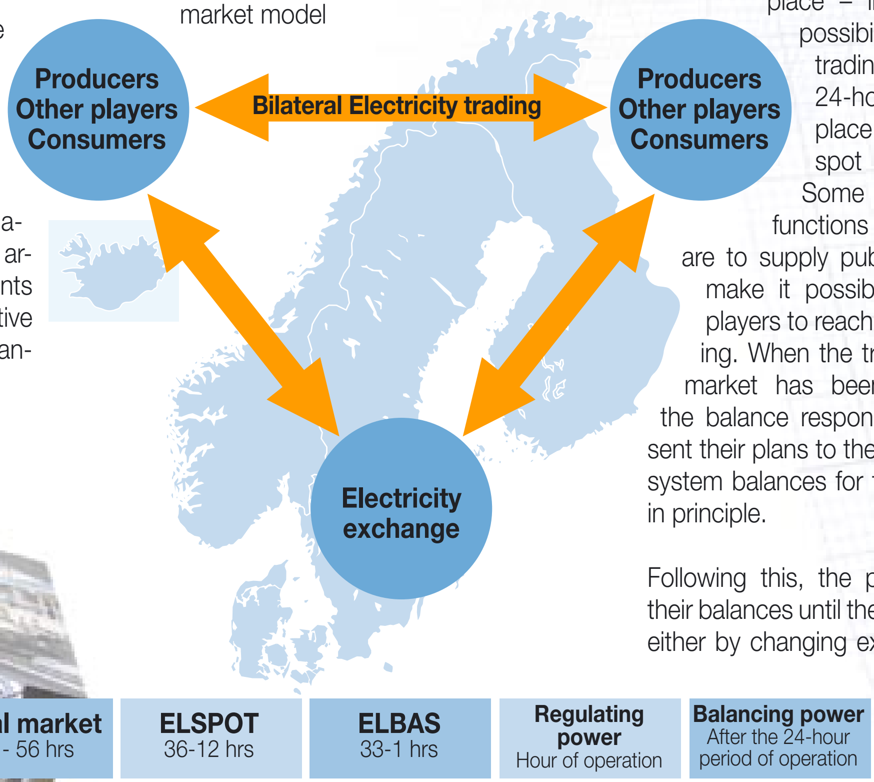
The Nordic Electricity Market

Since the mid-1990s, the Nordic electricity market has developed into a common market, and one of the cornerstones of this market is effective balance management. We have previously described the three fundamental conditions that must be met for a deregulated electricity market to work.

Equality and neutrality

All players must be treated equally and neutrally with equal access to the common transmission grid. The legislation must provide the necessary framework and ensure that there is an independent Transmission System Operator (TSO) that secures the system operation and offers neutral balancing services. Relevant information must be available to all players on equal terms.

Figure 1. The Nordic electrity market model



Tariffs on the use of the transmission grid

There must be clear and non-discriminatory tariffs on the use of the transmission grid. The point access tariff system offers the same prices on transmission services to all players, which gives sound management of the transmission capacity.

Efficient system operation

The TSO must ensure physical balance and safe system operation, which includes frequency control and handling of operational disturbances and bottlenecks. To achieve this, the TSO can maintain an efficient regulating power market and a balance settlement system that give the market players the right incentives.

Figure 1 shows the Nordic electricity market model. Fundamentally, all market players have access to an efficient exchange providing a common market place – in addition to the possibilities for bilateral trading. The physical 24-hour trading takes place bilaterally or at the spot market ELSPOT. Some of the important functions of the spot market are to supply public pricing and to make it possible for the market players to reach a balance by trading. When the trading on the spot market has been concluded and the balance responsible players have sent their plans to the TSOs, the power system balances for the next 24 hours, in principle.

Following this, the players can adjust their balances until the hour of operation, either by changing existing agreements or by entering new bilateral agreements or by trading on the ELBAS (so far only in Sweden and Finland). During the hour of operation, the TSOs ensure the balance through regulating power. After the day of delivery, any imbalances are settled in terms of regulating power. For management of the players' risks and needs for long-term hedging, the electricity exchange offers trading in commercial forwards at the financial market.

Balance Management

In practice, it is not possible to store large volumes of electricity. Therefore, there must be a continuous balance between production and consumption to keep a stable frequency. To most consumers electricity is a natural product that they take for granted and to which there is access without having to think in terms of consumption plans and balances. When a consumer has entered a delivery contract with a supplier, the system is expected to work. This means that a large share of the consumption is non-dispatchable, and, in addition, it is not immediately possible to regulate the electricity produced by wind turbines and local combined heat and power plants since this production is dependent on several factors, such as the weather. Hence to achieve a balanced situation, the remaining production is adjusted according to the consumption and the non-dispatchable share of production. Work is ongoing to make the electricity consumption more flexible so that it will react to price signals from the market. This might contribute to maintain the balance of the power system.

The market players must make sure that they manage their balances. In practice, deviations arise between the contracted and actual supply and demand, and these deviations must be balanced and settled. The balance management comprises a balance service that in the hour of operation creates a balance between production and consumption, and an imbalance settlement that follows after the 24-hour period of operation. The balance service of the Nordic power system is based on a regulating power market with a market-based supply of regulating power for upward and downward regulation of production and consumption. The TSOs use the regulating power market to maintain a physical balance between production and consumption of electricity and for counter trade to alleviate bottlenecks in the transmission grid.

The imbalance settlement distributes income and expenditure for balance management. After the 24-hour period of operation, the imbalances of the players in the individual countries are computed. The imbalances are considered as an equivalent purchase or sale of balancing power, which is settled between the players and TSOs in the country concerned. The imbalance between the countries is settled between the TSOs based on the regulating power price, which is set as the hourly marginal price of accepted offers for regulating power.

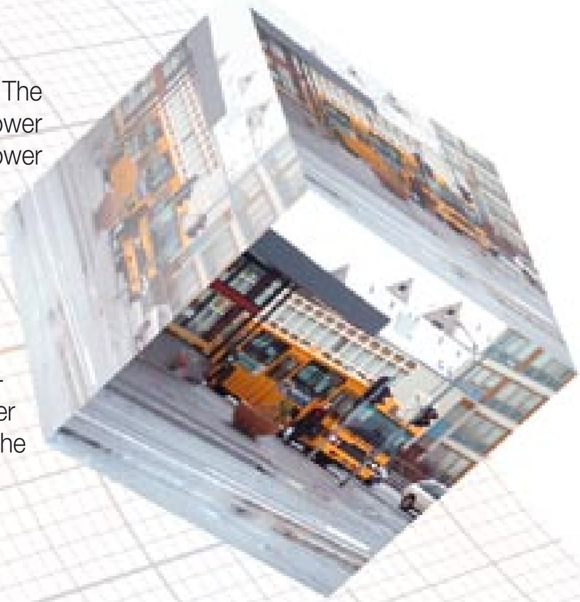
The TSOs buy regulating power to cover the imbalances of the players and hence their purchases of balancing power. The net purchases of regulating power made by the TSOs equal their net sales of balancing power hour by hour.

Regulating power is used to maintain the balance and hence the frequency of the total power system.

Balancing power is used to cover the deviations of the players between contracted and actual supply and demand.

The regulating power price is determined hour by hour as the marginal price of accepted offers for regulating power.

Imbalances between countries are settled on the basis of the regulating power price.



Operational Reserves and regulating Resources

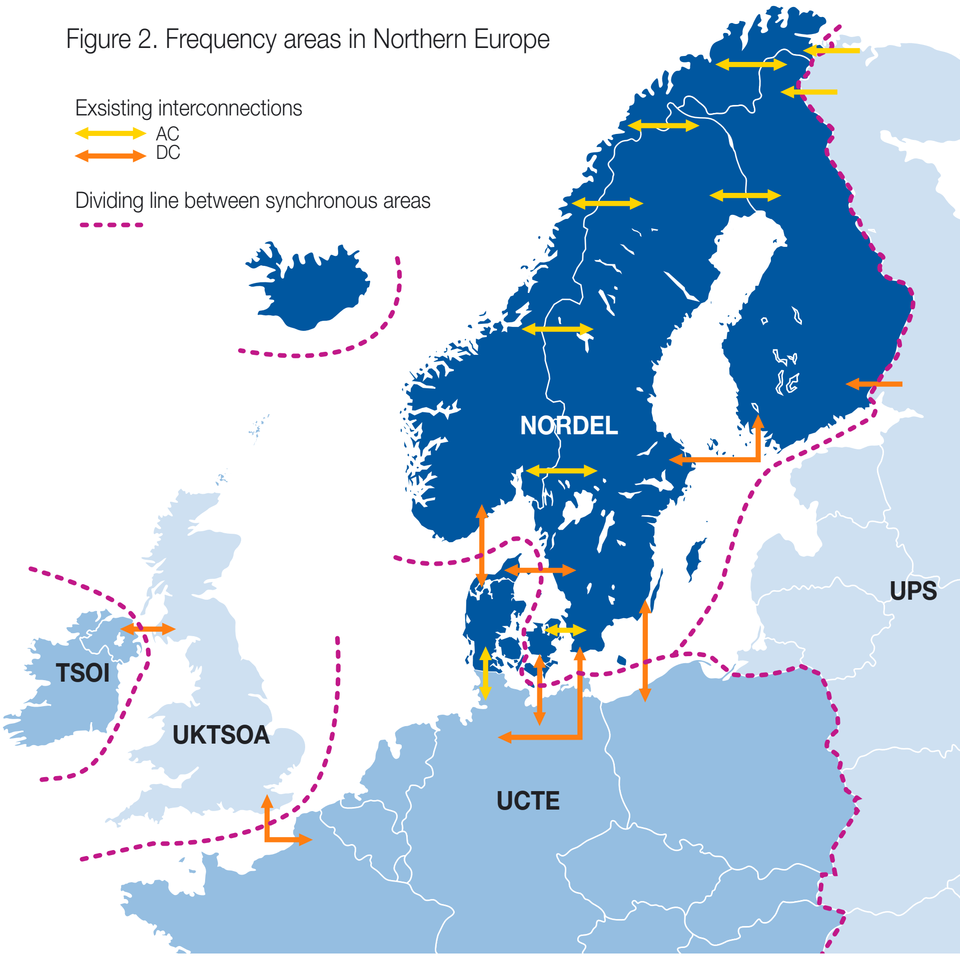
Operational Requirements

The interconnected Nordic synchronous power system is made up of national subsystems, where the TSOs are responsible for the operational reliability and the balance between production and consumption of electricity. In an interconnected synchronous area, the frequency is the same for the entire area, and an overall balance is necessary to keep the frequency at a constant level. If there is an imbalance, the frequency rises or falls for the entire area – irrespective of where such imbalance arose. It is therefore possible to regulate the imbalance using the cheapest regulating power in the entire area, while also avoiding simultaneous upward and downward regulation in several areas.

As can be seen from figure 2, Western Denmark is synchronously interconnected with the Central European power system UCTE, and is interconnected with the synchronous part of Nordel through DC interconnections. Consequently, the frequency in Western Denmark is not affected by imbalances in the other parts of Nordel. However, Western Denmark can contribute to control the frequency by delivering regulating power through the DC interconnections. The balance management performed in the Western Danish system can also use regulating power resources in the remaining Nordic area.

The operational requirements for the Nordic power system are specified in the System Operation Agreement, which will be included in the future Grid Code for the Nordic power system. These requirements comprise such issues as maintaining sufficient operational reserves and regulating power in the synchronous part of Nordel, and the requirements will be distributed between subsystems according to the principles agreed upon.

Figure 2. Frequency areas in Northern Europe



The operational reserves are used to compensate for deviations from the forecasts and variations in the electricity consumption, and to limit the impact of breakdowns and other operational disturbances in the production and transmission system. The operational reserves comprise a frequency regulation reserve and an instantaneous disturbance reserve and fast and slow reserves. The frequency regulation reserve and the instantaneous disturbance reserve are activated automatically by frequency deviations. The fast reserve is activated manually, and must restore the automatic reserve within 15 min. The slow reserve is used to restore the fast reserve within a few hours.

Usually, the frequency in the synchronous part of Nordel is allowed to fluctuate between 49.9 and 50.1 Hz. To regulate the frequency within this band, the System Operation Agreement stipulates a total output of 600 MW at 50 Hz that can be used with a regulating power of 6,000 MW/Hz. This means that the frequency regulating reserve is fully activated at a frequency of 49.9 Hz. For major frequency deviations, as low as 49.5 Hz, the instantaneous disturbance reserve is activated.

If the electricity consumption exceeds expectations, an imbalance occurs between the consumption and the scheduled production and this causes a frequency drop. The frequency drop makes the automatic reserve upward regulate and a new balance is reached, with a constant frequency but lower than 50 Hz. Because of the low frequency, the TSOs increase the production by upward regulating with regulating power. This makes the frequency rise and hence the automatic reserves will downward regulate again. Upward regulation with regulating power continues until a balance has been reached at a frequency of 50 Hz.

Nordel Regulating Principles

Previously, the regulation of the Nordic power system rested on maintaining a balance for the individual subsystems, which meant that the agreed exchanges between the areas were to be maintained within agreed tolerances. According to the new principles, the system is regulated in accordance with the composite balance of the synchronous part of Nordel, and the exchange between the areas is allowed free fluctuations provided the transmission grid does not impose constraints.

