Nordel Annual Report 2000

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Nordel

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The participants of Nordels Annual Meeting 2000 in Iceland had the opportunity of visiting the geyser Strokkur.

Photo: Haukur Snorrason.

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.

The organisation adopted new By-Laws at its Annual Meeting in June 2000, thereby formalising Nordel's changed status as an organisation for the TSOs in the Nordic countries. Under the amended By-Laws, the companies themselves are now the members of the organisation and not individual persons, as previously.

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 be able to consult with the market players. Likewise, it is important for the market players to be given the opportunity to make useful contributions and proposals to the TSOs. A Market Forum has been set up within the new Nordel organisation in order to pursue this dialogue.

Nordel's tasks fall mainly into the following categories:

- system development and rules for network dimensioning;
- system operation, operational security, reliability of supply and exchange of information;
- principles of transmission pricing and pricing of ancillary services;
- 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 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.

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 drawn from the various sectors involved in co-operation within Nordel.

Key figures 2000

		Nordel	Denmark	Finland	Iceland	Norway	Sweden
Population	mill.	**24,1**	5,3	5,1	0,3	4,5	8,9
Total consumption	TWh	**392,1**	34,9	79,1	7,7	123,8	146,6
Maximum load							
(measured 3rd Wednesday in January)	GW	**61,0**	6,0	11,8	0,9	18,5	23,8
Electricity generation	TWh	**393,8**	34,2	67,2	7,7	142,8	141,9
Breakdown of electricity generation							
Hydropower	%	**61**	0	21	83	100	55
Nuclear Power	%	**19**	.	32	.	.	39
Other thermal power	%	**18**	88	47	0	0	6
Other renewable power	%	**2**	12	0	17	0	0

. Data are nonexistent

0 Less than 0,5 %

Nordel's Activities in 2000

2000 was a highly eventful year for Nordel. At the Annual Meeting in Iceland on 30 June, a proposal to amend Nordel's By-Laws was adopted unanimously, following which Nordel became formally an organisation for the Transmission System Operators (TSOs) in Denmark, Finland, Iceland, Norway and Sweden.

Nordel's organisation has changed over time with the developments that have taken place in the electricity sector in the Nordic countries, and its By-Laws have been amended several times. After the opening up of the electricity market, the By-Laws were first changed in 1993. Further amendments followed in 1998, and the entire process culminated in the most recent amendment at the Annual Meeting in June 2000.

The driving force behind these changes has been the development of the electricity markets in the Nordic countries, with the focus on the harmonisation of a single Nordic market. These changes again generated a need for reorganisation. The opening up of the market was based on the premise that competitive activities such as the production and sale of electricity would be separated from monopolistic activities such as network operations. Regulations and roles with respect to system operator responsibility were developed and defined. There arose a greater need for co-operation between the Nordic TSOs.

The focus of the By-Law amendments passed in 1998 was on developing the organisation in a direction that would enable it to serve as a body for co-operation between the TSOs in the Nordic countries.

As a result of the development of the market from the mid-1990s onwards and the requirement for TSOs to treat all market players equally and impartially, it became difficult for the TSOs to deal with all the matters they were obliged to deal with in concert, within the Nordel organisation of the mid-1990s. Accordingly, the so-called Grid Companies' meeting was established as a forum exclusively for the TSOs. With the amendment to the By-Laws in 2000, Nordel has changed its status to an exclusively TSO organisation, and the work carried out by the Grid Companies' meeting has been brought back within the Nordel fold.

If the right conditions for developing an efficient electricity market are to be achieved, it remains important for the TSOs to be able to consult with the market players. Likewise, it is important for the market players to be allowed to make useful contributions and proposals to the TSOs. A Market Forum has been set up within the new Nordel organisation in order to pursue this dialogue.

Changes have also taken place in the international arena which are of significance for Nordel's further organisation. The EU's Internal Electricity Market (IEM) Directive was adopted in December 1996 and came into force on 19 February 1999. The European perspective has increasingly influenced the work done by Nordel.

In 2000, Nordel was heavily involved in the activities of ETSO, the Association of European Transmission System Operators. Nordel's Chairman, Odd Håkon Hoelsæter, who is President and CEO of Statnett, was also this year president of ETSO. The TSOs in Denmark, Finland, Norway and Sweden were represented on ETSO's Steering Committee. A number of persons from the Nordel countries took part in other work done by the organisation.

Although a lot of hard work was put into attempting to open up a single electricity market among ETSO's 17 member countries, it was unfortunately unsuccessful, owing to disagreement on the principles for cross-border trade and compensation for transit.

It is important that agreement be reached between the following parties if a single European electricity market is to be established: national assemblies (in order to establish harmonised laws) the European Commission, national regulators and TSOs. Solutions will have to be found to the issues involving cross-border trade, congestion management and exchange of information.

Nordel's Annual Meeting in June 2000 adopted the following recommendations for common definitions of energy reliability, power reliability and supply reliability:

- Energy reliability means the capability of the electricity system to deliver to consumers the desired amount of energy, of a defined quality.
- Power reliability means the capability of the electricity system to deliver to consumers the desired amount of power, of a defined quality.
- Supply reliability is a joint term covering both energy and power reliability.

2000 was a highly eventful year for Nordel. At the Annual Meeting in Iceland on 30 June, a proposal to amend Nordel's By-Laws was adopted unanimously. Photo: Emil Jonsson.

The Planning Committee's Activities in 2000

Objectives and responsibilities

The Planning Committee is responsible for technical matters of a long-term nature concerning the expansion of the transmission system and the exchange of information in relation to this. The Committee works basically from a Nordic perspective, albeit having regard for necessary international angles of approach. The Planning Committee is composed of the management of planning functions of 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 in ways that are consistent with environmental sustainability. When planning transmission facilities, impact assessments must integrate the need to preserve and protect the natural environment.

In order to achieve these objectives, the following main tasks have been defined:

- The drawing up of future scenarios for the expansion of the Nordic power system with a time horizon of up to 20 years. Working with these base scenarios, the Planning Committee can take the initiative to advance its objectives.
- The Planning Committee's main product will be the publication of a Nordic grid master plan. The plan will be based on alternative scenarios with a time horizon of up to 20 years, and will primarily consist of projects which impact on capacity either between the Nordic TSOs or on important corridors of the national grids.
- The continuous updating of recommendations for common grid dimensioning rules (planning criteria) for the TSOs and the Nordic main grid. The recommendations will comprise technical, financial and environmental matters.
- The preparation and updating of joint system requirements for future connections to the grid of generation, transmission and consumption facilities as well as for ancillary services required by the TSOs.
- The consolidation of the work involved in gathering, updating and applying shared grid, consumption and production data.

The Planning Committee's activities

The activities of the old Planning Committee

Prior to Nordel's Annual Meeting in 2000, the Planning Committee was composed of representatives drawn both from TSOs and electricity generating companies.

The Grid Group functioned as a permanent working group and reported its activities as in the next column.

The former Production Group was disbanded around year-end 1999/2000, although the Planning Committee choose to present a brief report of the Group's last calculations at the 2000 Annual Meeting. After the Annual Meeting, the tasks which had hitherto been the responsibility of the Production Group were assigned to the Balance Group. The work of the Balance Group is described on page 7.

In the light of the amendments to the By-Laws adopted at the 2000 Annual Meeting, the retiring Planning Committee chose not to call any further meetings of the old Planning Committee, but instead to forward to the new Planning Committee its recommendations for new projects.

The activities of the new Planning Committee

The new Planning Committee held its first official meeting in November 2000. The Committee worked relatively intensely during the start, in order to make a swift inroad into tackling the tasks entrusted to it.

The members of the Committee have concentrated their focus on the desire for stronger planning under Nordel's direction than was the case previously. This means that the Planning Committee has defined its most important task as the publication of a Nordic grid master plan. The aim is to present the plan to Nordel's Board by the end of 2001. The plan will be based on alternative future scenarios with time horizons in 2005, 2010 and 2020 respectively. The focus of the plan will be on future capacity requirements both between the TSOs but also for important domestic transfer corridors.

With the restructuring of Nordel, the Planning Committee has resumed the task of reaching an agreement between the TSOs for shared access to data and shared application and use of data. The agreement is a prerequisite for a common Nordic set of data for system analysis, among other things in connection with the Nordic grid master plan, both for the Grid Group and the Balance Group.

The Grid Group

The Grid Group has examined the consequences of large quantities of Non-controlable production in the Nordic electricity system. The analysis was found necessary because of the prospect of a rapidly growing number of wind turbines and small CHP plants in the years ahead. These new types of generation plant make demands on the regulating capacity of the system while at the same time to some extent displacing existing generation plants with good regulating capacity.

The Grid Group completed its final report, Non-controlable production in the Nordel system, in time for Nordel's 2000 Annual Meeting. The final report is available in the Nordic languages and in English. The report illustrates the technical interaction between non-dispatchable generation, other generation and the utilisation of the transmission grid. It demonstrates that, with the current rules and agreements, large quantities of non-dispatchable generation may change the distribution of the financial burden among the Nordel countries.

The continuing work done by the Grid Group on matters such as regulating capacity points to the need capacity to review the concept for regulation and reserve in Nordel. The work is being progressed in connection with the coming grid development plans and discussions with the respective countries' regulators.

In connection with discussions – between a system operator and a producer in a Nordel country – on the harmonisation of the technical criteria, which are followed by various system operators in Nordel and the rest of Europe, the Grid Group has prepared a report concerning Nordel's Recommendation 'Operational performance specifications for CHP plants'. The object of the report was to facilitate harmonisation without conflicting with the existing design base, which – in Nordel's case – is described in Nordel's (Operational performance specifications for CHP plants), Rules for dimensioning of grids and the Nordic System Operation Agreement.

The Grid Group has clarified and analysed a number of points in Nordel's operating specifications: plant size in relation to system size, voltage curve for self consumption facilities, reactive power and breaker failure. The Grid Group has also carried out an impact assessment with regard to the scope and distribution of instantaneous reserves when adapting large units to the system.

The Grid Group has re-examined the existing AC transmission capacity in the Nordel grid on the basis of the definition adopted in 1998: Transmission capacity in the Nordel system stage 2005. The definition of AC transmission capacity is complex, because the transmission capacity in a transfer corridor of the AC grid is dependent on parameters in the system of which the transfer corridor is a part. It is important to determine transmission capacity sections within and between the Nordel countries and on interconnectors with the rest of Europe in connection with power and energy balance studies.

The Grid Group has been instrumental in co-ordinating the current planning criteria dating from 1992 with a set of operating criteria which are in the process of being drawn up by the Operations Committee. The operating criteria are intended to reflect the transition to a market system without coming into conflict with the 1992 planning criteria.

The Balance Group

The Balance Group has drawn up a report to be presented at Nordel's Annual Meeting entitled Power balance for the three-year period 2001-2003). The report provides an overview of the energy and power balance for the Nordic power market. The forecasts contained in the report focus on the individual Nordel countries and the maximum transmission capacity between them.