Nordel relies on decentralised production management. This means that initially the balance is maintained by the players starting and stopping facilities and adjusting the production according to their production schedules. Next, the balance is secured by means of the automatic frequency regulation reserve (primary regulation) and the instantaneous disturbance reserve. In the event of major frequency deviations, the TSOs adjust the production or the consumption manually, using regulating power (secondary regulation). The TSOs in Sweden and Norway have agreed to share the responsibility of maintaining the frequency of the synchronous part of Nordel during operation. The TSO in Western Denmark is responsible for maintaining a balance between consumption and production in relation to the UCTE system. The TSOs are responsible for activating the regulating power of their own areas and for ensuring that the physical constraints of the transmission grid are observed.

After the deregulation, each subsystem has developed market-based methods to ensure the necessary reserves and regulating resources. Work is ongoing to look into the possibilities of harmonising this.

Functions of the Nordic Balance Management

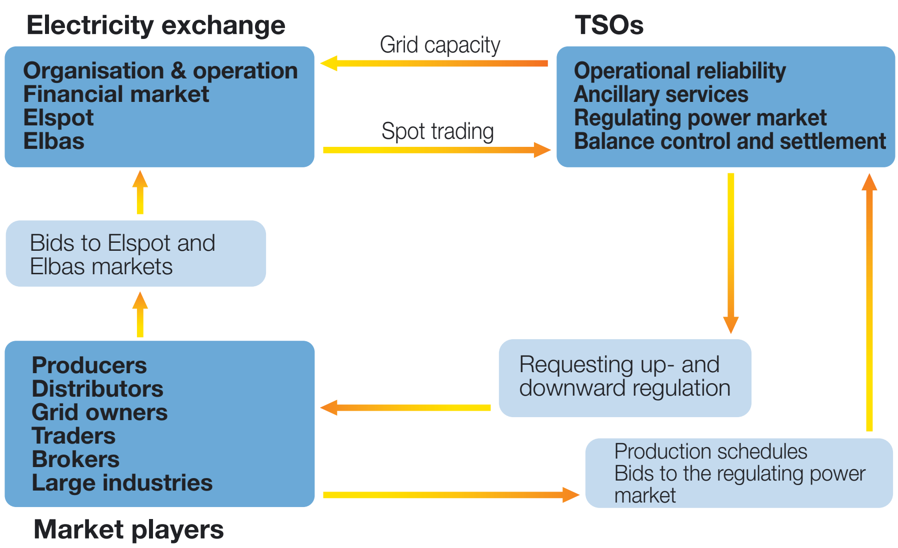
Roles

Figure 3 shows how the roles of the electricity market are distributed. Both players and TSOs alike contribute to maintain the balance of the system. The players are bound by the agreements they have entered into, and they have an economic incentive to predict their transactions as precisely as possible. To achieve this, they balance their schedules through bilateral trade and trading on the exchange. The players submit their schedules to the TSOs, and any faulty forecasts lead to imbalances that may produce economic losses for them. Since the schedules are developed 24 hours ahead, it must be possible to adjust them. The players can therefore change the submitted schedules, and in some cases they can do this up until and during the hour of operation.

The TSOs bear the overall responsibility for the operational reliability and the balance, and they assess player schedules on this background. The TSOs can demand a change of the schedules, if needed. Following that, the TSOs take over the regulation of the balance during the hour of operation.

They do this through a regulating power market, where the players submit their bids for upward and downward regulation of production or consumption.

Figure 3. Roles for players on the electricity market



Balance Responsible Players

In principle, each of the market players is responsible for balancing supply and demand of electricity. However, a player may ask another player to take over his responsibility and act as balance responsible player vis-á-vis the TSO on his behalf. A party wanting to act as balance responsible player must enter into a contract with the TSO of the area concerned.

A player is responsible for organising his purchases and sales and balancing the delivery contracts that he enters into. A balance responsible player bears the economic responsibility for the overall balance, for himself and the players with whom he contracts.

A balance responsible player often has regulating resources at his disposal, and this means that he can act as a player on the regulating power market. Having one's own regulating resources is, however, not a condition for being a balance responsible player. The number of balance responsible players varies in the Nordic countries, from tens of balance responsible players in Finland to more than a hundred in Norway where all players are balance responsible also.

The Regulating Power Market

Because of varying local conditions the Nordic countries have developed different principles of balance management; however, as part of their objectives, Nordel intends to harmonise this. Initially, the target has been to combine the regulating power markets to achieve the best possible use of the resources and ensure that the price of regulating power is determined on the same background in all of these countries. From a long-term perspective, another target could be common principles for balance settlement.

The regulating power markets were combined in September 2002. The balance of the synchronous part of Nordel is now controlled based on the frequency. Bids for regulating power in all the countries are compiled in a merit order list available to all Nordic TSOs in a common information system NOIS (Nordic Operational Information System).

The TSOs in Norway and Sweden maintain the frequency by making common decisions to upward or downward regulate, by activating the bids on the common list. Upward or downward regulations are requested through the TSO of the area where the regulation is to be effected. If the transmission grid is congested, the regulations that are necessary to alleviate the bottlenecks are made first, followed by regulation of the frequency, if necessary.

In practice, local imbalances in the power system often fully or in part neutralise each other, and therefore the TSOs' need for regulating power is smaller than the sum of the balance responsible players' need for balancing power. Figure 4 illustrates the structure of the common regulating power market. As part of their preparations to regulate the balance in the hour of operation, the TSOs receive bids from players that are willing to raise or lower their production or consumption. A bid for upward regulation indicates how much the player will ask to raise his production or lower his consumption. A bid for downward regulation indicates how much the player will pay to lower his production or raise his consumption. The TSOs enter all bids in a common list sorted according to rising or falling prices.

If upward or downward regulation is needed during the hour of operation, the bids are used in this sequence, unless grid constraints or operational safety considerations make it impossible. This manual regulation of the balance must be correlated with the automatic frequency regulation.

Figure 5 shows how regulating bids are handled. Accepting a bid means that

Figure 4. The regulating power market

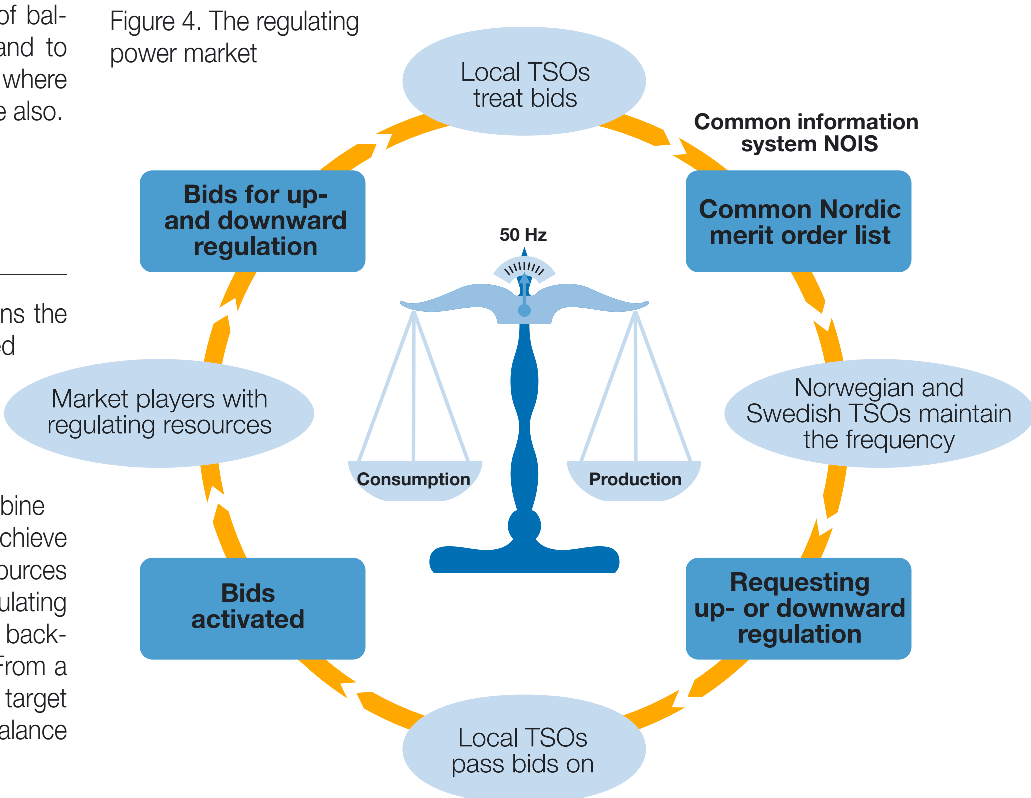
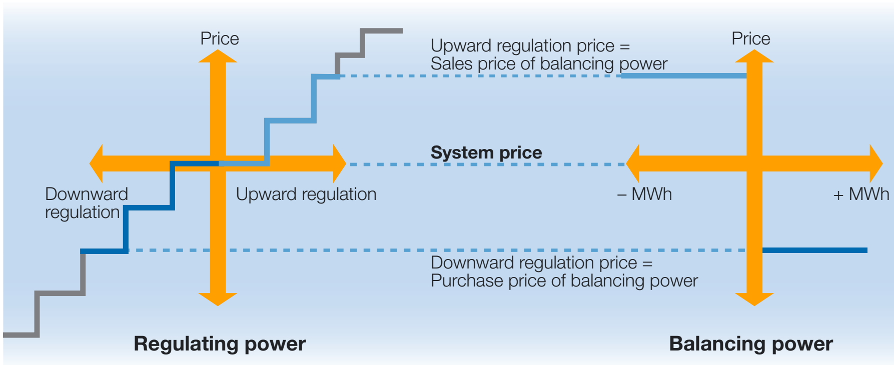


Figure 5. Handling of regulating bids



the player changes his production or his consumption. This makes him a supplier of regulating power, and the schedules that he made previously are modified accordingly. In Norway, Sweden and Finland the players are paid the equivalent of the highest or the lowest price, respectively, of the bids accepted for the hour concerned which means that they often get a better price than what they offered. It is done in this way to stimulate bids, and because all regulations in reality are worth the same to the regulating function. In Denmark, the players are paid the equivalent of their bid.

The prices of upward and downward regulations set the regulating power price, which is used to settle imbalances between subsystems and to settle player imbalances. Every hour, the regulating power price is set at the price of the latest upward or downward regulation according to whether the total regulation of the hour concerned has been up or down. If there have been no regulations, the regulating power price is set at the system prices quoted at the power exchange.

If there are no bottlenecks, the regulating power price becomes the same for all subsystems. If there are bottlenecks leading to an area, the regulating bids thus shut off are disregarded, and the regulating power price for this area becomes different from that of neighbouring systems.

Self Regulation

It has been a tradition in some of the Nordic countries for players to actively regulate their own balances during operation. However, development has demonstrated that there are several disadvantages to this self regulation. For one thing it may lead to exclusion of the regulating capacity from the common regulating power market, and for another it may lead to unco-ordinated control actions, which can cause difficulties for the TSO's planning of the operation of the system. In addition, it is difficult and expensive for the individual player to acquire sufficient real-time data about his balance. Finally, it serves both the individual player and the total market best that the player enters his bid in the regulating power market. Doing this the player makes certain that if the bid is not accepted, the price he will be paying for an imbalance, if any, will never exceed the price he has entered himself. In many cases it will be lower.

In Norway self regulation is prohibited according to new regulations. Sweden and Denmark have tightened the rules meaning that the players have to plan and keep separate balances for production, trading and consumption. In these markets, attempts are made to introduce different measures to eliminate all incentives for self regulation. The players do have the choice, however, to re-schedule their production or consumption due to physical factors, such as changes in wind or CHP (combined heat and power) production or changes in the inflow to the hydro plants, but to do this they have to give the TSO reasonable notice.

Operational Disturbances

When operational disturbances occur, other routines apply compared to situations of normal operation. When there is a major operational disturbance, the regulation is effected upon special directions from the TSO, and restoring the system to normal operation must follow issued instructions. When the power system is exposed to situations with insufficient power or interrupted operation, the most essential thing is to maintain operational reliability. Suspending production or consumption causes major imbalance, and it is important that there are available operating reserves that can be activated.

The TSOs have entered various agreements with producers and consumers to ensure a sufficient supply of dispatchable power. In some cases, the TSOs own their own regulating resources in the form of gas turbines. Experience has demonstrated that consumers are only modest contributors to regulating the power market, and to encourage consumers to lower their consumption some countries have introduced schemes that reward the consumers when they reduce their consumption. As a result of these schemes consumers enter a higher number of bids. Norway has set up an option market for regulating power to ensure the TSO sufficient reserves.

Information Exchange

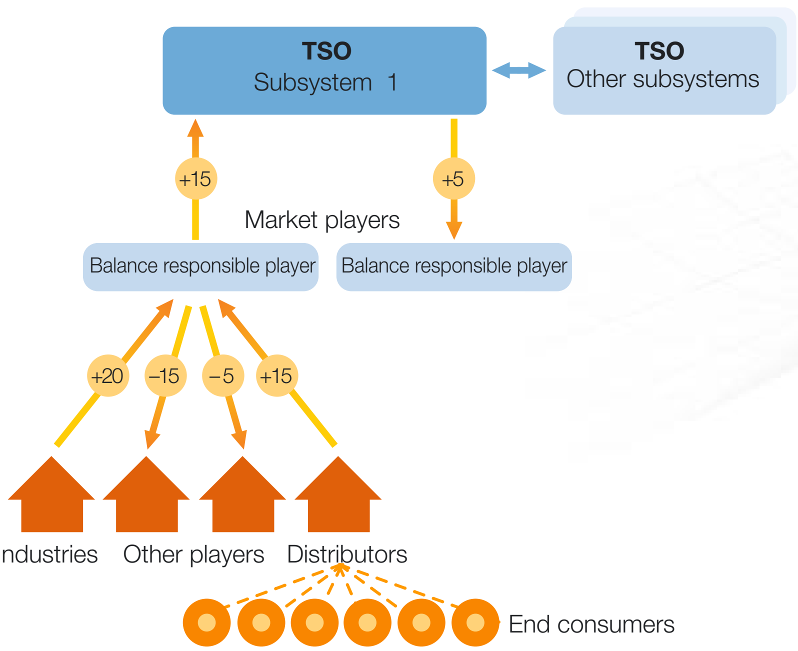
The various operational and settlement functions demand extensive exchange of information between the TSOs and the players. The exchange is electronic using the so-called EDIEL format (EDI in the ELectricity industry). For internal exchange of information between the TSOs, the information system NOIS has been set up.

Balance Settlement

The purpose of balance settlement is to settle income and expenditure for regulation of the balance. The basic principle is that the player causing the imbalance is to pay an equivalent share of the TSO expenditure to restore this balance. Imbalances are settled at several levels. There is settlement between subsystems and settlement within systems. The settlement between the subsystems takes place between the TSOs. The settlement in the subsystems takes place between the TSOs and the balance responsible players, and between the balance responsible players and the players that have placed their balance responsibility with the balance responsible player. Finally, there is settlement with the end customers at the level of distribution.

Figure 6 illustrates the structure of the balance settlement. Below follows a description of the settlement that is effected between subsystems, and an outline of the settlement within the subsystems. Imbalances that arise during an hour of operation are handled as purchase or sale of balancing power. The TSOs settle balancing power with the TSOs of the neighbouring systems, and they settle balancing power with the balance responsible players in their own area. Imbalances are computed as the difference between scheduled and actual production, trading and consumption. The scheduled values can be seen from the schedules that the players send to the TSOs, and the actual values can be seen from the meter readings that the owners of the grid are obliged to submit to the TSOs.

Figure 6. Balance settlement at various levels



Settlement between Subsystems

Normally, there is no longer any control based on ACE (area control error) between the subsystems, but only control based on the total balance of the Nordic power system. As a result of this the exchange between systems may vary significantly in relation to the scheduled exchange, and the additional energy thus exchanged is settled as balancing power between the TSOs.

Figure 7 shows an example of how the balancing power between subsystems can be calculated.

The reported exchanges between two subsystems are summed to determine the scheduled net exchange between these systems. The metered hourly values of the exchange on all interconnections between the two systems are collected and summed to determine the actual exchange between the systems. Following that the balancing power is calculated as the difference between the scheduled net exchange and the actually metered exchange.

The balancing power between two subsystems is settled between the TSOs based on the regulating power price hour by hour. If there has been transmission congestion between the subsystems and hence various regulating power prices, the mean values of these figures are used.

Settlement within Subsystems

Initially, imbalance settlement in subsystems takes place between the TSO and the balance responsible players in the relevant area. Imbalances are computed in the form of balancing power in all systems hour by hour as shown in figure 8.

The imbalance is computed as the difference between the scheduled and the actual supply and demand. Supply can be either production or purchase from other players or from the exchange. Demand can be either consumption or sale to other players or to the exchange. If the player has delivered regulating power, this is taken into consideration. A positive imbalance means that the player has produced more or consumed less than scheduled. A negative imbalance means that the player has consumed more or produced less than scheduled.

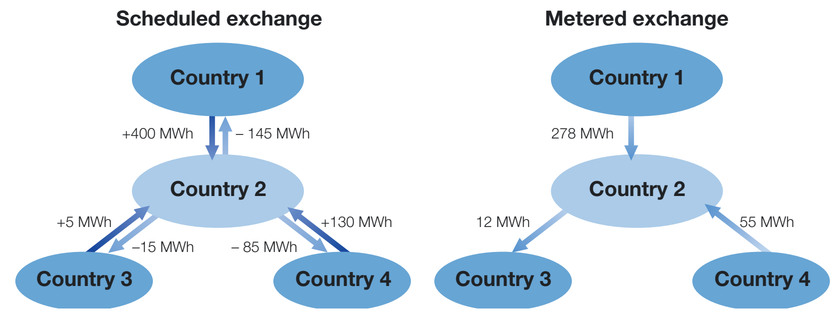
Sweden and Denmark settle imbalances for production, trading and consumption separately. One of the reasons for this is to prevent the players from taking self regulating measures. Norway and Finland settle total balances.

The countries price balancing power according to different principles. Norway uses a "one-price model" according to which the same price applies to both the purchase and sale of balancing power. The other countries use a "two-price model" according to which the price of the purchase or sale of the individual balance responsible player depends on whether the purchase or the sale has been to the advantage or disadvantage of the total regulation of the power system for the hour concerned.

The "one-price model" is simple and gives fast settlement. Players may, however, be tempted to produce deliberate imbalances to achieve a better price for the balancing power than the spot price. This is not allowed, however, and there has been no need for the TSOs to intervene against major and systematic imbalances. The "two-price model" is more complex, but it also gives the players better incentives to maintain their balance.

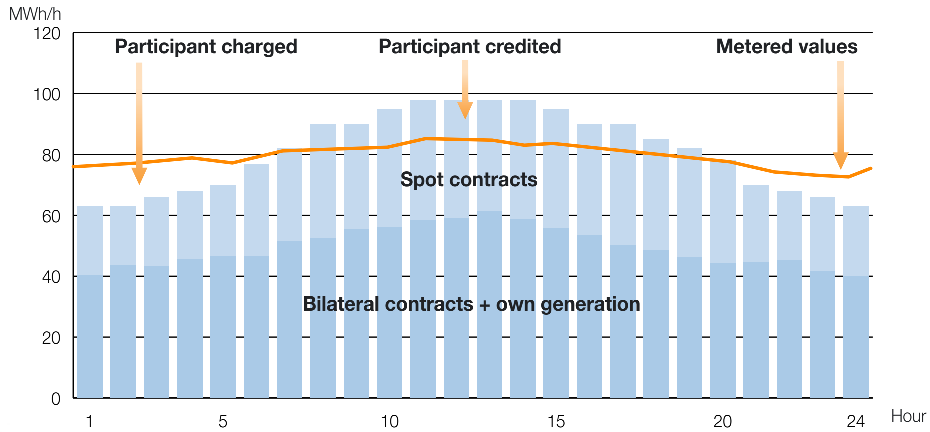
The "one-price model" creates a balance between expenditure and income for balance and regulating power hour by hour. With the "two-price model", the TSOs generate a surplus that can help cover the expenditure for balance management.

Figure 7. Sum of balancing power between subsystems



Counterparty to country 2	Scheduled trade Imports	Scheduled trade Exsports	Scheduled exchange	Metered exchange	Balancing power
Country 1	+400 MWh	-145 MWh	+255 MWh	+278 MWh	-23 MWh
Country 3	+5 MWh	-15 MWh	-10 MWh	-12 MWh	+2 MWh
Country 4	+130 MWh	-85 MWh	+45 MWh	+55 MWh	-10 MWh

Figure 8. Positive and negative imbalances of a player.



Conclusions

The model for common use of regulating resources, which was introduced in Nordel in September 2002, is an essential step on the road to harmonising the conditions for the players on the Nordic electricity market. The model has had the following outcome:

- Efficient balance control
- Lower total control cost for the TSOs
- Improved operational reliability due to simplified routines and improved overview in the TSO control centres
- Equalisation of the regulating power price in Nordel
- Increased interest in placing bids on the regulating power market
- Harmonisation of balance settlement between the countries
- In practice, the TSOs work as one company in this respect.

The work of investigating the possibilities of harmonising the internal balance settlement in the Nordic countries continues. According to the latest draft of the EU strategy report on the development of the electricity market, balance management is handled differently from one European country to the other, and the report points towards a common regulating power market as an efficient tool to prevent abuse of market power.

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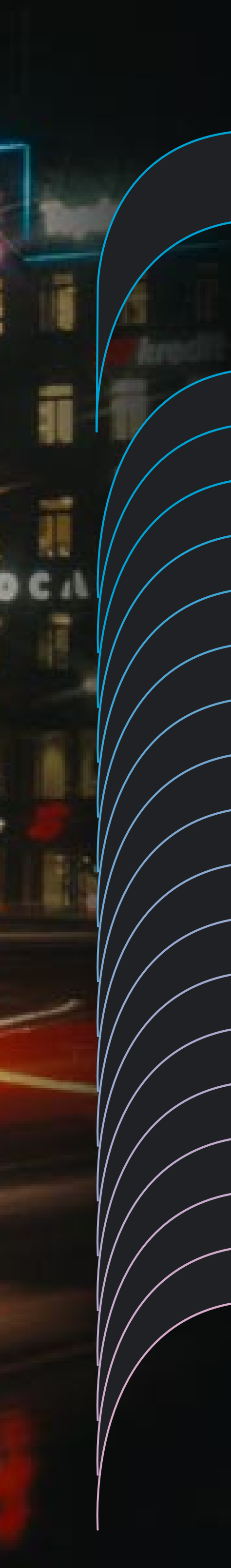

Statistics

Definitions, units and symbols

Units and symbols

kW	kilowatt	
MW	megawatt	= 1000 kW
GW	gigawatt	= 1000 MW
J	joule	
kJ	kilojoule	
PJ	petajoule	= 10^{15} J
kWh	kilowatt-hour	= 3600 kJ
MWh	megawatt-hour	= 1000 kWh
GWh	gigawatt-hour	= 1000 MWh
TWh	terawatt-hour	= 1000 GWh
~	Alternating current (AC)	
=	Direct current (DC)	
–	Data are nonexistent	
..	Data are too uncertain	
0	Less than 0.5 of the unit given	

Calculation of the electricity consumption

Electricity generation
\+ Imports
\- Eksports

= Total consumption
\- Occasional power to electric boilers

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

= Net consumption

Gross consumption

The sum of domestic generation and imports minus exports and occasional power to electric boilers; usually expressed in GWh.

Electricity generation
(net generation)

The output of a power plant, excluding the plant's own consumption; usually expressed in GWh. Registration of generation is referred to where the power plant is physically located.

Exchange of electricity

The monthly sums (in GWh) of the physically registered MWh values for each connection between the individual countries, per hour of exchange.

Installed capacity (net capacity)

The sum of the rated capacities of the individual power plant units (expressed in MW), excluding the power plant's own consumption of electricity (exclusive heat production).

Generation of 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.

Net consumption

The sum of the energy used by consumers of electricity; usually expressed in GWh.

Transmission capacity

The power (in MW) that a high-voltage line can transmit under normal conditions, taking into account any limitations that may be imposed on the rated capacity.

Pumped storage power

The electricity used for pumping water up to a reservoir, for the generation of electricity later on; expressed in GWh.

Losses

The difference between gross consumption and net consumption plus pumped storage power; usually expressed in GWh.

Occasional power to electric boilers

Expressed in GWh, this refers to the supply of electricity to electric boilers on special conditions for the generation of steam or hot water, which may alternatively be generated using oil or some other fuel.

Total consumption

The sum of electricity generation and net imports, expressed in GWh.

Combined heat and power (CHP) generation

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 industry. Previously known as backpressure generation.

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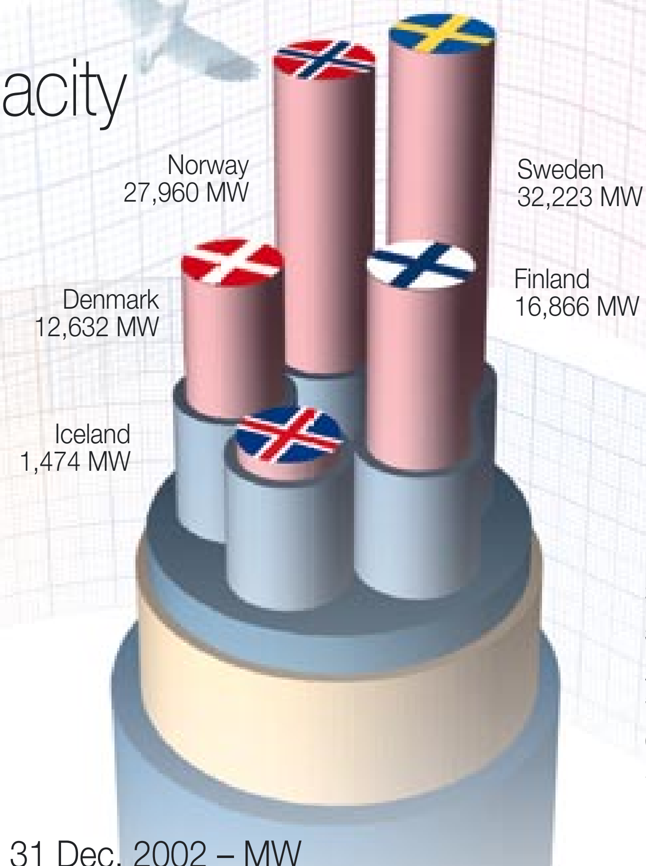
The statistical data can also be read on Nordel's Internet pages at www.nordel.org

Installed capacity



1) Refers to the sum of the rated net capacities of the individual power plant units in the power system, and should not be considered to represent the total capacity available at any single time.
2) Includes the Norwegian share of Linnvasselv (25 MW).
3)Includes capacity conserved for an extended period, Finland (230 MW).
4) Includes condensing power.
5) Includes long-time reserve of Vendsysselværket (295 MW).
6) Included industrial generated producer (appr. 24 MW).
7) Includes capacity of power plants which are included in the agreement considering power reserves in Sweden.