Future electricity consumption over the entire Nordel region is expected to increase by approximately 1 % per annum until 2003. The energy forecasts are based on both average precipitation and dry years. Thermal power with maximum capacity is included in the forecasts.
Provided that the most expensive forms of generation (including oil condensing plants and gas turbines) are not used for generating energy, Nordel has a small surplus in years with average precipitation in the hydropower reservoirs. However, both Norway and Sweden still need to import even in years with average precipitation. In dry years, Nordel as a whole also needs to import electricity, much of which must be taken from imports from Nordel's neighbours, and this despite the fact that expensive production methods are being used internally within the Nordel region. In dry years, the Balance Group believes that electricity consumption can be reduced somewhat by means of high prices and information via the media.

The results of the energy forecasts show that the margins which would permit the Nordel region to handle a dry year are not very substantial. A prerequisite here will be high utilisation of capacity in the interconnections with neighbouring countries outside Nordel. The internal interconnections within Nordel will also have to be utilised to a high degree. Provided that the power market functions well as regards factors such as competition, price determination, information, availability in the production system and the grid, and imports and exports between the countries inside and outside Nordel, conditions over the next few years should enable the Nordel system to handle the energy situation without having to resort to rationing.

The power forecasts to be reported to Nordel's Annual Meeting provide an overview of the respective countries' power capacity for extremely cold winters. The consumption forecasts apply to load levels with a return time of ten years. The report takes into account the constraints within the production system and requirements for instantaneous reserves. Physical capacity on the interconnections with neighbouring countries outside Nordel has also been analysed. The forecasts are described in further detail in the report on the activities of the Operations Committee on page 8.

Fortun powerstation, Luster, Sogn and Fjordane.
Photo: Birger Areklett, Samfoto.

The Operations Committee's Activities in 2000

Objectives and tasks

Nordel's Operations Committee is responsible for technical system issues in the short-term and for the technical framework for grid operations.

The Operations Committee has intended to contribute to the best total utilisation of the inter-Nordic power system by being a body for co-operation between the Nordic transmission system operators and for the market players represented in the Nordic electricity market. In the year 2000, the Operations Committee especially focused on issues such as the further development of the efficient Nordic electricity market taking into account the neighbouring systems, technical investigations and co-ordination, compilation of recommendations, and international co-operation and exchange of information.

The by-laws accepted by Nordel in 1998 provided in 2000 a guideline for the work of the Operations Committee. The year 2000 was also characterised by a clear need to renew Nordel's by-laws, reflecting the increasing international co-operation which has been distinctive of the power business. The Operations Committee has been actively involved in the development of new objectives and duties; these efforts resulted in the new by-laws of Nordel introduced last summer and in the radical restructuring of work to be undertaken within Nordel.

The Operations Committee formerly consisted of representatives of both transmission system operators and market players. After the revision of the by-laws in the Annual Meeting, the Committee continued its work until the end of the year, and a new Operations Committee exclusively composed of system operators' representatives started its work after the turn of the year.

There have been four permanent working groups subordinated to the Operations Committee:

- Working group for power system operations (NOSY)
- Balance working group
- Working group for information technology issues (NORCON)
- Working group for developing and standardising Electronic Data Interchange (EDI), Ediel Nordic Forum

Some ad-hoc working groups have also been established to work under the Operations Committee.

Operations reporting

Consumption and power balances

Consumption of electricity in the Nordic countries during 2000 had a growing trend, with the total consumption amounting to 392 TWh. The increase is at least partly attributable to the prevailing favourable economic trend and to the high price of oil. When adjusted to the normal temperature pattern, the increase in the consumption of electricity would have been even higher. The consumption increased by approximately 3 per cent in Sweden and by more than 2 per cent in Finland. Electricity consumption within the Nordel area is expected to increase further, but the growth rate during the following three-year period is anticipated to be slightly slower than what it has been during the most recent five-year period.

The balance working group has drawn up energy balances for the next three-year period and power balances for the coming winter. A novelty introduced in the year 2000 was a study of the statistical probability of power shortage in the various parts of the Nordel system.

The three-year balances indicate that the Nordel system has but small power margins. The power balance in Sweden is so weak that measures on the consumption side may become necessary. Norway has become increasingly dependent on imports. This has led to a situation where Jutland and Zealand have gained greater importance in the maintenance of power balance in Norway and Sweden. Since Jutland and Zealand only have limited opportunities to export electricity, there is an increasing need for imports from Germany. The power balance forecast shows that Finland has fewer problems in coping with the power balance than the other countries included in the Nordel system.

The power balances describe the power capacities of the various parts of the Nordel system under an extreme load situation. It transpired that during such situations, Sweden depends on imports especially as far as the southern and central parts of the country are concerned. Power balance in Norway is gradually becoming poorer. Finland has a slightly stronger balance than the other countries because it can import electricity from Russia. The Operations Committee has identified a risk of power shortage in the Nordic system and expressed a need to make investments in power generation and to guarantee that the maintenance of reserve power capacity is made profitable.

The main challenges for the transmission business include competition, pricing, information, availability of the power generation system and transmission grid as well as imports and exports between countries within and outside Nordel.

Power exchange

Hydropower generation volumes in the year 2000 reached all-time record figures, which has naturally had an impact on the power flows. Sweden, which was a major net exporter in 1999, was a net importer in 2000 with its approximately 4.7 TWh. Denmark and Norway were net exporters in the year 2000. Finland is usually a net importer during good hydropower years. This was also the case last year, when Finland's net imports amounted to approximately 11.9 TWh. The average system price for Nord Pool's Elspot trading in 2000 was EUR 12.75 per MWh.

Production

The abundant precipitation has resulted in low prices of electricity in the market and in major local bottleneck problems on cross-border connections. Since the latter part of the year 2000 was very warm, the low prices have prevailed even after the change of the year. The substantial supply of electricity at an inexpensive price has naturally minimised power generation by conventional thermal power stations. The hydropower generation volume in Norway in the year 2000 was 142 TWh, which is as much as approximately 20 per cent more than in a year with normal rainfall. The total hydropower generation volume within the Nordel area was 241 TWh in 2000.

In the year 2000, nuclear power in Sweden generated almost 15 TWh less electricity than the previous year. This reduction was due to factors such as prolonged inspection periods, a number of restricting faults at the plants and the extreme water situation. An analysis of the conditions for the closing of Barsebäck 2 nuclear power unit was conducted, indicating that the unit cannot be closed as early as in 2001 which was the objective in the plans. One of the reasons for this is that substitute energy has not become available to the extent projected earlier.

A connection between Sweden and Poland, referred to as SwePol Link, was introduced on 2 August 2000.

Baltic Cable was recommissioned on 22 April 2000 after the repair of cable damage which had occurred in December 1999.

International co-operation

The Operations Committee has continued to participate in the activities of UCTE and to monitor deregulation within the UCTE area. A meeting with the corresponding group of UCTE (Verbundbetrieb) was held in Paris in the summer. Among the concrete results of this meeting were decisions to establish a shared ad-hoc group for HVDC issues and to make a suggestion to ETSO concerning the appointment of a task force to draw up a shared recommendation of a joint standard for information exchange between system operators and between system operators and market parties.

The Operations Committee has also continued to follow the developments within ETSO, for instance through reporting by those Committee members who are also members in any of ETSO's task forces.

Activities of the working groups

The working group for power system operations (NOSY) analyses technical grid operation issues, including those concerning system and frequency quality as well as operational reliability. This working group also prepares technical recommendations.

The working group has given reports of power flows, number of minutes with deviating frequency and operational disturbance situations. The reports indicate that frequency has been out of the permitted range especially during hour changes. Among the reasons for this, the reports name inadequate co-operation between system operators and poor preparations for converting the energy plans into power plans.

The working group suggested the revision of recommendations concerning frequency, time deviation, regulation power and reserves. These recommendations provide partial grounds for network companies' system operation agreements, but the current recommendations are more of a description of the prevailing situation. The revised recommendations give among other things greater opportunities for flexibility and utilisation of reserves. The wide area protection concept within the Nordel area was updated. The so-called operational criteria have been revised so that they complement and clarify the dimensioning criteria. The working group has also prepared a report of load limits for specific situations. Preparations for the co-ordination of HVDC connections was initiated within the task force established together with UCTE, but this co-ordination did not actually start during the year 2000.

The balance working group is responsible for the drawing up of Nordel's power balance forecasts, both short-term (for the winter period) and long-term (three-year and five-year balances). This working group was subordinated to the Planning Committee in the autumn of 2000.

Ediel Nordic Forum works with the development and extended use of the Ediel standard and supports Ediel users. This working group was subordinated to the new Marketing Committee in the autumn of 2000.

Norcon is a contact group for information technology issues. This working group follows projects carried out within operational control systems and balance calculation and settlement systems and makes suggestions concerning technical options.

The ad-hoc working group for grid statistics aims to improve the rules for grid disturbance statistics compiled within Nordel. The final report of this working group is to be expected in the early part of 2001. Contact group STÖRST handles Nordel's grid disturbance statistics annually.

Ad-hoc working group NOIS was established last year to create a shared Intranet system for the Nordic system operators. The working group has studied the existing data communications interfaces and estimated the costs of the necessary improvements. The plans are based on the Electronic Highway, which is the main channel of data communication within ETSO, being also chosen as the main channel of communication between the Nordic system operators. In this way, there would be an identical system throughout the ETSO-Nordel area. Additional information on this working group and its work can be found at **http://system.fingrid.fi/nois**

The engineers on duty are responsible for the operation of the power system. Here a situation at Fingrids Control Center. Photo: Juhani Eskelinen.

The Transmission Pricing Committee´s Activities in 2000

Objective and tasks

The Transmission Pricing Committee has been responsible for issues related to tariffs and conditions for using the transmission networks of the Nordic system. The objectives of the committee have been as follows:

- to contribute towards further developing the prerequisites for an efficient Nordic power market
- to act as the Nordic reference group for European tariff collaboration within ETSO, and to participate in other international collaboration agencies
- to initiate surveys regarding the development of network tariffs and other conditions on the Nordic market, and to draw up information on current network tariffs and other conditions.
- to act as a discussion and collaboration forum between the market players and the system operators

The committee has been composed of representatives of system operators and regional network companies, as well as market players.

Harmonisation of Nordic tariffs

Each of the Nordic grid operators has developed its grid tariffs based upon national circumstances. With a common and open Nordic power market, it is a matter of urgency to evaluate the pricing of grid utilization in a Nordic perspective.

Following a proposal by the Transmission Pricing Committee, the Nordic grid operators reached a decision in the spring of 2000 in respect of principles for achieving the harmonisation of Nordic grid tariffs. The purpose of tariff harmonisation is to create as level a playing field as possible for the electricity market players of the Nordic area, who are exposed to competition. Other requirements for tariffs include being correct cost-wise, simple to understand and objectively formulated.