S1 Installed capacity on 31 Dec. 2002 – MW

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Installed capacity, total [1]	12,632	16,866	1,474	27,960	32,223	**91,155**
Hydropower	11	2,948	1,150	27,558	16,097 [2]	**47,764**
Nuclear power	–	2,640	–	–	9,424	**12,064**
Other thermal power	9,733	11,235	122	305	6,363	**27,758**
• condensing power [3]	–	3,882	–	73	1,356 [7]	**5,311**
• CHP, district heating	9,019 [4)5)]	3,655	–	12	2,492	**15,178**
• CHP, industry	444 [6]	2,820	–	185	956	**4,405**
• gas turbines, etc.	270	878	122	35	1,559 [7]	**2,864**
Other renewable power	2,888	43	202	97	339	**3,569**
• wind power	2,888	43	–	97	339	**3,367**
• geothermal power	–	–	202	–	–	**202**
Commissioned in 2002	529	181	47	193	687	**1,637**
Decommissioned in 2002	378	106	–	81	174	**739**

S2 Average-year generation of hydropower in 2002 – GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Average-year generation 2002	-	12,759	6,790	118,174	65,000	**202,723**
Average-year generation 2001	-	12,759	6,580	118,051	64,000	**201,390**
Change	-	0	210	123	1,000	**1,333**
Reference period		1961-90	1950-95	1970-99	1950-00	**–**

S3 Changes in installed capacity in 2002

Power category	Power plant	Com-missioned MW	Decom-missioned MW	Change in average -year generation (hydropower) GWh	Type of fuel
Denmark - East					
CHP	Asnæsværket block 3		270		Coal / oil
	Avedøreværket block 2	3			Gas / biofuel
CHP, district heating	Decentral CHP	3	5		Gas / biofuel
CHP, industry	Decentral CHP	9			Other
Wind power	Windmills	19			
Denmark - West					
CHP, district heating	Decentral CHP	10			Other (Biofuel/Natural gas)
	Local CHP	3			Biofuel
	Local CHP		1		Other (Biofuel/Natural gas)
CHP, industry		11			Other (Biofuel/Natural gas)
			14 [2]		Other
Wind power	Windmills	471 [1]	88		
Finland					
CHP, district heating	Parkatti	15			Peat
	Lappeenranta		46		Natural gas
CHP, industri	Äänekoski	26			Peat; waste wood
	Kuusankoski	80	30		Peat; waste wood
	Jämsänkoski	46			Peat; waste wood
	Ristiina	10			Waste wood
Condensing power	Kokkola		30		Peat; waste
Wind power		4			
Iceland					
Hydropower	Vatnsfeill	45		210	
Gas turbines	Varius engines for stand by	2			Oil
Norway					
Hydropower	Various	113	81	123	
Wind power	Smøla	40			
	Havøygavlen	40			
Sweden					
Condensing power	Karlshamn G1 [3]	332			Oil
	Various changes	1			Oil
Gas turbines	Stallbacka G3 [3]	86			Oil
	Arendal [3]	60			Oil
	Various changes	2	10		Oil
CHP, district heating	Lugnvik	45			Biofuel
	Händelö	11			
	Various changes	66			Biofuel
CHP, industry	Munksund	25			Biofuel
	Various changes	3			Biofuel
Hydropower	Harsprånget		110		
	Porsi		12		
	Various changes	10	30		
Nuclear Power	Various changes		12		
Wind Power	Approx. 50 new aggregates	46			

1) Incl. upward adjustment of power per 2002-12-31 (11 MW) 2) Autoproducers. 3) Included in the Swedish power reserve plants which are conserved for an extended period of time.

S4 Power plants (larger than 10 MW): decisions taken

Power category	Power plant	Capacity MW	Estimated start-up Year	Change in average -year generation (hydropower) GWh	Type of fuel
Denmark - East					
Wind power	Rødsand	150	2003	-	-
Denmark - West					
-	-	-		-	-
Finland					
CHP, district heating	Savonlinna	17	2003	-	Waste wood, peat
Hydropower	Valajaskoski	28	2003	23	-
Iceland					
Hydropower	Kàrahnjùkar	630	2007	4,450	-
Norway					
Hydropower	Bjølvo (net increase)	15	2003	65	-
	Tyin (net increase)	168	2004	230	-
Sweden					
Gas turbines	Hallstavik	120	2003		oil

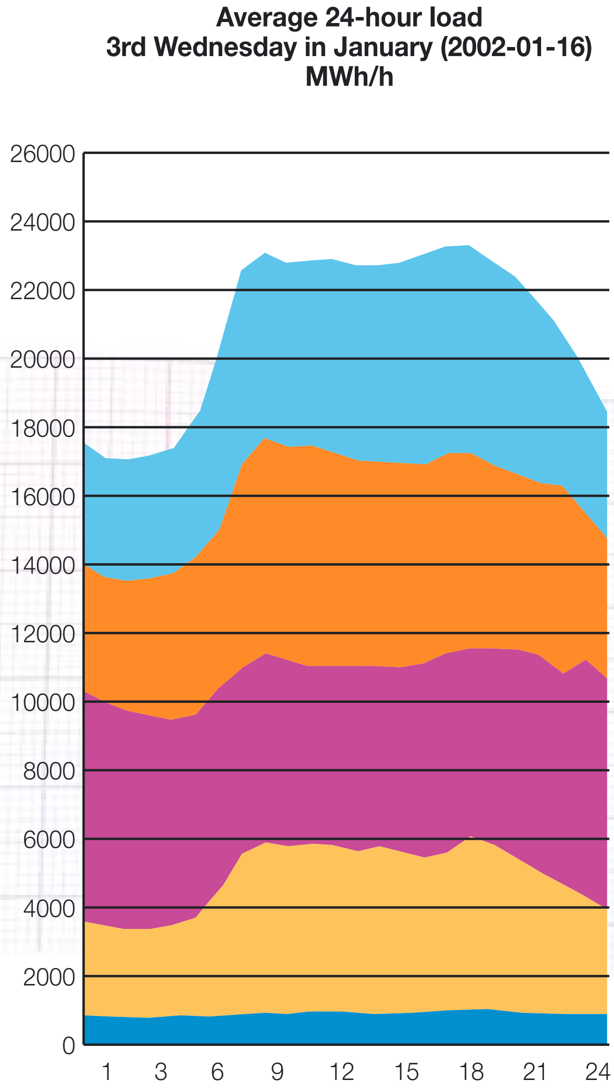
System load

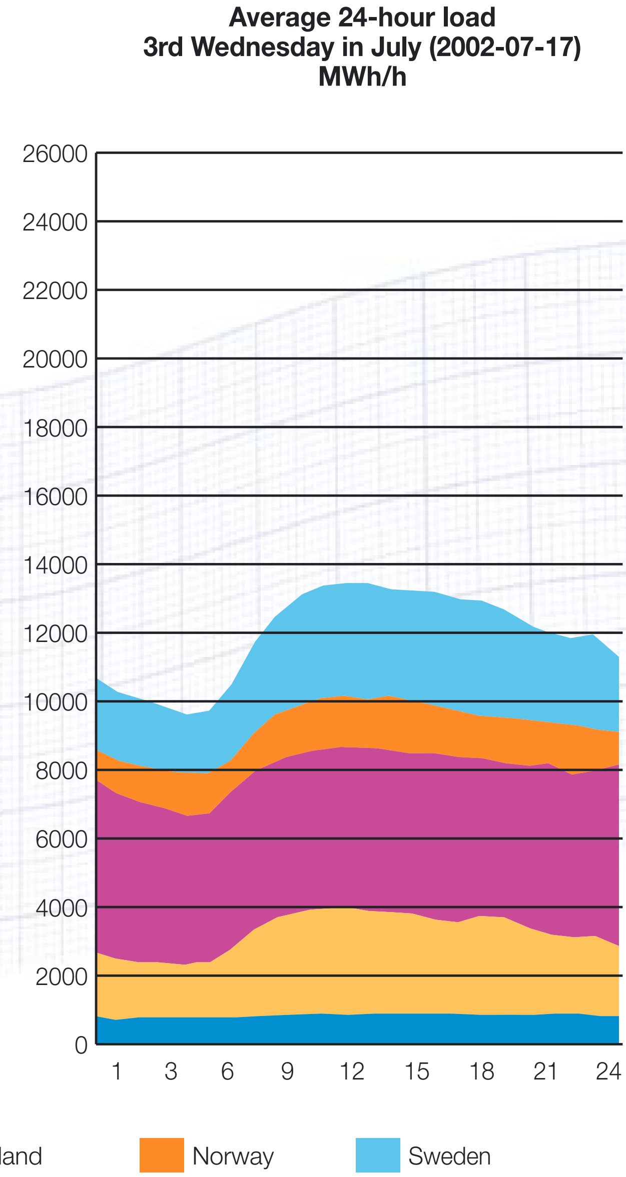
S5 Maximum system load for each country in 2002 [1)]

	MWH/h	Date	Time
Denmark - East	3,656	2002-12-10	05-06 PM
Denmark - West	2,683	2002-01-03	05-06 PM
Finland	13,655	2002-12-31	04-05 PM
Iceland	1,010	2002-03-04	10-11 AM
Norway	20,689	2002-01-04	10-11 AM
Sweden	25,800	2002-01-02	04-05 PM

1) The system load is not corrected vs. temperatures and all hours are local time.

System load 3rd Wednesday in January and 3rd Wednesday in July 2002





Maximum load 3rd Wednesday in January and 3rd Wednesday in July 2002

All hours are local time

	3rd Wednesday in January 2002, 05-06 PM - MWh/h	3rd Wednesday in July 2002, 12-01 PM - MWh/h
Denmark	6,082	3,908
Finland	11,603	8,653
Iceland	959	885
Norway	17,260	10,090
Sweden	23,301	13,428
Nordel	**59,205**	**36,964**

The transmission grid in the Nordic countries

Interconnections

S6 Existing interconnections between the Nordel countries

Countries/ Stations	Rated voltage/kV	Transmission capacity as per design rules [1] MW		Total length of line/km	Of which cabel/km
Denmark - Norway		**From Denmark**	**To Denmark**		
Tjele-Kristiansand	250/350=	1,040	1,040	240/pol	127/pol
Denmark - Sweden		**From Sweden**	**To Sweden**		
Teglstrupgård - Mörarp 1 and 2	132~	350 [2]	350 [2]	23	10
Hovegård - Söderåsen 1	400~	800 [2]	800 [2]	91	8
Hovegård - Söderåsen 2	400~	800 [2]	800 [2]	91	8
Vester Hassing - Göteborg	250=	290	270	176	88
Vester Hassing - Lindome	285=	380	360	149	87
Hasle (Bornholm) - Borrby	60~	60	60	48	43
Finland - Norway		**From Finland**	**To Finland**		
Ivalo - Varangerbotn	220~	100	120	228	–
Finland - Sweden		**From Sweden**	**To Sweden**		
Ossauskoski - Kalix	220~	1,600 [3] (Ossauskoski - Kalix, Petäjäskoski - Letsi, Keminmaa - Svartbyn combined)	1,200 [3] (Ossauskoski - Kalix, Petäjäskoski - Letsi, Keminmaa - Svartbyn combined)	93	–
Petäjäskoski - Letsi	400~			230	–
Keminmaa - Svartbyn	400~			134	–
Raoma - Forsmark	400=	550	550	235	198
Senneby - Tingsbacka (Åland)	110~	80	80	81	60
Norway - Sweden		**From Sweden**	**To Sweden**		
Sildvik - Tornehamn	132~	50	120	39	–
Ofoten - Ritsem	400~	700	1,350 [4]	58	–
Røssåga - Ajaure	220~	415 [5]	415 [4, 5]	117	–
Linnvasselv, transformator	220/66~	50	50	–	–
Nea - Järpströmmen	275~	900 [5]	900 [5]	100	–
Lutufallet - Höljes	132~	40	20	18	–
Eidskog - Charlottenberg	132~	100	100	13	–
Hasle - Borgvik	400~	2,200 [5] (Hasle - Borgvik, Halden - Skogssäter combined)	2,200 [5, 6] (Hasle - Borgvik, Halden - Skogssäter combined)	106	–
Halden - Skogssäter	400~			135	–

1) Maximum permissible transmission.

2) Thermal limit. The total transmission capacity is 1775 MW to Denmark and 1700 MW to Sweden.

3) In certain situations, the transmission capacity can be lower than the limit given here.

4) Thermal limit. Stability problems and generation in nearby power plants may lower the limit.