The main structure of tariffs

In accordance with the grid operators' decision, the new tariffs are to be introduced into the individual countries by 2002 at the latest. Briefly, harmonisation entails the Nordic tariffs being formulated with the following main structure (two elements):

- a tariff element with a governing influence (loss fee)
- a tariff element covering the remaining revenue requirement

The tariff element with the governing influence is formulated as a flexible entry fee based on the marginal loss principle at grid points. The fee must reflect the costs of the marginal losses, and is calculated with regard to the entire Nordic system. The market price should form the basis for calculating the fee. The fee is formulated as an energy fee.

The tariff element covering remaining revenue requirements varies greatly today within the Nordic area. The harmonisation now being proposed is that the average fee for input into the network, excluding the loss fee, will be within the range 0.5 ± SEK0.003/kWh throughout the Nordic area. The remaining revenue requirement should be allocated to the customers least influenced by the tariff, i.e. in most cases consumption.

The overall entry fee, including the loss fee, will vary between different points or areas of the network due to the variation of the flexible fee.

Managing bottlenecks

As regards the management of bottlenecks, it is pointed out that occasional bottlenecks are resolved using counter-trading while permanent and major, prolonged bottlenecks are managed using fixed systematic pricing areas, or by augmenting the network. Internal bottlenecks within a area should not be moved to area borders, instead being counter-traded.

Principles for tariff setting towards a third country without reciprocity

The national grid tariffs should not be debited in respect of costs for interconnectors towards a third country without reciprocity. However, interconnectors towards a third country are debited in respect of the national grid tariff and, whenever necessary, in respect of installation subsidies.

Other activities

Besides the work of harmonising tariffs, the Transmission Pricing Committee has worked with transit issues, via separate workgroups, as well as the apportionment of bottleneck revenues between the grid operators of the Nordic area.

The transit group has been working with methods of calculating transits through a country. During the autumn, the bottleneck group has been working with models for apportioning bottleneck fees between the grid operators, from 2001 and on. Based upon the proposal by the group, agreement has been reached between the grid operators in respect of the apportionment of these fees for 2001 and 2002.

Representatives of the Transmission Pricing Committee have informed both the European Commission and the European regulatory authorities about the Nordic grid operators' decision concerning tariff harmonisation at their meeting in Florence.

Future work on Nordic market issues

As a part of the work of creating an expedient organisation for collaboration in Nordel, the Board decided, during the autumn of 2000, to set up a special committee for market issues. At the same time, the activities of the Transmission Pricing Committee ceased (see "Nordel's activities" page 5).

The Market Committee's objectives are:

- to contribute towards creating a borderless Nordic market for the market players in order to thereby augment the efficiency and modus operandi of the market,
- to contribute towards the rules of play in Europe being formulated in a way which promotes a positive market trend and an efficient interaction with the Nordic market.

It is a central task for the Market Committee to continue working with tariff and transit issues, as well as issues relating to the management of bottlenecks. The committee will also work towards common rules for power settlement and trading in certificates for renewable energy.

Developments in 2000

The electricity market

The single Nordic electricity market was expanded on 1 October 2000 with the integration of Eastern Denmark in the spot market of Nord Pool (the Nordic Power Exchange). This market the completion of the integration process for the electricity market in the four countries of Denmark, Finland, Norway and Sweden.

According to a statement issued by the Energy Ministers of the Nordic countries after their meeting in Greenland in August 2000, the development of the Nordic electricity market was proceeding according to the principles that had been drawn up. Important areas where the ministers saw a need for further developing existing co-operation include the following: the removal of border tariffs, the expansion of ownership in Nord Pool to include the Finnish and Danish transmission system operators (TSOs), the European Commission's draft directive on renewable energy, transmission tariffs as a basis for effectively utilizing the transmission capacity of the electricity grid, and the development of co-operation between the Nordic TSOs in order to ensure the efficient management of potential power problems and the rational utilisation of reserve capacity.

The Energy Ministers' statement is regarded as providing solid support for the work done by Nordel to pave the way for an efficient electricity market in the Nordic countries.

The year 2000 was marked by exceptionally high rainfall and the consequent production of huge amounts of hydro-electric power in Norway and Sweden. The extreme situation created by the water masses gave rise to a pressing need to transmit power from the hydropower system in the north and west of the Nordic system to the thermal power-dominated system in the south and east. The situation also focused attention on the increasing problem of bottlenecks in the electricity system and how best to manage them. This problem is referred to in a separate feature article in this report.

Photo: Tor Oddvar Hansen.

In the financial market, Nord Pool introduced from November a system of contracts enabling players to hedge the difference between the system price and the area prices referring back to a number of key nodes in the network. The introduction of this product has made it easier for market players to manage the risk associated with area prices.

The restructuring of the industry continued throughout 2000. There were more mergers and acquisitions in production, network operations, sales and distribution. Strategic alliances were established. In addition to continuing high activity in the Nordic countries, Vattenfall in particular expanded in both Germany and Poland. At the same time, the German company E.ON made an offer for Sydkraft's entire business.

Prices in the electricity market remained consistently low throughout 2000.

The economies of the Nordic countries

The economies of the Nordic countries continued to grow throughout 2000 and this trend is expected to remain stable in 2001. Forecasts suggest the same level of growth as in the other OECD countries.

The Danish economy remains stable, despite somewhat higher rises in wages and prices than in other countries. Wages rose by 4.1 % and prices by 2.8 % in 2000, compared with rises of 2.6 % and 2.4 % respectively in the euro zone as a whole. However, there is still a surplus on the balance of payments' current account as well as in the public-sector finances. Domestic demand was checked through a slowdown in private consumption and a modest rise in public spending, although business investments, and not least extraordinary investments in housing repairs following the severe storms of December 1999, also drove up domestic demand. At the same time, favourable economic conditions abroad served to boost continuing advances in exports, although they were overshadowed by a slightly higher increase in imports. The growth in GDP is estimated at 2.4 %. Without the extraordinary effect of housing repair investments, it is estimated that growth would have been about 1.8 %, or almost unchanged compared with 1999. Unemployment fell marginally in 2000 to 150,000, or 5.3 % of the entire workforce. With a rise in exports and imports of the same proportion, the balance of payments' total current account showed a surplus of DKK 29 billion, while the surplus in the public-sector budgets remained unchanged at DKK 34 billion.

Finland has experienced a relatively favourable economic development ever since 1993. The most recent calculations show that the increase in GDP for 1999 has been adjusted upward, to 4.2 %. Forecasts suggest that GDP will rise by 5.7 % for 2000 and by 4.5 % for 2001. The electrical sector remains the most powerful motor for growth. Inflation for 2000 will rise to approximately 3.4 %, largely because of the high price of oil, but is forecast to fall again to about 2 % in 2001. Unemployment continues high in relation to the favourable economic conditions. Average unemployment in 2000 stood at almost 10 %, and is expected to fall by less than 1 % in 2001.

Iceland's economic recovery continued, with GDP rising by 4 % during the course of 2000. This is a slightly lower rate of growth than in the previous year. There was no change in the real value of the country's most important export sector, fisheries products. Growth in other export industries stood at 10.4 %, with general growth in exports of industrial products. Unemployment was further reduced and averaged 1.3 % during the year. Inflation was 5.1 %, compared with 3.4 % the year before.

2000 was a year of consolidation for the Norwegian economy. Growth in manufacturing and employment was very moderate. Costs continued to rise, but at a more moderate pace than in previous years, although unemployment was low and there were considerable skills shortages in parts of the labour market. The picture of the Norwegian economy that emerges on the threshold of 2001 must be characterised as unusually favourable. Now that the boom in the mainland economy appears to be largely over, the economy will grow somewhat faster again. Despite slightly lower oil prices and a weaker US dollar, the external sector of the economy is expected to show a very large surplus. The surplus on the balance of trade in 2000 was NOK 196 billion. This was NOK 150 billion up on 1999, and the highest surplus ever recorded. The increase in GDP was 1.8 %, against 0.8 % in 1999. Inflation stood at 3.1 %, compared with 2.3 % in 1999. The rise in wages was 4.3 % calculated per standard work-year, which was 1 % under 1999 and 2 % under 1998. Unemployment stood at 3.4 %, compared with 3.2 % in 1999.

Although the Swedish economy is continuing to grow rapidly, it has now started to level off. During the year, GDP rose by 3.8 % compared with the previous year. Much of this rise is attributable to increasing household consumption, a rise in gross investments and continuing strong foreign trade. Industrial production rose by 4.6 %. In the goods manufacturing sector, production rose by 5.4 %. The biggest rise in production was in traditional industries such as wood pulp and chemicals, and the manufacture of telecom products. Exports of goods and services, as well as imports, climbed steeply during the year, by 9.8 % and 10.1 % respectively. Inflation stood at 1.3 % in 2000. The continuing strong level of demand in the Swedish economy during the year caused employment to go on rising. The total number of people employed in Sweden increased by 2.0 % on the previous year, causing visible unemployment to fall from 5.6 % to 4.0 %.

Electricity consumption and electricity generation

Electricity consumption (excluding supplies to electric boilers) in the five Nordel countries totalled 384 TWh in 2000, which is an increase of 1.9 % compared with 1999. The increase was 0.6 % in Denmark, 1.7 % in Finland, 6.3 % in Iceland, 1.3 % in Norway and 2.0 % in Sweden.

Total electricity generation in the Nordel countries was 394 TWh in 2000, an increase of 10 TWh or 2.6 % on 1999.

- Hydropower was by far the largest production source with 241 TWh, which is an increase of 30 TWh on 1999 and represents 61.1 % of overall production.

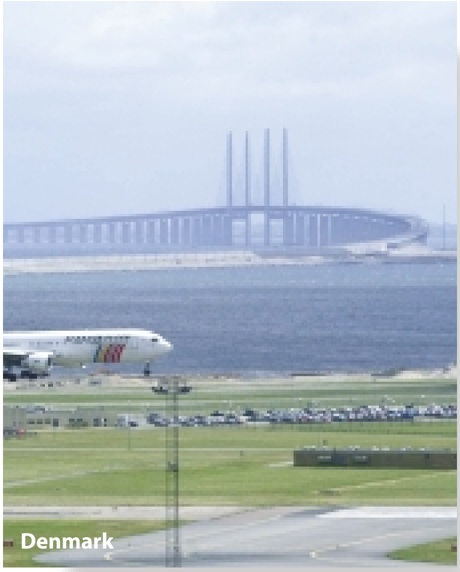
- Nuclear power was the second largest production source, with an annual output of 76 TWh. Nuclear power's share of total production was reduced by 16 TWh on the previous year, ending at 19.4 % in 2000 compared with 24 % in 1999. As in previous years, the average efficiency in the nuclear power units, from an international perspective, was excellent.

- Other thermal power had an output of 71 TWh and accounted for 17.9 % of total production. This was a reduction of 2.1 % on 1999.

- All other energy, e.g. wind power and geothermal power, totalled 6 TWh, an increase of 1.4 TWh on 1999 and accounting for 1.6 % of total energy generation in 2000.