5) The transmission capacity can in certain situations be lower, owing to bottlenecks in the Norwegian and Swedish network.

6) Requires a network protection system during operation (production disconnection).

S7 Existing interconnections between the Nordel countries and other countries

Countries/ Stations	Rated voltage/kV	Transmission capacity/MW		Total length of line/km	Of which cabel/km
Denmark - Tyskland		**From Nordel**	**To Nordel**		
Kassø - Audorf	2x400~	1,200	1,200 [3]	107	–
Kassø - Flensborg	220~			40	–
Ensted - Flensborg	220~			34	–
Ensted - Flensborg	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]	2x400~	–	1,400	67	–
Kymi - Viborg [2]	400~	–		132	–
Nellimö - Kaitakoski	110~	60	60	50	–
Norway - Russia		**From Nordel**	**To Nordel**		
Kirkenes - Boris Gleb	154~	50	50	10	–
Sweden -Germany		**From Nordel**	**To Nordel**		
Västra Kärrstrop - 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.

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

3) The transmission capacity is limited to 800 MW due to internal restrictions in Denmark West.

S8 Interconnections: decisions taken

Countries/ Stations	Rated voltage/kV	Transmission capacity/MW	Total length of line/km	Of which cabel/km
At present no new interconnections have been decided. For futher information see the Nordel Grid Master Plan 2002.				

S9 Transmission lines of 110-400 kV in service on 31. dec. 2002

	400 kV, AC og DC/km	220-300 kV, AC og DC/km	110,132,150 kV/km
Denmark	1,346 [1]	504 [2]	3,954 [3]
Finland	4,062 [4]	2,403	15,300
Iceland	94 [6]	514	1,315
Norway	2,144	5,639 [2]	10,470
Sweden	11,067 [5]	4,628 [2]	15,000

1) Of which 2 km in service with 150 kV and 46 km with 132 kV.

2) Of which 80 km in Denmark and 96 km in Sweden (KontiSkan), 89 km in Denmark and 382 km in Norway (Skagerrak) in service with 250 kV DC, and 75 km in Denmark and 74 km in Sweden (KontiSkan 2) in service with 285 kV DC.

3) Of which 13 km in service with 60 kV and 118 km with 50 kV.

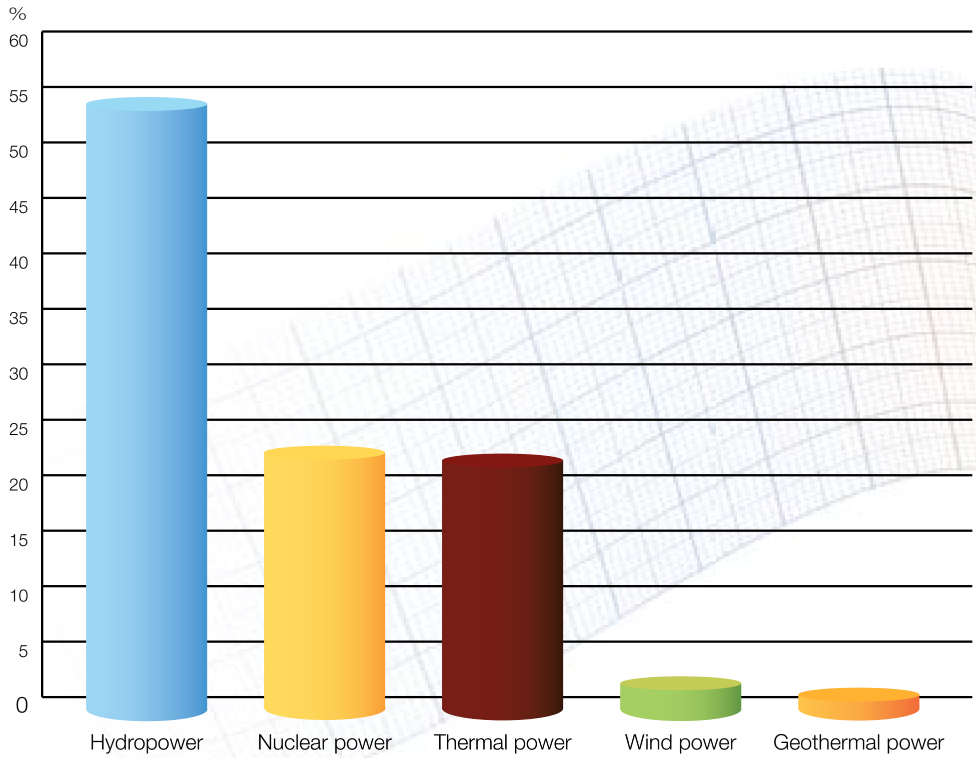
4) Of which 99 km submarine cabel (DC) and 34 km land cabel (DC) in Finland (Fenno-Skan).

5) Of which 99 km submarine cabel (DC) and 2 km land cabel (DC) in Sweden (Fenno-Skan). Also 38 km submarine cabel (DC) in Sweden, 182 km in international water and 22 km in Poland, + 2 km land cabel (DC) in Sweden and 12 km in Poland (SwePol Link).

6) At present in service with 220 kV.

Electricity generation

S10 Total electricity generation within Nordel 2002



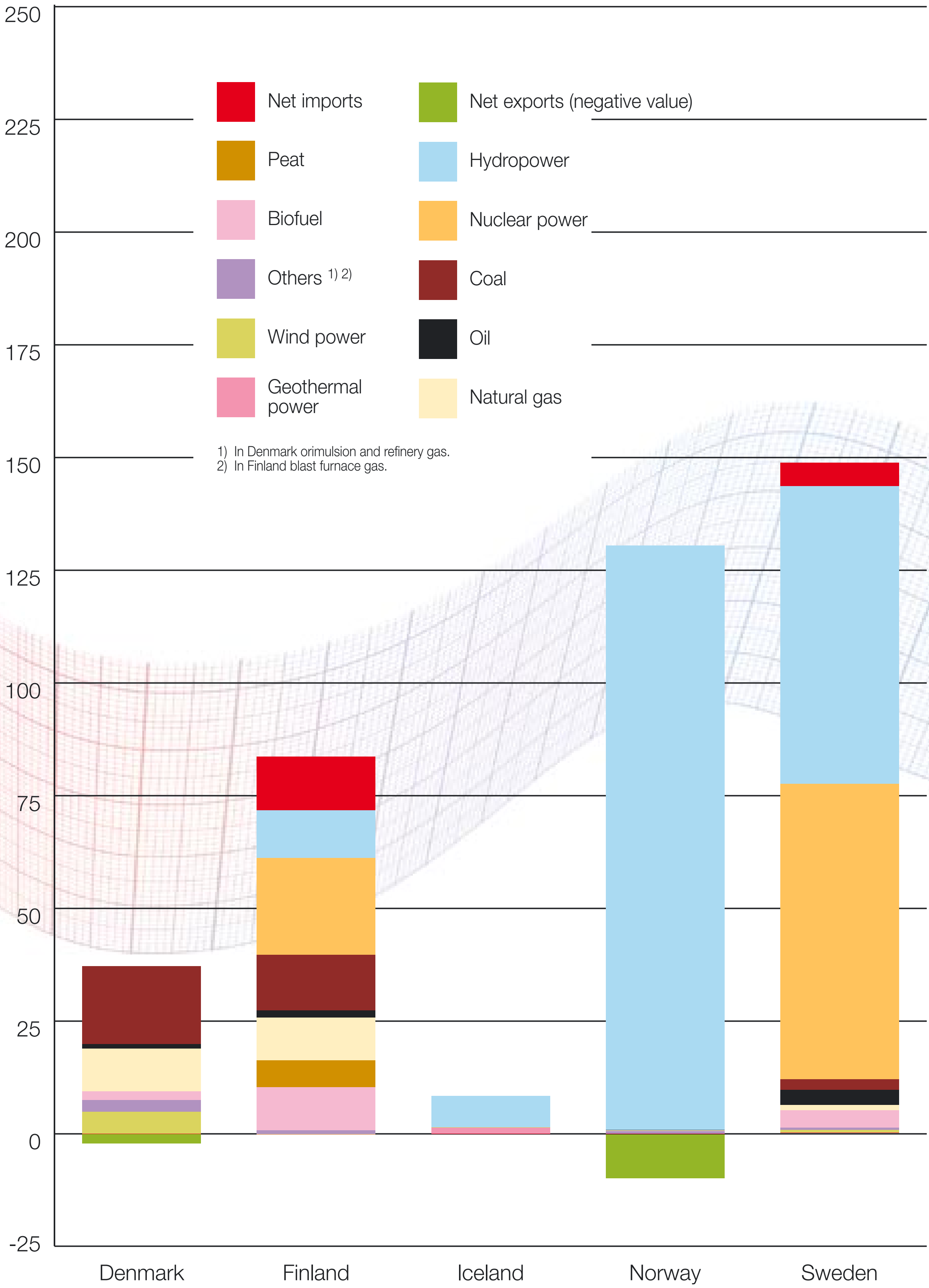
S11 Electricity generation 2002 – GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total generation	37,260	71,938	8,404	130,591 [2)]	143,361	**391,554**
Hydropower	32	10,636	6,968	129,732	66,046	**213,414**
Nuclear power	–	21,443	–	–	65,572	**87,015**
Thermal power	32,349	39,793	3	783	11,185	**84,113**
• condensing power	–	12,875	–	–	1,026	**14,116**
• CHP, district heating	30,232 [1)]	14,635	–	–	5,425	**50,292**
• CHP, industry	2,117	12,268	–	371	4,699	**19,455**
• gas turbines etc.	–	15	3	197	35	**250**
Other renewable power	4,879	66	1,433	76	558	**7,012**
• wind power	4,879	66	–	76	558	**5,579**
• geothermal power	–	–	1,433	–	–	**1,433**
Total generation 2001	36,009	71,299	8,028	121,872 [2)]	157,712	**394,850**
Change as against 2001	3.5%	1%	4.7%	7.2%	-9.1%	**-0.8%**

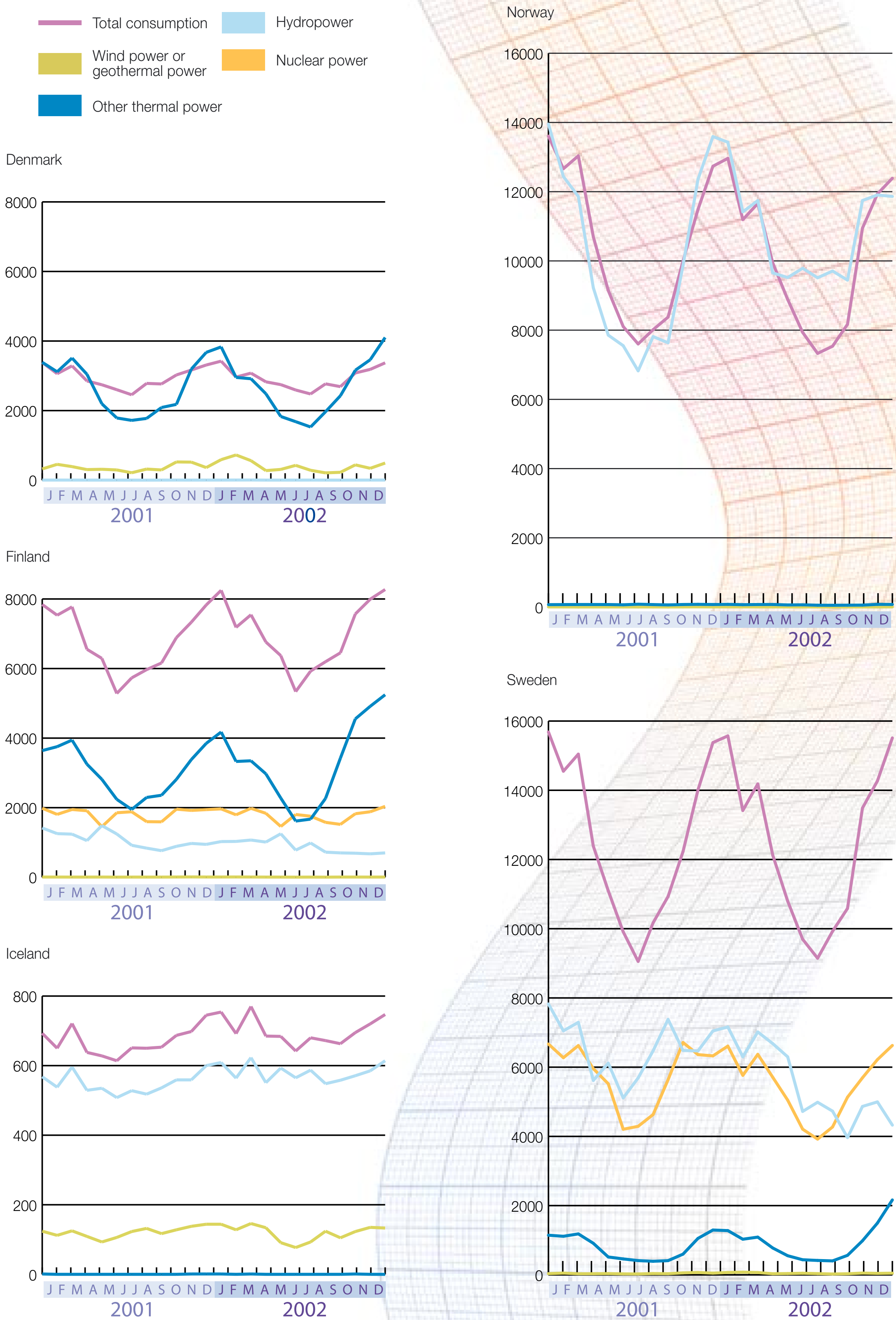
1) Includes generation in combined heat and power stations.