Power trading between the five Nordel countries totalled 36 TWh, against 27 TWh the year before. Added to this is trade with Germany, Russia and Poland of 12 TWh, which was the same as in 1999. During the year, Norway was the largest net exporter of power (19 TWh), while Finland was the largest net importer (12 TWh).

Kilingar, Landmannaleid. Photo: Haukur Snorrason.


Denmark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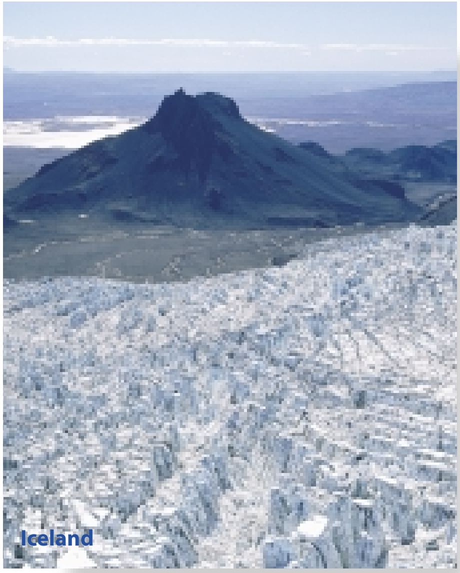

Iceland

With Eastern Denmark's entry into Nord Pool, all Nordic countries have now joined a common market, and in 2000 cooperation between the countries was further strengthened with the opening of the Øresund Fixed Link.
Photo: René Strandbygaard/Polfoto.

Energy Policy

The Danish power supply system has been drastically restructured during 2000. A new Electricity Supply Act took effect at the beginning of the year, and in the following months specific provisions for company structure and regulation were prepared for the distribution and transmission area. The new Act defines a clear division between monopoly (system operation, transmission and grid) and competition (production and electricity trade). There are special requirements of consumer influence on the entire monopolistic field, and there is public representation on the boards of the transmission system operators (TSOs). The need to elaborate and concretise the obligations and rights of the TSOs arose concurrently with the elaboration of the new structure. This was effected in the form of an amendment, of the Act, which was passed by a large majority in the Folketing (the Danish Parliament) on 15 December 2000. On the basis of the amendment, "Regulations for System Operation" is in preparation.

Environmentally friendly power generation has a special status – when it comes to economy and grid access. According to the Electricity Supply Act, all Danish consumers must buy a pro rata share of "prioritised production" at a politically fixed price. The major part of wind power (80 per cent) is generated in Western Denmark that represents 60 per cent of the total Danish electricity consumption. In 2000, the Folketing decided that renewable energy production must be harmonised between Western and Eastern Denmark.

The physical and economic harmonisation took effect from 1 January 2001, but it will have full effect as from 2002.

A special act on energy savings was also passed in 2000. It is the intention to determine saving objectives within each individual sector and to appoint local energy-saving committees with activities covering one or several municipalities. The electricity supply companies have been chosen to play an important part in the energy-saving scheme. One of their tasks will be responsibility for the financing.

The European Commission approved the Danish Act on CO_2 Quotas for Electricity Production in the middle of the year. The Act could therefore take effect from 1 January 2001. A total quota of 22 million tons has been laid down, which is to be reduced to 21 million tons in 2002 and to 20 million tons in 2003.

The Power Market

On 1 April 2000, the threshold to the Danish electricity market was lowered to an annual consumption of 10 GWh. The limit was reduced to 1 GWh on 1 January 2001, and it will be completely removed on 1 January 2003.

Since July 1999, Western Denmark has been an integral part of the common Nordic power market. On 1 October 2000, Eastern Denmark also joined Nord Pool as an elspot area. The price formation on the East Danish market is closely connected to the Swedish price area and the power situation in Southern Sweden. The trading capacity on the Øresund Link has a decisive effect on the East Danish elspot price. In 2000, Elkraft System had several discussions with Svenska Kraftnät (the Swedish TSO) regarding initiatives to ensure sufficient transmission capacity.

From the beginning, the West Danish market developed dynamically with good price stability. During a few months day-ahead trade via Nord Pool made up some 30 per cent of the total West Danish power consumption. In the beginning of 2000, local price rises occurred unexpectedly, although there was available capacity on the international interconnections. Eltra informed the Danish Energy

New 150 kV connections are mainly laid underground. This also applies to a 30 km section across Djursland (Mesballe-Grenå). The cable was put into operation at the end of 2000. Photo: Jørgen Schytte.

Regulatory Authority about its observations and required that the "use-it-or-lose-it" principle was to be applied on international interconnections. The Folketing followed up immediately with legislation on the field. The wording of the act was later included in the amendment regarding system operation, which was approved around Christmas-time.

However, Eltra considered it most important that the market players would have free access to the capacity of all international interconnections. After negotiations with Statkraft, Elsam, E.ON Netz (previously PreussenElektra) and Statnett, consensus was reached in July on the conditions for replacing old exchange and transit agreements on the Skagerrak Interconnection with financial agreements. Statnett and Eltra later entered into an operation and maintenance agreement. The total agreement package took effect on 1 January 2001 after approval by the Norwegian Storting. At the same time, Eltra negotiated with E.ON Netz on flexible capacity handling across the Danish-German border. A Danish proposal to establish a Nord Pool elspot area on the border had to be abandoned. Instead it was agreed to supplement monthly capacity auctions with daily auctions of surplus capacity to the market players. The new scheme was introduced in late September. In practice, it has turned out to be very effective, especially after cancellation of an old transit reservation of 400 MW from Denmark to Germany in consequence of the agreed adjustment of the Skagerrak Interconnection.

When Western Denmark became a part of the Nordic power market in 1999, Sweden wanted to maintain the existing border tariff on trade with Denmark until further notice. In spring 2000, Elkraft System and Eltra prepared a common statement on Danish-Swedish power exchange. As a consequence, Svenska Kraftnät decided to halve the Swedish border tariff from 1 October 2000 and to recommend the Swedish government to remove the border tariff completely from 1 January 2001. But this did not happen.

Denmark has always been electrically divided by the Great Belt. Eastern Denmark is physically connected to the Nordic power system, whereas Western Denmark is a part of the Western continental system. Establishment of an electrical connection between the two parts of the country has often been discussed.

At the beginning of the year, Eltra and Elkraft System presented a consultative report, which recommended not to make any decisions on a cable project until the requirements of the market have been investigated further.

Electricity Consumption

The electricity consumption in Denmark including grid losses was 34.9 TWh – which is an uncorrected increase of approx. 0.1 per cent. Broken down by the different consumer groups – households, industry, and trade/-service/public institutions – each group accounted for 30 per cent of the electricity consumption. Agriculture and transport bought the rest.

Electricity Production

As from 1 January 2000, the large Danish power stations and power companies merged into two production companies. In Western Denmark, the power stations of Nordjyllandsværket, Midtkraft, Skærbækværket, Sønderjyllands Højspændingsværk, Vestkraft and Fynsværket merged into Elsam A/S. The company has a total capacity of approx. 3,000 MW.

In Eastern Denmark, SK Power Company, Københavns Energi Produktion A/S and EK Energi Power Company merged into one production company called ENERGI E2. The company has a total capacity of some 4,100 MW. Furthermore, a 600 MW natural gas and biomass-fired CHP unit is being constructed at Avedøre Power Station within the metropolitan area.

As an element of the political agreement regarding the electricity reform it was decided that the two newly established production companies must guarantee a necessary minimum capacity in Denmark for a transitional period of four years.

The total electricity production was 34.2 TWh – a decrease of 2.6 TWh. Net import was approx. 0.6 TWh.
The electricity production was distributed on:

21.4 TWh (primary power stations)
8.6 TWh (small-scale CHP plants)
4.2 TWh (wind power)

The production side was affected by the closing down of old coal-fired facilities. In Western Denmark, it affected plants with a total capacity of 1,200 MW. At the same time, a 305 MW coal-fired unit was "preserved".

Maintenance of future offshore wind farms in the rough North Sea presents a special challenge. In consideration of time and safety, it has been decided to let help be airborne. In 2000, successful tests were carried out when service personnel were lowered from a helicopter onto a 2 MW wind turbine in Tjæreborg. Photo: Jørgen Schytte.

In Western Denmark, there was an increase of 486 wind turbines with a total installed capacity of 470 MW. This means that there are 4,950 wind turbines with a total capacity of 1,853 MW in Western Denmark. The number of small-scale CHP plants increased by some 40 MW to a total of 1,440 MW.

By the turn of the year 2000/2001, the authorities had approved the offshore wind farm project at Horns Rev in the North Sea (40 km west of Esbjerg). The offshore wind farm to be built by Elsam will include 80 wind turbines with a total installed capacity of 160 MW.

Elsam has decided to rebuild the small-scale CHP plant (90 MW electricity) in Herning for wood-chips burning. At the same time, Elsam wants to use combined straw and coal firing at several of its large power stations.

Eastern Denmark has seen a moderate expansion of small-scale CHP plants and substantial wind power expansion. In the year under review, the first wind power plants were commissioned at the new offshore Middelgrunden wind farm close to Copenhagen.

The Transmission Grid

At the moment, a new 400 kV transmission line (approx. 32 km) is under construction between Vejen and Endrup (Esbjerg) in Western Jutland. The line is expected to be in operation in October 2001. After 10-11 years of consideration by the local authorities, it is expected that the 400 kV transmission line between Aalborg and Århus (112 km) will be approved in early 2001. The line will be approved on condition that there will be underground cabling in the Mariager Fjord and Gudenåen and also in urban areas in Aalborg. The project also includes an extensive grid renovation within the Aalborg area. The new transmission line will remove substantial bottleneck problems in Western Denmark and is expected to be in operation in 2004. In November 2000, a new 150 kV underground cable in Djursland (some 30 km between Mesballe-Grenå) was put into operation.

In Eastern Denmark, the Metropolitan Project, which was approved in 1993, has now been completed. It consists of two 400 kV cable links connecting the 400 kV overhead grid with the capital. The cables run from: 1) a 400 kV substation in Ishøj to H.C. Ørsted Power Station via Avedøre Power Station and from 2) a 400 kV connection point at Måløv to a new 400 kV substation at the existing Glentegård substation in Gladsaxe. A new substation at Kastrup, forming part of the 132 kV grid in Copenhagen, has been commissioned. The substation is connected to the 132/30 kV substation at Amager Power Station and to Amager substation via two new 132 kV cables.

The considerable wind turbine expansion on the island of Lolland has resulted in an enforced transmission grid within the area, as a 132 kV cable between Radsted substation near Sakskøbing and Rødby substation was commissioned in 1999.

Unit 2 at Avedøre Power Station, which is under construction, will be connected to the 400 kV substation at Avedøre Power Station where a 400 kV cable is connected to H.C. Ørsted Power Station, and a 400 kV cable is connected to the 400 kV Ishøj substation. Furthermore, a 400/132 kV transformer is being installed at the 400 kV substation at Avedøre Power Station linking the 400 kV substation and the 132 kV substation at Avedøre Power Station. This will improve the grid connection for Avedøre Power Station's units 1 and 2.

Electricity Prices

In early 2001, the average electricity price for private consumers (annual consumption 4,000 kWh) was 58 øre/kWh. Government taxes of 64 øre/kWh and 25 per cent VAT must be added, i.e. a total of 152 øre/kWh.

At a consumption of 15,000 kWh (typically households with electric heating) the average price is 49 øre/kWh. With government taxes of 59 øre/kWh plus 25 per cent VAT, the total is 135 øre/kWh.

Since 1965, the life of 350 portal towers, which have carried 400 kV transmission lines along the Jutland ridge (from Tjele to Vejen), has been extended. All towers have been taken down one by one, dismantled and cleaned in order to undergo a regenerating galvanisation. Photo: Jørgen Schytte.

Industrial design of transmission towers on the Länsisalmi-Kymi line, design by Professor Antti Nurmesniemi. Photo: Juha Sarkkinen.

Energy policy

In accordance with the Kyoto Protocol and the EU's principles for the division of environmental burden, Finland intends to reduce its greenhouse gas emissions to the level which prevailed in 1990. One of the objectives of the Government of Finland is to secure stable economic development in which Finland provides a competitive environment for domestic and international investments. A ministerial working group is supervising the investigations conducted by the Ministry of Trade and Industry. The projected energy policy measures include higher level of energy taxation, energy conservation and the promoted use of renewable energy sources. Replacing coal-based power and heat generation with the use of natural gas or expanded nuclear power units has also been assessed. The suggestion of the ministerial working group is to be expected at the beginning of 2001 after which the matter will be handled by the Government with the objective of submitting a report to Parliament.

There have also been investigations concerning increasingly flexible mechanisms through which the climatic objectives could be attained. A report on this issue states that national emission trading is not an optimum solution for this. Instead, Finland should endeavour to be involved in international emission trading. Uncertainties concerning international climatic negotiations mean that preparations are made for future solutions such as test programmes for JI (Joint Implementation) och CDM (Clean Development Mechanism). The absence of flexible application mechanisms and rules on how to adapt the climatic strategy to national and international market conditions are additional elements of uncertainty for industry.

In December, the Finnish Government accepted an application by Posiva Oy concerning the final repository of spent nuclear fuel in Olkiluoto adjacent to the existing nuclear power plant owned by Teollisuuden Voima Oy. The Government decision requires acceptance by Parliament.

In November, Teollisuuden Voima Oy submitted an application concerning the building of a new nuclear power unit. The new unit with a power of 1,000 to 1,600 MW would be located in Olkiluoto or Loviisa, where the existing nuclear power plants are situated. The objective of the new nuclear power unit is to guarantee a stable price of electricity in the future, to reduce carbon dioxide emissions and to reduce Finland's dependence on imported electricity.

Environment and research

A number of environmental directives were being prepared during the year 2000. During French chairmanship in the EU, consensus was reached on the application of the Large Combustion Plants (LCP) directive and the National Emission Ceilings (NEC) directive. The Waste Incineration Directive (WID) was accepted after negotiations and published in December. A compromise was also reached concerning the Water Framework Directive (WFD).

A new environmental protection act became effective in Finland on 1 March 2000. This act enforces the IPPC directive on the joint control of emissions within the EU. The authority to grant environmental permits in Finland also changed. Since matters relating to the contamination of waterways were subjected to the environmental protection act, a need for a comprehensive revision of water legislation emerged. A committee was appointed to serve from March 2000 to June 2002 to prepare the new act. Another important change in Finnish environmental legislation was the new land use and building act where the primary changes to the former legislation concern zoning. This act entered into force on 1 January 2000.

The Finnish Energy Industries' Federation Finergy co-ordinates research co-operation within two five-year projects: the Environmental Pool and the Development Pool for Power Technology. These pools initiate, finance and co-ordinate environmental and power technology research which benefits the entire Finnish power industry. The year 2000 was the second year of operation for the two pools.

In the year 2000, the Environmental Pool focused on solutions for the climate change, utilisation of by-products created in power generation processes, health impacts, investigation into the consequences of amended environmental legislation as well as the ecological impacts of energy generation and transmission. The Environmental Pool financed a total of 17 projects, granting approximately FIM 1.9 million (EUR 320,000 million) for research purposes.

Research projects undertaken by the Development Pool for Power Technology included intensified network planning, building, operation and maintenance, commercial and technical risks and quality issues, environmental issues pertaining to power transmission, distribution and operation, synergies within network operations, business processes as well as new concepts such as Internet technology and data communications. The Development Pool for Power Technology funded a total of 8 projects assigning approximately FIM 1.2 million (EUR 202,000 million) for them. The projects have been co-funded by other organisations and through public funds, which is why the total volume of the projects is many times higher than this figure.

In addition to the above research efforts, Finergy, together with the Finnish Electricity Association initiated a study into the costs of different methods of heating detached houses. The results indicate that apart from district heating, electric heating is the most inexpensive method of heating for new detached houses in Finland.

Together with the other Nordic energy organisations, Finergy has launched a project to promote inter-Nordic research co-operation. These organisations had a preliminary investigation, Nordic R&D Cooperation, made in order to identify the opportunities and challenges of commencing shared research work. This co-operation will be further expanded in 2001.

Electricity consumption

In the year 2000, a total of 79.1 TWh of electricity was used in Finland. This was 1.7 % or 1.3 TWh more than in 1999. The calendar and temperature adjusted growth rate was 2.8 %.

Industrial consumption of electricity grew by 2.7 % to 43.2 TWh. Industries accounted for almost 55 % of all electricity consumption in Finland.

Households and agriculture used some 24 % of all electricity and the service and public sectors a total of more than 17 %. The transmission and distribution losses were less than 4 %. Use of electricity by households decreased by 2 % because of the warm latter part of last year. Consumption by the other user groups increased by almost 3 %.

Electric heating, which is included in all user groups, constituted less than 10 % of the total use of electricity. Approximately 13,000 homes were connected to electric heating. At the turn of the year, a total of about 593,000 homes, providing accommodation for approximately 1.6 million Finnish people, were heated with electricity.

Electricity production

27.3 % of all electricity was generated through nuclear power, 18.2 % through hydropower, 31.1 % through industrial and municipal combined heat and power generation, 8.3 % through separate electricity generation and 0.1 % through wind power. Domestic power generation grew by 0.8 % from the previous year and accounted for 85 % of consumption.

Net imports of electricity rose by 6.8 % and covered 15 % of electricity consumption in 2000. The all-time high figure in net imports, 11.9 TWh, was recorded last year. Imports from Sweden grew by 25 % while imports from Russia decreased by 13 %.

The water situation in the year 2000 was better than normal, with hydropower generation consequently rising by almost 15 %. Wind power generation grew by 60 % as the new capacity built in 1999 began to generate electricity at full rate.

Nuclear power generation decreased by approximately 2 % from the record figure reached in 1999. The slight decrease was attributable to a modernisation and intensification project at the Loviisa Nuclear Power Plant. The annual overhaul carried out at Loviisa in 2000 was very extensive, and the capacity of the plant could be boosted by approximately 4 MW in conjunction with the overhaul. In other respects, the operating rates of nuclear power plants remained very high.

Combined heat and power (CHP) production decreased by just under 1 % from 1999. Combined heat and power production by industries decreased while that by municipal power plants increased. In municipal CHP production, natural gas increased its proportion among the fuels used by 2 % and the proportion of coal decreased correspondingly. The use of wood fuels increased while the use of peat decreased. The year 2000 was approximately 2 degrees warmer than average, and the last months of the year were especially warmer than normal.

Electricity generation through condensing power decreased by some 9 % from the previous year as a result of increased electricity imports and hydropower generation.

Electricity prices

The total price of electricity, including electric energy, transmission and tax, decreased by an average of 1.1 % in 2000. At the beginning of 2001, the average price of household electricity was 50.0 Finnish pennies per kWh. This means a decrease of 0.7 % in a year. The total price of electricity, including electric energy, transmission and tax, for medium-sized industry was 30.2 pennies per kWh at the beginning of this year. This price has reduced 0.4 pennies per kWh, i.e. some 1.2 %, over the past year.

Electricity transmission charges levied by owners of distribution networks decreased by an average of 0.1 %. List prices of electric energy which is subject to competition decreased during the year 2000 by an average of 2.3 %. There were no changes in the taxation of electricity in 2000.

The price of electricity has been decreasing since the autumn of 1998, when real competition also extended to cover customers with small-scale consumption. The decrease in the price of electricity since that time has given a typical household user of electricity average savings of approximately FIM 150 to 170 (EUR 25 to 28) per year and approximately FIM 500 to 550 (EUR 84 to 92) to those using electricity for heating even if the consumer had not subjected electricity procurement to competition. Since the autumn of 1998, customers of distribution network companies have already saved almost FIM 2 billion (EUR 336 million) in more inexpensive prices of electricity.

Electricity market

At the beginning of 2001, there were approximately 100 electricity distribution companies in Finland while the figure was 105 a year before. When the Electricity Market Act came into force in 1995, there were 117 distribution network companies, and 141 in 1990. Changes in the ownership and structures of energy companies continued in the year 2000. One of the foremost changes was the acquisition of Keski-Suomen Valo Oy and Hämeenlinnan Energia Oy by Vattenfall Oy.

The foremost transaction within power generation was the sales of Stora Enso Oyj's ownership in hydropower and nuclear power units in Sweden and Finland to Fortum Oyj.

The Supreme Administrative Court confirmed a decision by the Energy Market Authority concerning the reasonableness of electricity transmission pricing (Megavoima Oy). This precedent specifies the framework for the supervision of the reasonableness of electricity transmission pricing which concerns hundreds of network companies.

The good hydropower situation in 2000 led to considerable electricity transmissions throughout the year. As a result of exceptionally high transmission volumes, the Nordic power system was split into price areas, which had an impact on the price of electricity in Finland. These price areas were created partly because of shortage of transmission capacity between Sweden and Norway and partly because of insufficient transmission capacity between Sweden and Finland. Fingrid, the Finnish grid operator, has aimed to plan outages having an impact on transmission capacity so that the outages have no effect on the electricity market.

Price differences between Nord Pool's system price and the area price in Finland caused much criticism towards the main grid operator, and the reasonableness of system price as reference price was questioned. Trading based on the area price increased in the market.

The favourable cost trend in Fingrid's grid operations enabled a reduction of 5 % in the grid tariffs at the beginning of 2000. The same cost level can also be retained during 2001. Moreover, Fingrid refunded its customers almost FIM 50 million (EUR 8.4 million) of the exceptionally high bottleneck revenues which had accrued. This meant a further reduction of 5 % in the grid fees.

Main grid and cross-border connections

Approximately EUR 37.5 million was used for grid investments during the year 2000. The foremost projects were the building of the 120-kilometre 400 kV line east of Helsinki and the modernisations of the Ventusneva 220/110 kV substation and the Forssa 400/110 kV substation.