2) Gross production.

S12 Total electricity generation by energy source, and exchange of electricity - TWh



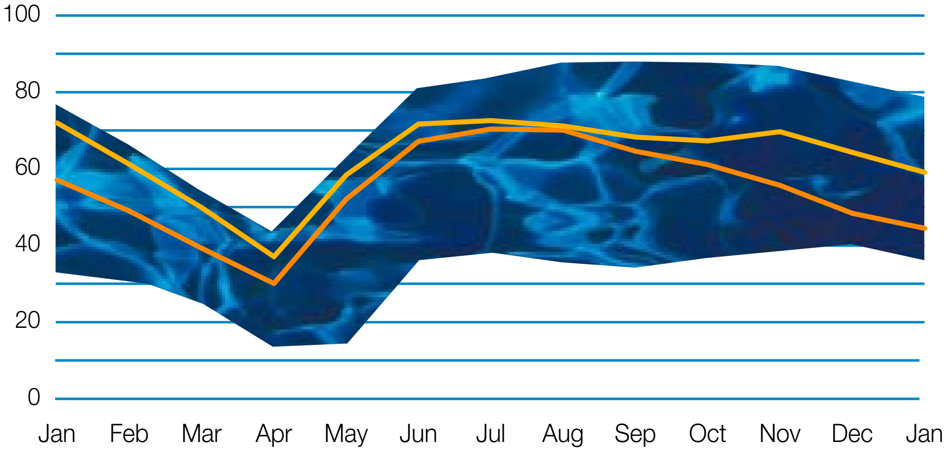
S13 Monthly generation and total consumption of electricity 2001-2002 – GWh



Water reservoirs

S14 Water reservoirs 2002

Finland



Water reservoirs 2002 expressed in %

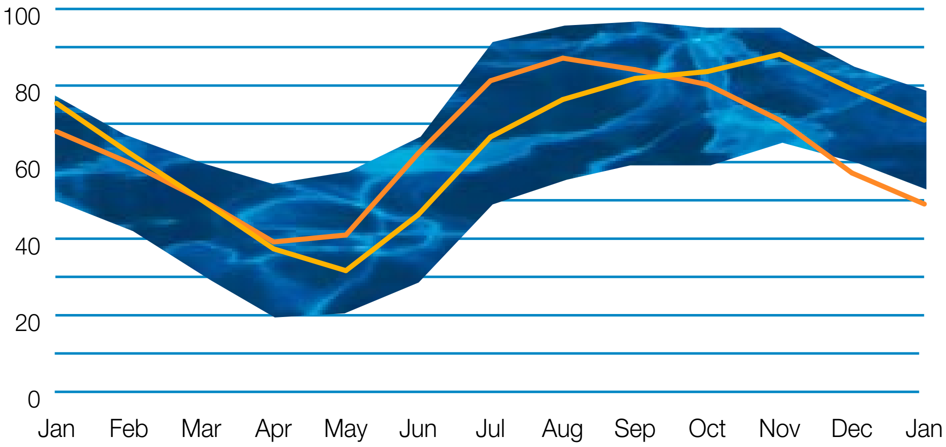
Water reservoirs 2001 expressed in %

Minimum and maximum values in %

Reservoir capacity
5,530 GWh.

Minimum and maximum limits are based on values for the years 1978-2001.

Norway

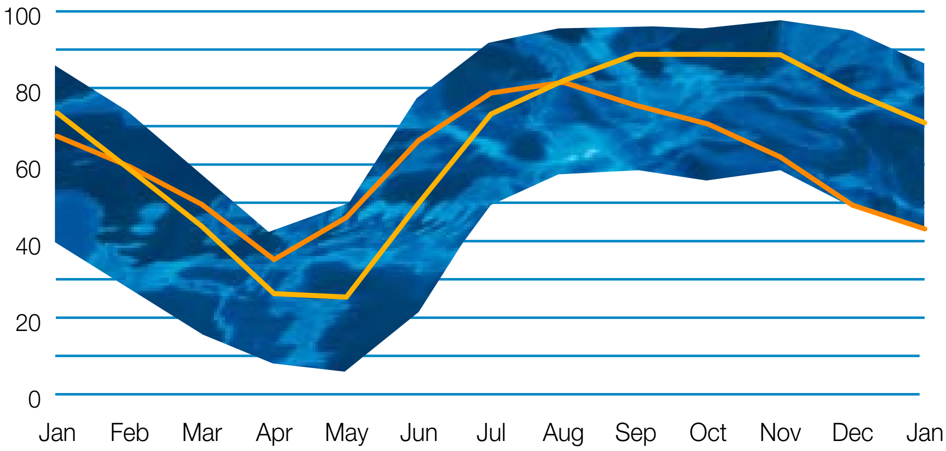


Reservoir capacity
81,729 GWh.

The statistics show appr. 97.1% of the total reservoir capacity.
The total capacity is 84,147 GWh.

Minimum and maximum limits are based on values for the years 1990-2000.

Sweden

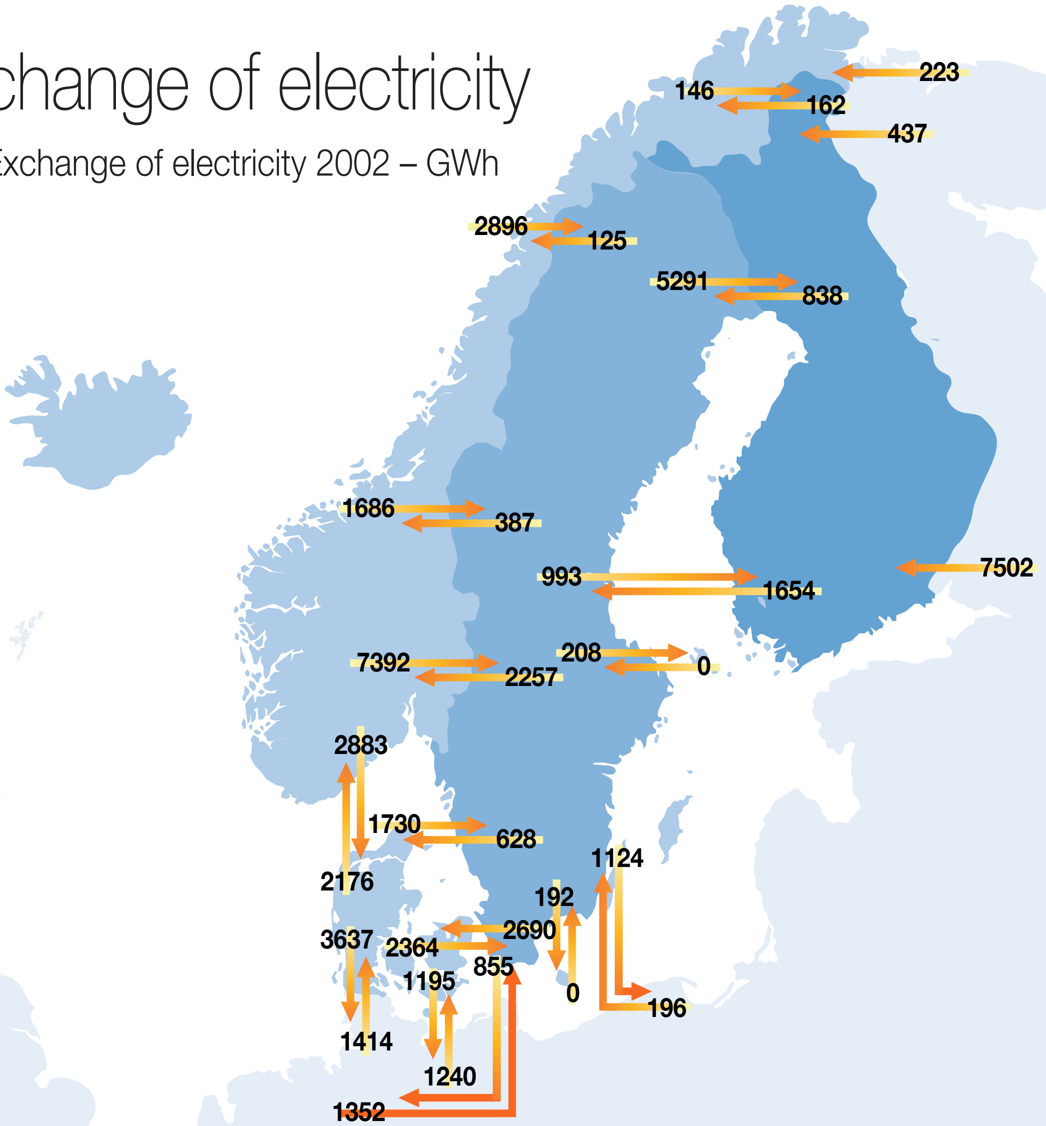


Reservoir capacity
33,748 GWh.

Minimum and maximum limits are based on values for the years 1950-2001.

Exchange of electricity

S15 Exchange of electricity 2002 – GWh

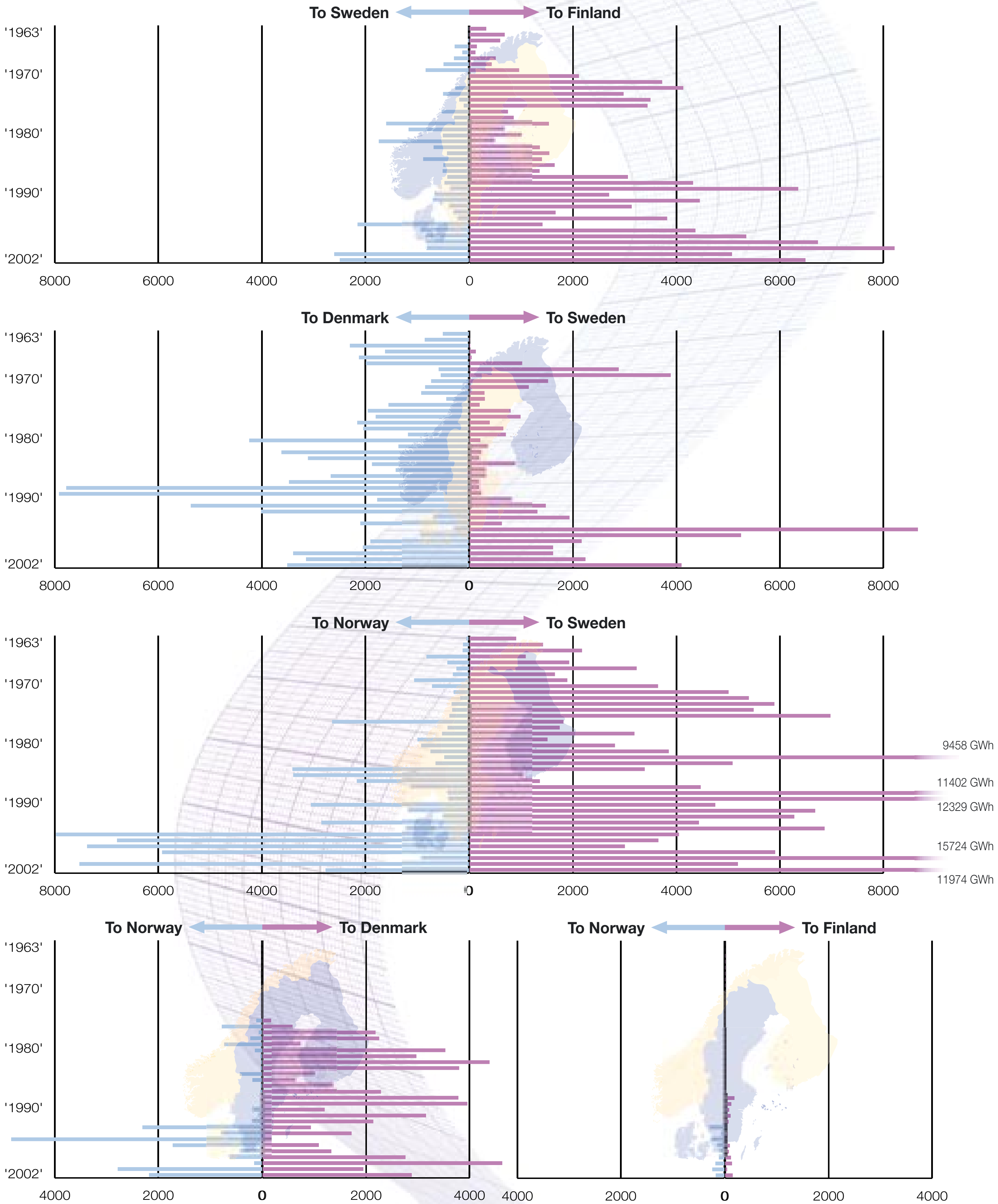


S16 Exchange of electricity 2002 – GWh

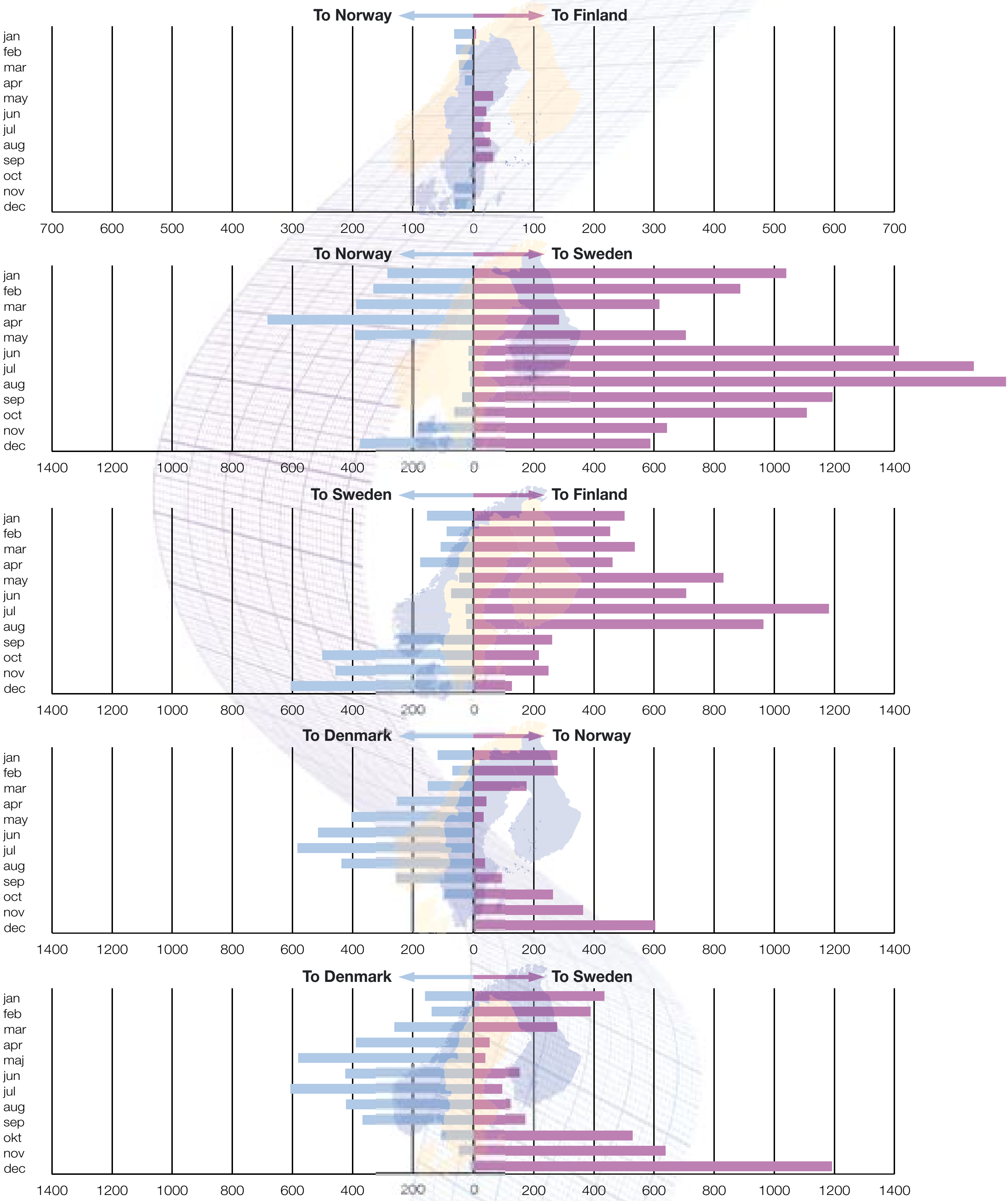
From / To	Denmark	Finland	Norway	Sweden	Other countries[1]	Σ From
Denmark	–	–	2,176	4,094	4,832	**11,102**
Finland	–	–	162	2,492	–	**2,654**
Norway	2,883	146	–	11,974	–	**15,003**
Sweden	3,510	6,492	2,769	–	1,979	**14,750**
Other countries [1]	2,654	7,939	223	1,548	–	**12,364**
Σ To	9,047	14,577	5,330	20,108	6,811	**55,873**
						Nordel
Total to	9,047	14,577	5,330	20,108		**49,062**
Total from	11,102	2,654	15,003	14,750		**43,509**
Net imports	-2,055	11,923	-9,673	5,358		**5,553**
Net imports/total consumption	-5.8%	14.2%	-8.0%	3.6%		**1.4%**

1) Russia, Germany and Poland.

S17 Exchange of electricity between the Nordel countries 1963-2002 – GWh

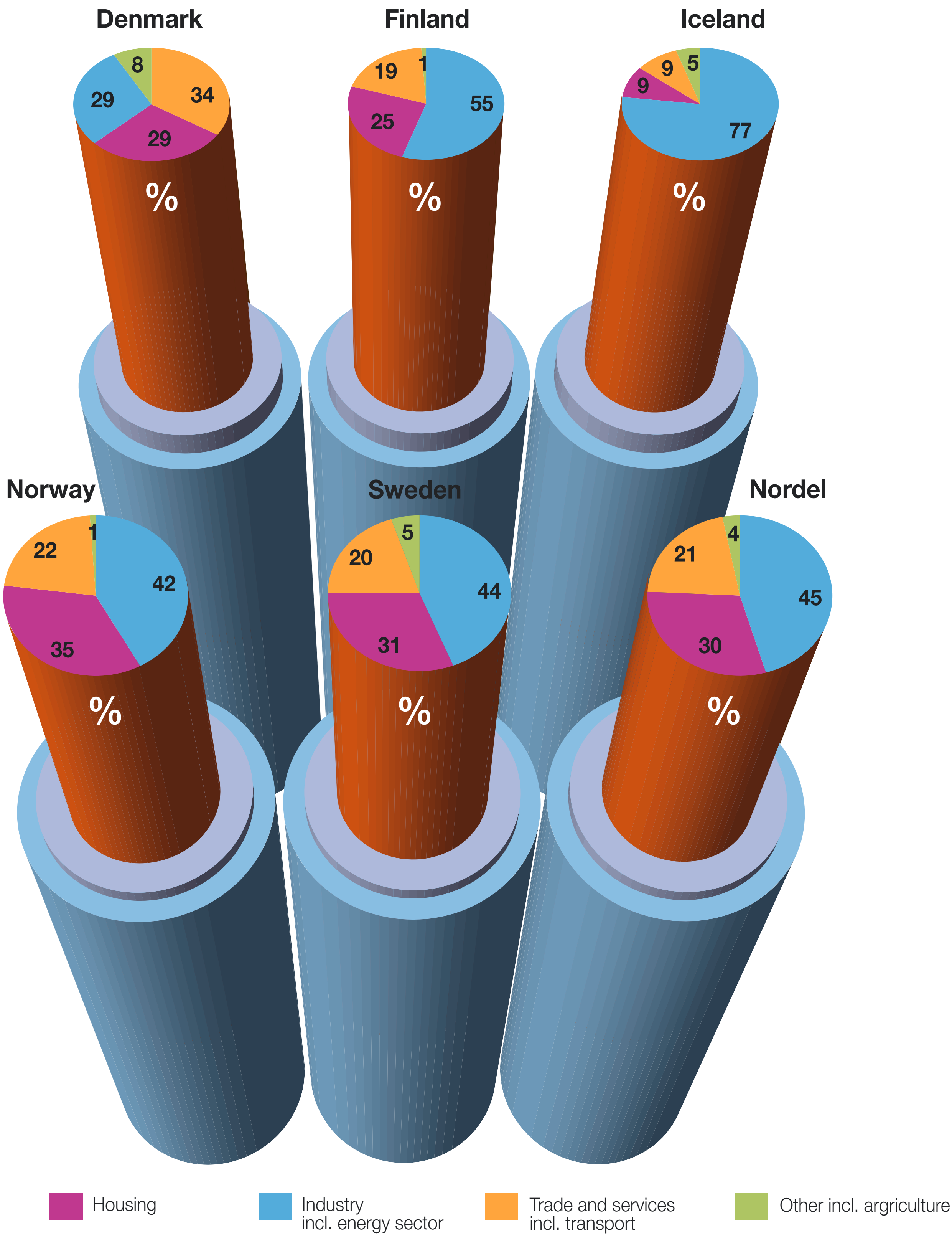


S18 Monthly exchange of electricity between the Nordel countries 2002 – GWh



Electricity consumption

S19 Net consumption of electricity 2002, by consumer category

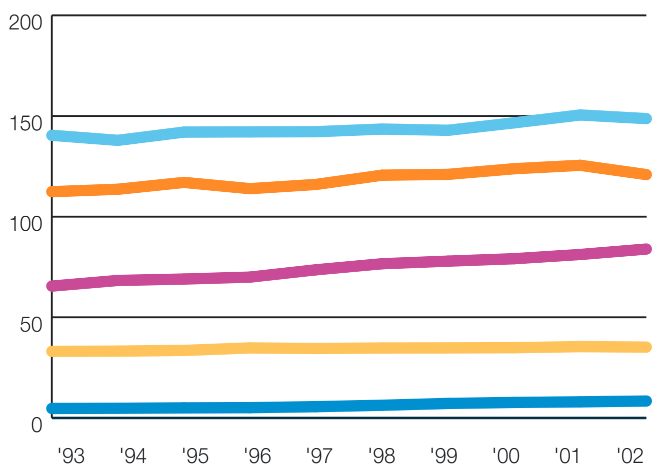


S20 Electricity consumption 2002 – GWh

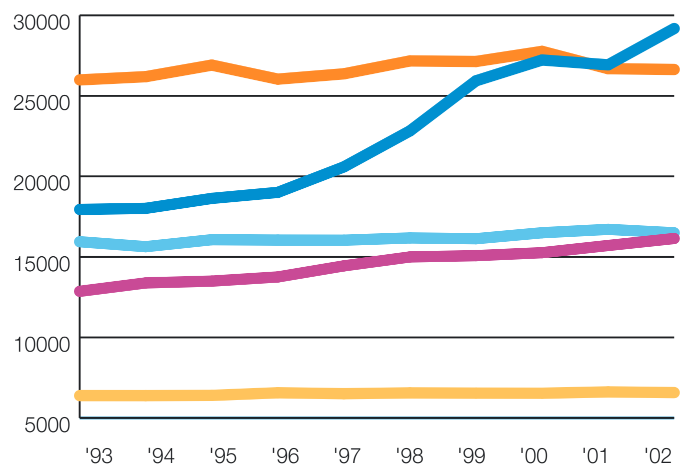
	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total consumption	35,205	83,861	8,404	120,918	148,719	**397,107**
• Occasional power to electric boilers	–	81	303	4,670	1,220 [1)]	**6,274**
Gross consumption	35,205	83,780	8,101	116,248	147,499	**390,833**
• Losses, pumped storage power	2,405	2,998	497	10,523	11,932	**28,355**
Net consumption [2)]	32,800	80,782	7,604	105,725	135,567	**362,478**
• Housing	9,600	20,580	665	37,016	41,887	**109,748**
• Industry (incl. energy sector)	9,550	44,060	5,877	43,909	60,093	**163,489**
• Trade and services (incl. transport)	11,100	15,322	686	23,200	26,547	**76,855**
• Other (incl. agriculture)	2,550	820	376	1,600	7,040	**12,386**
Population (million)	5,374	5,206	0,288	4,538	8,941	**24,347**
Total consumption per capita kWh	6,551	16,109	29,181	26,646	16,497	**16,053**
Total consumption 2001	35,432	81,188	8,028	125,464	150,421	**400,533**
Change as against 2001, %	-0.6%	3.3%	4.7%	-3.6%	-1.1%	**-0.9** %

1) Only electric boilers at district heating plants shown. 2) Estimated net consumption.

S21 Total consumption 1993-2002 – TWh



S22 Total consumption per capita 1993-2002 – kWh



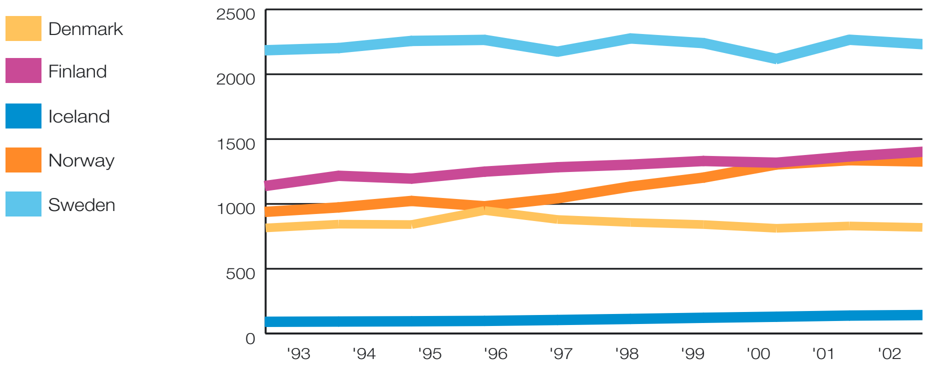
Denmark Finland Iceland Norway Sweden

S23 Total consumption 2002 – GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Generation 2002	37,260	71,938	8,404	130,591	143,361	**391,554**
Net imports 2002	-2,055	11,923		-9,673	5,358	**5,553**
Total consumption 2002	35,205	83,861	8,404	120,918	148,719	**397,107**
Generation 2001	36,009	71,229	8,028	121,872	157,712	**394,850**
Net imports 2001	-577	9,959		3,592	-7,291	**5,683**
Total consumption 2001	35,432	81,188	8,028	125,464	150,421	**400,533**

Total energy supply

S24 Total energy supply 1993-2002 – PJ



Prognosis

S25 Total consumption of electricity 2002 and prognosis for 2006 – TWh

	Denmark	Finland	Iceland [3]	Norway	Sweden
2002 [1]	35	84	8,4	121	149
2006 [2]	37	88	8,6	127	152

1) The consumption is not corrected vs. temperatures.