The project for increasing transmission capacity on the 400 kV connection between northern and southern Finland by means of series compensation is ahead of the schedule, and the project will be complete in May 2001. As a result of considerable increase in electricity need by industries, two separate projects were launched to boost transmission between the 400 and 110 kV grids. A new 400 kV line between Keminmaa and Sellee and a substation in Sellee are being built in northern Finland. In southern Finland, a new 400/110 kV transformer will be installed at the Yllikkälä substation, and the 110 kV grid will be reinforced. In all, some 50 building and refurbishment projects for the Finnish grid were in progress last year.

In June, Fingrid Oyj and the Russian system operator RAO EES Rossii signed a system agreement covering the technical and commercial conditions for electricity transmission between Russia and Finland. Fingrid's new transmission services valid as of 1 January 2001 are based on these conditions. From the beginning of 2001, the entire commercial transmission capacity of 900 MW available on the cross-border connections between Finland and Russia has been reserved by three importers. Moreover, Fingrid has reserved 100 MW of the total transmission capacity of 1,000 MW for power system management purposes. In December, Fingrid and RAO signed an agreement concerning the building of a third 400 kV connection between the Kymi substation in Finland and the Viipuri substation in Russia. With this line, the total transmission capacity between the two countries will rise to 1,400 MW. The new connection will be in use at the beginning of 2003.

There were no major disturbance situations in the main transmission grid which would have threatened operational reliability. There were a total of 277 minor disturbance situations, 27 of which took place in the 400 kV grid. The most significant disturbance took place in the summer when the Fenno-Skan direct current link was disconnected from the grid. This disturbance occurred when the need for transmission capacity was at its height because of the prevailing power situation. Operational reliability during the disturbance was ensured by activating fast disturbance reserve, i.e. gas turbines, and by purchasing substitute generation from the Finnish electricity market parties.

Based on investigations carried out, Fingrid decided to reorganise the grid operations. The operational control of the entire 110 kV grid will be centralised in a new Network Control Centre in Hämeenlinna. The former four regional control centres and four local control centres will be closed with the exception of operational planning and maintenance. Local grid operation and telecommunications maintenance services will be purchased from service suppliers.

The electricity market was continuously informed of the available transmission capacity and of the status of the power system in real time at Fingrid's Internet pages.

The revised terms for connection with the grid and system technology requirements for power plants were introduced in 2000. A new delivery model for reactive power was introduced in November. The model enables deliveries of reactive power in a technically and financially optimum manner. The maintenance of reactive power reserves will be subject to monetary compensation in 2002.

Fingrid has been studying the potential decay risk in tree trunks whose tops have been cut using a helicopter. The findings are encouraging. Photo: Risto Jutila.

Eystri Hagafellsjökull, Langjökli.
Photo: Haukur Snorrason.

Energy policy

A restructuring of the Icelandic electricity supply is planned to take place in 2002. The Icelandic Government is preparing a new electricity law due to be presented in the first half of 2001. The new law is expected to clearly separate monopolistic activities (responsibility for network operations, transmission and distribution) from competitive activities (production and sale). If everything goes according to plan, the first step towards a free market will be taken in 2002, and the entire reform will be complete no later than 2004.

Iceland has not signed the Kyoto Agreement because it is believed that doing so would limit the development of energy-intensive industry. It is felt that this would be unjust treatment of a small country like Iceland, while at the same time there should be acceptance of the fact that Iceland had already done a great deal to tackle its CO_2 emissions prior to the limits agreed in the Kyoto Agreement.

The energy market

Interest is steadily growing, particularly among farmers in more remote rural areas, in installing small hydropower plants. The first "energy farmers" are expected to connect their power plant units to the system in 2002. Although they will not represent a large proportion of the total capacity, these small plants are expected to enable the system to be used more effectively, especially at lower voltage levels.

Electricity consumption

In 2000, Iceland's gross electricity consumption totalled 7.7 TWh, including all losses and the power system's own consumption. The corresponding figure for 1999 was 7.2 TWh, representing a rise of 6.9 %. Consumption comprised 6.9 TWh primary power and 0.8 TWh non-guaranteed power. Of the total electricity consumption, energy-intensive industry accounted for 63.4 % (62. 4 % in 1999). General use rose by 4.5 %. If consumption is adjusted for deviations in temperature from the average temperature, the increase is 4.3 %.

The proportion of electricity in terms of total energy supplied to end-users was 26 %.

General use is expected to increase by 60 % until 2025.

Electricity generation

The generation of electricity covers total electricity consumption, including transmission losses. In 2000, of the total production of 7.7 TWh, 6.4 TWh or 83.1 % was generated by hydroelectric power (6.0 TWh or 84.1 % in 1999), while 1.3 TWh or 16.9 % was generated by geothermal power (1.1 TWh or 15.9 % in 1999).

Consumption in 2000 set new records, with a peak load of 950 MW and 7.7 TWh. The increase is primarily attributable to the current economic prosperity.

Frostastadavatn, Landmannaleid. Photo: Haukur Snorrason.

Installed capacity in the production facilities totalled 1353 MW at year-end 2000 (compared with 1256 MW the year before). The new Sultartangi hydropower station built by Landsvirkjun, the national power utility, became fully operational in February, when the last generator was commissioned. Landsvirkjun is now constructing a new hydropower station, Vatnsfell, which is planned to become operational in September 2001.

Orkuveita Reykjavíkur is now installing the third 30 MW generator in Nesjavellir, a geothermal power plant at Nesjavellir.

The transmission system

Work is progressing on a large number of projects, including analysing whether the system's transmission capacity can be increased by upgrading or rebuilding individual components or sub-systems. Studies are also being made of whether new innovative solutions can be used in maintenance or whether intelligent relay systems can be installed, which can provide increased transmission capacity by coming close to system boundaries.

A new 400 kV line is being planned from the Sultartangi hydropower station at Thjorsa to the Brennimelur transformer station, close to the Nordic Aluminium smelter and the ferrosilicon plant in Hvalfjørdur.

The electricity market

Landsvirkjun is in talks with Nordic Aluminium on the possible further enlargement of the smelter, which may increase annual production from 90,000 tonnes to 300,000 tonnes in 2003.

Landsvirkjun is also continuing discussions with Norsk Hydro to deliver power to an aluminium smelter in eastern Iceland with an annual production of 120,000 tonnes, and with the possibility of increasing annual production to 460,000 tonnes.

The price of electricity

Landsvirkjun's wholesale tariff to the distribution companies was raised by 2.9 % on 1 July 2000. The distribution companies changed their tariffs by between 0 % and +6 % during the course of the year.

There were no changes in tax or duties levied on electricity in 2000. The only tax on electricity is value added tax at the general rate of 24.5 % or 14 % on domestic heating.

In order to even out the price difference between the majority of domestic customers who are able to use geothermal power to heat their homes and the minority who are obliged to use the more expensive electricity, the State subsidises the latter category. Heating for commercial premises is not subsidised.

Kolgrafarfjördur, Snæfellsnesi. Photo: Haukur Snorrason.

There has been a steady increase in domestic heating subsidies, which for 2000 are expected to total approximately ISK 760 million. These costs represent by far the biggest costs to the State in the energy supply sector. Various state subsidies are also helping to fund the operation of new district heating utilities, which will replace heating by electricity. There is currently a debate going on as to whether the most expensive district heating utilities should be subsidised. Landsvirkjun will also contribute ISK 97 million.

Other relevant events

Landsvirkjun founded a telecoms company, Fjarski, which took over Landsvirkjun´s telecom infrastructure at the end of 2000. Fjarski will offer transmission capacity and special services in the telecom sector. Landsvirkjun also set up the company Stikla, which offers TETRA (Terrestrial Trunked Radio) services in Iceland.

Landsvirkjun is planning a new national control centre, to become operational in 2002. It is expected that the contract for the delivery of the national control centre will be signed at the beginning of 2001.

Lina.Net, which is owned by Reykjavik Energiverk, among others, expanded its operations during the year and also started a company offering TETRA services in Iceland.

The State, which owns 40 % of Orkubú Vestfjarda, is considering purchasing the remaining 60 %, which is owned by the municipalities of the Vestfjord region. The situation will be clarified in 2001. Hitaveita Sudurnesja and Rafveita Hafnarfjardar have been in merger talks. The outcome is expected to be known at the end of the year.

Rarik and Nordurorka are discussing a merger, although no date has been set for a decision.

Snæfellsjökull, midnight 21. June. Photo: Haukur Snorrason.

The scenery of Briksdalen in Western Norway is one of the most beautiful you can find in Norway. An exuberant and green scenery with rivers flowing in a wild dance towards the sea. Photo: Megapix/Husmo Foto.

Energy policy

During the Norwegian Storting's parliamentary debate on the energy white paper (White Paper No. 29 (1998-99)) in March 2000, the Bondevik Government called for a vote of confidence on the gas power issue. The Government lost the vote, resigned and was replaced by the Stoltenberg Government.

In Norway licences have been issued for the construction of gas-fired power plants, which in total will generate 12 TWh annually. In addition to the two gas-fired power plants at Kollsnes and Kårstø, which have previously received licences, a licence has been awarded for an 800 MW gas-fired power plant in Skogn in Nord-Trøndelag. None of the companies awarded licences has taken any final decision about the start-up of these projects.

During the past year, a licence was issued to expand four large wind farms. Norsk Miljøkraft Tromsø and Troms Kraft Produksjon have received licences for 80 wind turbines at Kvitfjell in Tromsø with an installed capacity of 200 MW and an estimated mean production of 660 GWh. Statkraft has been awarded a licence to build three wind farms on the islands of Hitra and Smøla and at Stadlandet in Selje with installed capacity of 56 MW, 70 MW and 150 MW respectively, and an overall mean production of 770 GWh.

In Beiarn in Nordland, the planned hydropower expansion licensed at the end of the 1980s was halted on political grounds in the autumn of 2000, when work should have commenced. The Norwegian Prime Minister, Jens Stoltenberg, signalled in his New Year's speech that there would now be an end to all major hydropower expansion projects in Norway. The Government will present a white paper during the course of the spring, which will consider the future energy and power balance in Norway.

It has been decided to reorganise the national energy efficiency scheme in Norway. A new government body will be set up, under the name ENOVA, to deal with the task of reorganising energy use and energy production. ENOVA will be headquartered in Trondheim and will be financed by a new fund, of NOK 500 million in the first year. The ENOVA administration will not carry out its projects itself, but will buy in outside expertise and operators. ENOVA's operations will be characterised by greater competition for projects and a strong focus on results. The objective is to increase the amount of electricity generated from new, renewable sources of energy so that wind power and water-borne heat make up a larger part of overall energy production.

The Storting decided just before year-end to open the Skagerrak cables to the market. The Norwegian Statkraft and the Danish Elsam agreed last summer to change the exclusively physical power trading agreement to a financial agreement. The same agreement was reached between Statkraft and the German E.ON with regard to the exclusively physical power trading agreement through Denmark. These changes mean that the preferential rights to the use of the Skagerrak cables for a good 20 years ahead have now ceased. The entire transmission capacity of 1,040 MW between Norway and Denmark will now be available to the market, and will help bring about a more integrated and efficient market in the Nordic countries. The opening of the cables to third party access is also in line with EU requirements to further the development of the single electricity market.

The restructuring of the Norwegian power supply industry also continued in 2000. Change is being effected by means of acquisitions, amalgamations and co-operation agreements, so as to create more efficient and rational units.

An airy and important workplace in the power system.

Electricity consumption

In 2000, gross total consumption, i.e. consumption including transmission losses, was 123.8 TWh in Norway. This was an increase of 2.8 TWh (2.3 %) on 1999. Gross consumption in the ordinary supply totalled 82.2 TWh, a reduction of 0.4 TWh on 1999. Adjusted to normal temperature conditions, ordinary consumption was estimated at 86.7 TWh, an increase of 4.1 TWh (5.9 %) in relation to the same period last year. Consumption by power-intensive industries was 32.1 TWh, an increase of 0.7 TWh (2.1 %) on 1999. Overall power consumption for electric boilers and pumped storage power was 6.7 TWh, a jump of 30.9 % on 1999.

The consumption of light heating products (light fuel oils and paraffin) totalled 713 million litres, which was 244 million litres (25 %) down on 1999. The consumption of heavy fuel oils was 192 million litres, which is 127 million litres (40 %) down on 1999. NVE estimates net domestic final consumption of energy in 2000 at 798 PJ, which is 17 PJ (2.0 %) less than in 1999. Of this, electricity consumption accounts for 50.4 %, which is an increase of 2.1 percentage points on 1999. Petroleum products accounted for 36.0 % and solid fuels for 12.9 %. District heating accounted for around 0.7 %.

The maximum load relating to domestic consumption, including electric boilers and pumped storage power, occurred at the 18th hour on 31 December 2000 and totalled 20,420 MW, a fall of 599 MW compared with 1999. 1,834 MW was exported in the maximum load hour, at a system price of NOK 155 per MWh.

Electricity generation

Hydropower generation was measured at 142.1 TWh in 2000. An additional 0.7 TWh of thermal power brought total generation up to 142.8 TWh, which is 20.0 TWh (16.3 %) higher than last year. Power trading with other countries resulted in net exports of 19.0 TWh, an increase of 17.1 TWh compared with 1999.

New access to hydropower in 2000 totalled net 33 MW, with a mean annual production of 145 GWh. The capacity is spread over a total of 9 plants.

NVE estimated that mean annual production in the Norwegian hydropower system at 1 January 2001 was 117.9 TWh, based on precipitation data collected between 1970 and 1999. This represents a change in the time series used by NVE to calculate its mean annual production, which was formerly 1931 to 1991. In addition to hydropower, Norway's thermal power stations are capable of generating 0.8 TWh. Overall power generation in Norway in 2000 was therefore 120.8 % in relation to an estimated theoretical mean production. Installed capacity in the hydropower stations at 1 January 2001 totalled 27,463 MW. At the same date, reservoir capacity totalled 81.7 TWh.

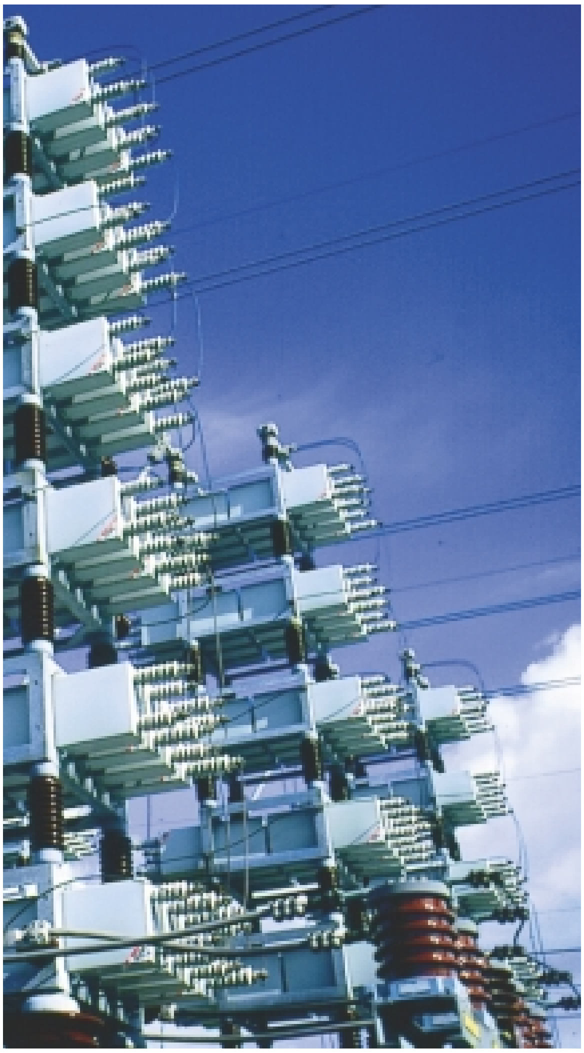
Electricity prices

The Norwegian Competition Authority has calculated that between 1 January 2000 and 1 January 2001, the average weighted power price to households rose 11.9 % to 35.57 øre/kWh including VAT and consumption tax (electricity tax). The average weighted transmission price to households excluding VAT at 1 January 2001 has been estimated at 19.27 øre/ kWh, compared with 18.94 øre/kWh at 1 January 2000.

Consumption tax (electricity tax) is levied on the consumption of power, and is added to the power price (but not the grid hire) before VAT is calculated. Industry, mining and labour market companies engaged in industrial production and greenhouse industries were until 31 December 2000 exempt from electricity tax. A change is being introduced on 1 January 2001 removing tax exemption from electricity supplied to administration buildings, defined as buildings where the area associated with administrative activities is more than 80 % of the total area. Consumers in the far northern counties of Finnmark and Nord-Troms do not pay electricity tax.

In 1999, consumption tax stood at 5.94 øre/kWh, while for 2000 it was raised to 8.56 øre/kWh. A further increase has been made for 2001, to 11.3 øre/kWh.

Photo: Tor Oddvar Hansen



In common with all other goods and services liable to VAT, electricity is also subject to VAT, which rose on 1 January 2001 from 23 % to 24 %. The three northern-most counties are not liable for VAT.

The Main Grid

In 2000, Norwegian generating companies had a high transmission requirement owing to the high water levels in reservoirs, combined with the gradual run-down of Swedish nuclear power. The transmission requirement exceeded the available transmission capacity for long periods, particularly on exports from Southern Norway to Sweden (over Hasle) and from Central and Northern Norway to Sweden. At the end of the year, an import bottleneck to Central Norway also arose at night.

Statnett uses the physical electricity market (Elspot) to manage structural bottlenecks in the main grid. Statnett does this by dividing the country, on a seasonal basis, into spot areas based on network and precipitation conditions. Each day Statnett sets transmission capacity between adjoining areas based on the current operating situation. If the transmission requirement between two areas exceeds the given capacity, a bottleneck arises (where the size of the bottleneck is the transmission requirement less the available capacity). Half the price difference between the two areas multiplied by the size of the bottleneck is known as the socio-economic cost.

Bottleneck costs in the Main Grid ran to NOK 120.5 million in 2000, NOK 114 million of which was with an intact grid and NOK 6 million because of grid maintenance and other circumstances. This is a considerable increase on the NOK 62.2 million in costs in 1999.

In 2000, minor bottlenecks also arose during the operating phase, which were managed by counter-trading/special regulations, which incurs costs for the system operator. In 2000, NOK 21.5 million was spent on counter-trading. Of this, NOK 10.5 million was due to bottlenecks arising from maintenance and NOK 8.3 million to bottlenecks with intact grid. Disturbances gave rise to special regulation costs of NOK 2.2 million. Disturbances on both the Kobbelv-Ofoten and Ofoten-Ritsem lines incurred special regulation costs of NOK 0.6 million.

To ensure that there are sufficient fast reserves in the system, Statnett has entered into reserve output contracts with market players. Until 1 November 2000, Statnett employed a system of reserving output on a daily basis if a power shortage was expected. Generators were paid not to report production on the spot market, but instead report this reserve output in the regulating power market. This system was replaced on 1 November by long-term reserve output contracts for three months or one year at a time. Contracts were signed comprising in total approximately 1,000 MW of production and 700 MW of consumption.

The Nordic countries collaborate closely on balance regulation. The cheapest regulating object must be used if there is no congestion in the grid. In total, 735 GWh was traded for this purpose in 2000.

Capacity between Southern Norway and Sweden was increased by 200 MW in May 2000. This was made possible by, among other things, greater use of emergency control schemes in the form of generator tripping in the event of critical disturbances. Several generators are automatically disconnected from the grid if specific disturbances occur, permitting secure operations to be maintained. In the autumn of 2000, an automatic load shedding system was installed in the Finnfjord smelting plant, which will help reduce the consequences of serious disturbances north of Narvik.

Photo: Tor Oddvar Hansen

Sweden

Photo: Bengt Johansson.

Energy policy

In accordance with a parliamentary resolution from 1997, the objective of Sweden's energy policy is to safeguard the supply of electricity and other sources of energy, both in the short and long-term and at prices that are internationally competitive.

In accordance with energy policy guidelines, the second reactor at Barsebäck was to have been shut down prior to 1st July 2001 with the proviso that lost production could be compensated for through increased electricity generation which was primarily based on renewable forms of energy, as well as through the reduced consumption of electricity. Against the backdrop of the evaluation of the energy policy programme implemented in the summer of 2000, the government was of the opinion, however, that the conditions for closing the second reactor would not be met within the specified time. According to the assessment made by the government, the conditions for closure will not be met until the end of 2003, at the latest.

During the year, the Climate Committee tabled a proposal for a national objective for Sweden entailing a reduction in greenhouse gases of 2% between 2008 and 2012, compared with the level for 1990. The Committee proposes a plan of action encompassing both national and international measures for achieving this objective. Nationally-based measures include information campaigns and investment grants. The international measures mention that Sweden should be a driving-force in bringing about an international trade in emission rights. With the aim of improving the prerequisites for renewable electricity production, the government called in a special investigator, in August 2000, charged with devising a system for trading in certificates based on quotas for using electricity from renewable sources of energy. The trade in certificates in combination with quotas will in time replace the current support for renewable and small-scale electricity production. The system will be developed with a view to coming into operation on 1st January 2003.

A spinner weighing 400 kg and used for winding opto cable around the skywire is being lifted by helicopter over the ridge of the pylon. Photo: Anders Wiklund.

Due to the power outages of recent years resulting from severe winter storms in different parts of Sweden, the National Electrical Safety Board was commissioned in January 2001 to investigate which measures government authorities can take in order to avoid similar situations in the future. Matters to be analysed include the system of rules for obtaining authorization for and running the network operation, as well as criteria for installing electricity networks. The investigation is to be completed by the summer of 2001.