2) Prognosis is based on data from the Balance Group in Nordel and shows the total consumption according to normal winter conditions.

3) Prognosis based on data from the Energy prognosis committee.

S26 Maximum system load 2002/2003 and prognosis – winter 2006-2007 – MWh/h

	Denmark	Finland	Iceland [3]	Norway	Sweden
2002/2003 [1]	6,410	13,930	1,010	19,985	26,400
2006/2007 [2]	6,820	14,500	1,180	22,400	27,600

1) The consumption is not corrected vs. temperatures.

2) Prognosis is based on data from the Balance Group in Nordel and shows the maximum system load according to 2 years winter temp.

3) Prognosis based on data from the Energy prognosis committee.

S27 Prognosis for available production capacity for the market – winter 2006-2007 – MWh/h

	Denmark	Finland	Iceland [2]	Norway	Sweden
2006/2007 [1]	7,400	13,700	1,500	23,600	27,400

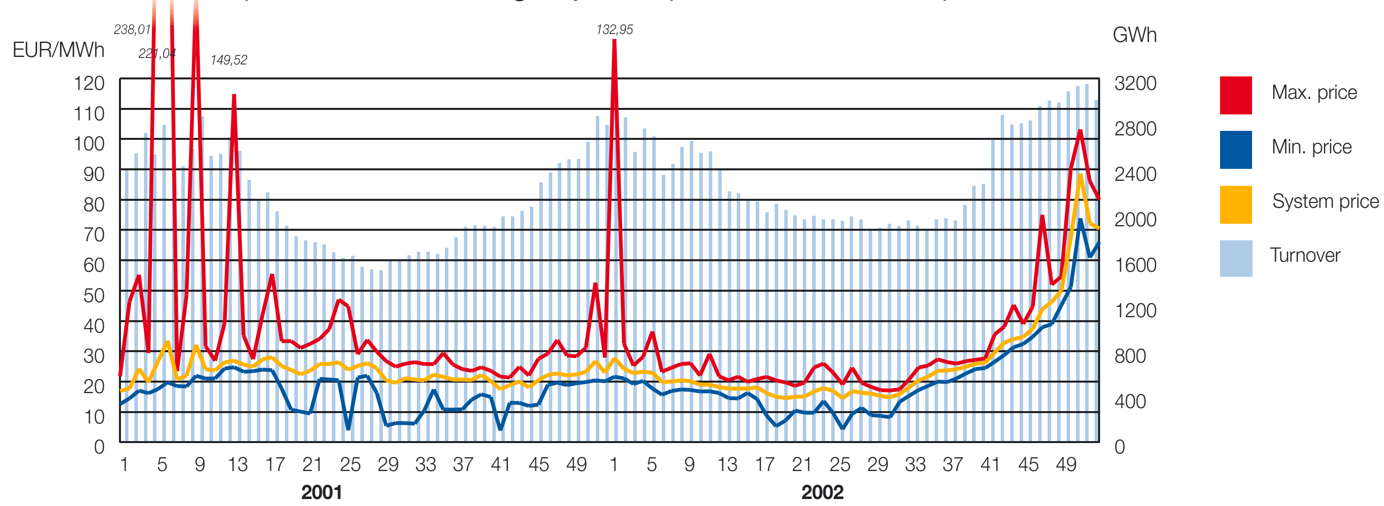
1) The Prognosis is based on data from the Balance Group in Nordel and shows the available production capacity for the market according to 2 years winter temp.

2) Prognosis based on data from the Energy prognosis committee.

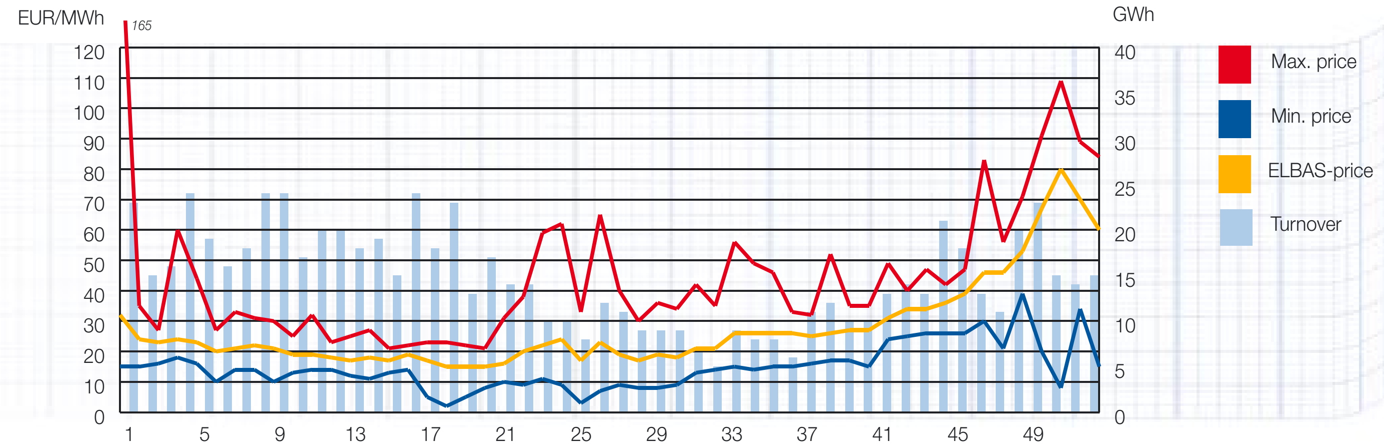
Spot prices

S28 Spot prices and turnover on the Nordic electricity exchanges 2001-2002

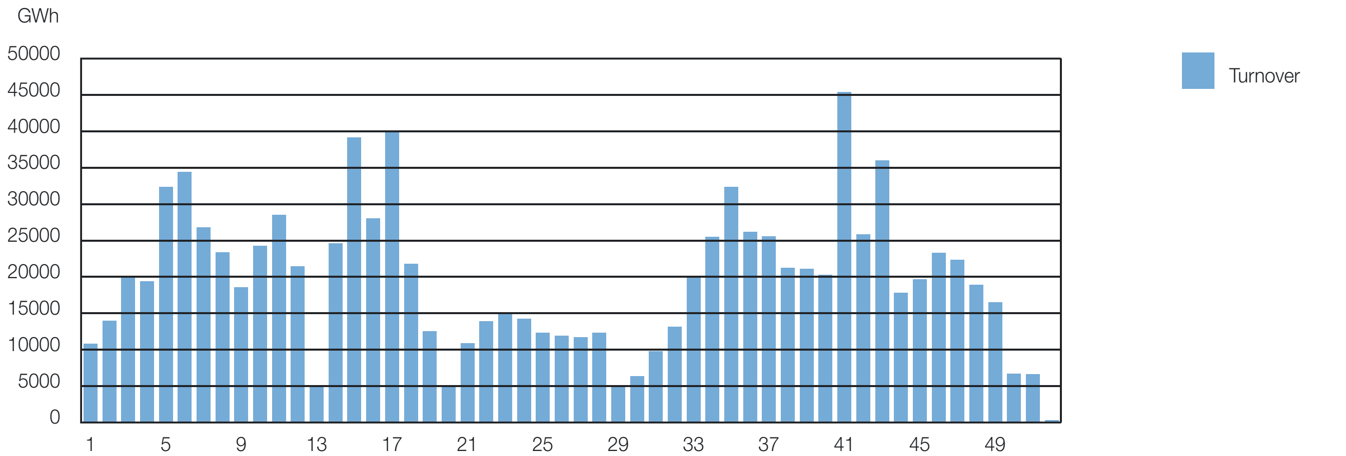
Nord Pool ASA spot market - average system price and turnover per week



ELBAS-market - turnover and prices per week 2002



The Nord Pool financial market - turnover per week 2002



Current Nordel Recommendations

- Availability Concepts for Thermal Power. *September 1977*

- Localisation of System Oscillations Equipment *August 1992*

- Network Dimensioning Criteria *October 1992*

- Common Disturbance Reserve *February 1992*

- Operational Performance Specifications for Thermal Power Units Larger Than 100 MW *August 1995*

- Operational Performance Specifications for Small Thermal Power Units *August 1995*

- Standardised Communication Procedure *August 1995*

- Recommendations for Frequency, Time Deviation, Regulating Power and Reserves. *August 1996*

- Summery of recommendation *May 1997*

- Trade with Reserves within the Nordic Countries *August 1998*

- Recommendation on definitions of energy reliability, power reliability and reliability of delivery *June 2000*

Symbols:

Nordic version

English version

Electronic versions of most recommendations are available at www.nordel.org

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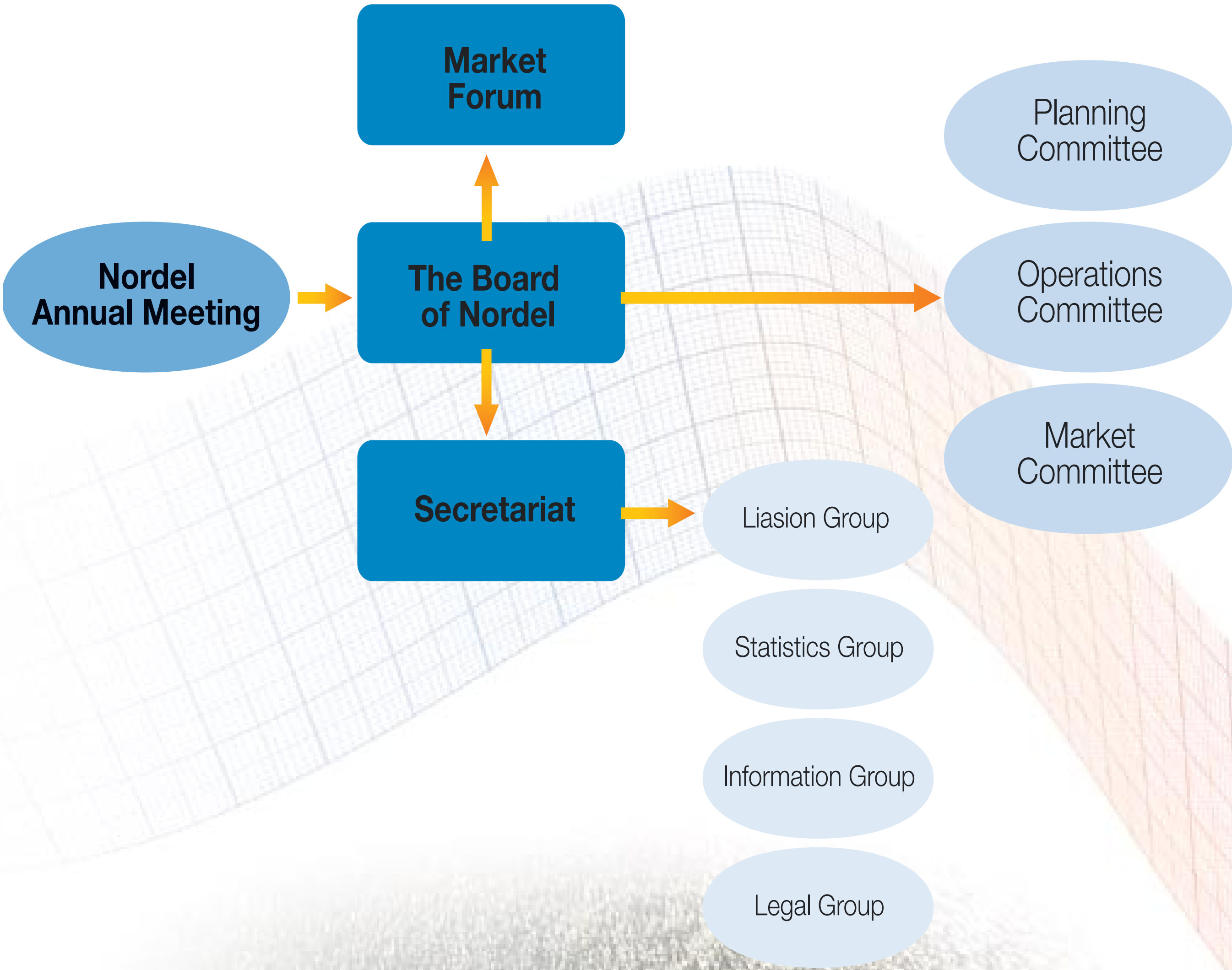
For contact information see cover.

Organisation Chart



"Færgegården" on the island of Rømø situated at the rim of the Jutland Wadden Sea (the south eastern part of the North Sea) provided the setting for the Nordel Annual Meeting 2002.

Members of Committees

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