Electricity consumption

Overall electricity consumption in 2000 set a new record, amounting to 146,6 TWh. This is an increase of 3,7 TWh, or just over 2 %, on last year. The increase can primarily be explained by the economic boom and a high oil price, contributing to an increased demand for electricity for heating. Adjusted for the normal temperature, the increase would have been even greater. The increased basic requirement for electricity is assessed to have increased by just over 1,000 MW on last year, corresponding to an increase of approximately 5% in the power requirement.

Transmission losses during the year amounted to 11.6 TWh, 3.1 TWh of which being grid losses.

The consumption of electricity in industry increased sharply during the year as a result of the high price of oil and robust increases in production within the power-intensive industries. In the paper and pulp industry, which is the most power-intensive branch of industry, consumption rose by 6% to 22.8 TWh. The overall consumption of electricity in industry amounted to 56.8 TWh. Consumption in the sector of housing, services etc, amounted to 67.5 TWh, an increase of 0.8 TWh on last year.

The electricity supply

Thanks to good precipitation levels during the summer and considerable inflows into the major Swedish rivers, hydropower production was 77,8 TWh, more than 13 TWh up on a normal year. The degree of filling of the reservoirs at year-end was 76.2 %, almost 14 percentage points up on the end of 1999. The average value during the period 1950-1996 is 67.2 %.

The year's overall electricity generation of 141,9 TWh was, however, unusually low compared with previous years, due to the lower utilization of capacity at nuclear power plants. As a result of the good water situation and the closure of Barsebäck 1, nuclear power production levels have fallen by almost 16 TWh, or 22%. Power generated at nuclear plants during the year amounted to 54.8 TWh.

Combined heat and power and condensing plants produced 8.9 TWh, down 0.4 TWh on last year. Almost 40 % of combined heat and power and condensing generation was based on bio-fuels (incl. re-circulated liquors in the forestry industry).

The number of wind generators continues to rise. All in all, there are now approximately 500 wind-generating plants, which produced 0.4 TWh during the year, an increase of 0.1 TWh on last year. Exchanges of power with neighbouring countries increased markedly during 2000. Sweden imported 18.3 TWh and exported 13.6 TWh. From being a net exporter, in particular, during previous years, Sweden became a net importer last year. Last year's export surplus of 7.6 TWh turned into an import surplus of 4.7 TWh during the year. This despite an extremely good supply of water and good availability at the nuclear power plants.

Sweden's combined production capacity increased again during the year after having been in decline during recent years as a result of reserve power plants, mostly oil-fired condensing power plants and gas turbines corresponding to around 3,000 MW, being decommissioned for economic reasons. The reason for this increase is a procurement of reserve capacity implemented under the aegis of Svenska Kraftnät and trade association Swedenergy. Sweden's overall power output currently amounts to approximately 30,900 MW.

For the second year in succession, Western and Southern Sweden were hit by severe storms during December, entailing widespread power outages. This year too, problems centred on the regional and local networks.

Installation of broadband. The opto cables are jointed every eighteen hundred metres. A 64 fibre cable consists of four pipes with 16 fibres in each. In the picture, jointer Tommy Bergh is sitting in the jointing workshop. Photo: Anders Wiklund.

The electricity market

The Swedish electricity market is characterized by competition that continues to increase in the wake of profile settlement regulations being introduced in the autumn of 1999. Demands on companies have increased as a result of a good supply of electricity and low prices on the power exchange.Electricity prices for household customers have, all in all, fallen about SEK 0.15 kWh since the reform was implemented. Approximately one household in three has actively obtained lower electricity prices, either by changing supplier or by renegotiating with the current supplier. About 15 % of the country's 5 million household customers have changed supplier and 15 % have renegotiated their electricity prices since the electricity reform came into effect. Besides the price of the electrical energy itself, household customers also have to face network fees and taxes. The cost of electrical energy makes up about 20 % of the overall cost, with the network fee and taxes accounting for about 40 % each. For customers in apartments and detached houses, network fees have increased by just over 3 % since the electricity market reform was introduced in 1996. As at 1st January 2000, the network fee for an apartment was SEK 0.423 kWh, while for a detached house with electrical heating, the fee was SEK 0.208 kWh.

The price trend for trade and industry customers, especially in power-intensive industry, nowadays follows the trend on the Nordic power exchange. The price on the exchange increasingly functions as a reference for bilateral deals.

During the year, the Profile Delegation was set up on the initiative of the industry. The task of the delegation is to identify and propose measures for solving the remaining problems connected with customers changing supplier. The problems that still exist can largely be attributed to the late delivery of the IT systems required for efficient management, which the current system of rules presupposes.

The issue of Sweden's power reserve was in focus this year, too. Uncertainty was great in respect of how the Swedish electricity market would cope with the power balance during the winter. In addition to reserves in the form of oil-fired condensing power plants having been in decline over recent years, Barsebäck 1 was also decommissioned in November 1999. January 24th 2000 saw the most critical power situation on the Nordic market this winter. On this occasion, the Baltic Cable was also out of service as a result of the extensive winter storm at the beginning of December 1999. The situation was deemed so serious that Svenska Kraftnät issued a power shortage warning. The high spot and balance prices that arose led to a reduction in exit power, whereupon the power balance could be tackled with margins that were sufficient to preclude the rotating disconnection of consumption.

Based on the subsequent discussion within the industry following the events of January 24th, several concrete measures have been taken, both on the production side and on the consumption side. Collaboration between Svenska Kraftnät, the National Energy Administration and the Federation of Swedish Industries has been embarked upon with the aim of entering into an agreement with industry companies regarding the reduction of their electricity consumption when Sweden is facing a risk of power shortages, i.e. reducing their consumption on market-adapted terms and conditions during high prices on the electricity spot market.

During the autumn of 2000, Svenska Kraftnät and trade association Swedenergy agreed upon a transitional solution for safeguarding the supply of power reserves at times of severe cold during the coming three years, thus reducing the risk of power shortages. The objective is to reinstate up to approximately 1,000 MW of reserve power plants "mothballed" during recent years.

Svenska Kraftnät procured operational availability from seven reserve power plants, primarily oil-fired condensing power plants. It will be possible to offer the capacity of the plants, whenever there is a risk of power shortages, on Nord Pool's electricity spot market. After the three-year period, it is our ambition that a permanent model for a power reserve market will be ready.

Taxes

Electrical energy is taxed in Sweden both as regards consumers and producers. Certain customer categories additionally pay VAT. Tax varies with location and application. During the spring of 2000, a decision was reached regarding a green tax shift which entails taxes being raised on energy, and which is offset by taxes being lowered on labour. Within the framework of the tax shift, the electricity tax was generally raised by SEK 0.018 kWh from 1st January 2001.

For household customers, the electricity tax at 1st January 2001 amounts to SEK 0.125 kWh in Northern Sweden and SEK 0.181 kWh in the rest of the country. Electricity consumed in the supply of power, gas, heating and water is taxed at a lower rate, SEK 0.125 kWh in Northern Sweden and SEK 0.158 kWh in the rest of Sweden. Manufacturing industry, the greenhouse sector and, as of 1st July 2000, agriculture, forestry and aquaculture, do not pay an energy tax on electricity.

Fuels used in the generation of electricity are exempt from energy tax.

The nuclear power tax, which was previously based on the level of electricity production, was restructured effective 1st July 2000 and is now based on the thermal output of nuclear reactors, corresponding under certain conditions to the previous tax of SEK 0.027 kWh. In addition, SEK 0.0015 kWh is charged under the Studsvik Act, as it is known, and an average of SEK 0.01 kWh is paid in accordance with the Act regulating the financing of future charges for spent nuclear fuel. Moreover, all electricity-generating installations pay a property tax amounting to 0.5 % of the rateable value.

The grid and the overseas interconnectors

During the year, several measures have been taken aimed at increasing capacity for transmissions on the grid. Conversion and extension work is being carried out on the 400 kV grid station at Borgvik with a view to commissioning it in 2001. The project entails an increase in capacity of about 350 MW from Sweden to Norway. The investment is estimated to amount to about MSEK 100 in total.

In Hasle in Norway, a network protection has been built which will boost the transmission capacity towards Sweden by about 100 MW, depending on temperature, to 2,100 MW. The network protection will go into service at the beginning of 2001.

A new power converter station for the DC interconnector Kontiskan 1 between Gothenburg and Jutland is being projected. The new station plus some further upgrades will boost the capacity of Kontiskan 1 by 90 MW to 360 MW.

The work of building a 66 km long 400 kV line between Alvesta and Hemsjö in the counties of Kronoberg and Blekinge continued during 2000 as well. The new line, built in order to increase the capacity of the transmission of electricity from centres of production in the north to centres of consumption in the south by 300-400 MW, was planned to go into service in December 2000. At the end of November 2000, however, a material defect was discovered which delayed commissioning. However, the line was able to go into service on 30th January 2001. The investment cost is estimated to be approximately MSEK 270 in total.

After a lot of to-ing and fro-ing in the Environmental Court and the Supreme Environmental Court, it was finally time for testing and trial operation of the Swepol Link. Commercial operation of the interconnector between Karlshamn in the county of Blekinge and Slupsk in Poland commenced at the beginning of September 2000. The total investment for the interconnector was SEK 2.7 billion.

The work of installing opto links for telecommunications transmissions continued during the year. In addition to the expansion of Svenska Kraftnät's optic fibre networks for its own data and telecom transmission requirements, the utility is also installing, on the instructions of the government, a national network for broadband communications, i.e. high-speed data and telecom transmissions. The network, which is to be installed as a commercial venture, will reach all the principal municipal centres. Work is planned to be completed before the end of 2002.

Congestion management in the electric power system

The Nordic power system and electricity market have undergone a comprehensive process of restructuring in recent years. This occurred at the same time as we experienced both extremely dry and extremely wet years. In 1996, for example, the interconnecting Nordic system generated 167 TWh of hydroelectric power, compared with 234 TWh in 2000. Total generation in the system in these years was 363 TWh and 386 TWh respectively.

The big fluctuations in hydropower generation, particularly in Norway and Sweden, have led to big variations in the transmission requirement within the power system. This has occasionally created a transmission demand that considerably exceeds the capacity of the power grid in the Nordic region. Our ability to manage congestion, or bottlenecks as they are often called, in the system has therefore been put to the test repeatedly. In 2000, there was considerable congestions for long periods of the year.

In this article, we will take a general look at methods of managing congestion, and sum up our experience of employing the type of methods used in the Nordic region. We will also consider the possibilities for developing and improving methods of congestion management.

The expansion of a supranational transmission network in the Nordic region has taken place gradually. Right up until the 1980s, the focus was primarily on national expansion programmes aimed at satisfying domestic demand for electricity, with respect to both the network and electricity generation. At the same time, there were big differences between the individual countries. Sweden, Finland and Denmark had a relatively strong main grid with few internal bottlenecks, while Norway had a weaker national grid, since energy sources and generation were more evenly spread across the country.

While capacity between the countries has gradually increased since then, combined with the factors mentioned above it has led to other bottlenecks now arising, which have more serious consequences for the power system. These bottlenecks are not necessary linked to national borders, but are to do with the fact that large power imports and exports lead to new patterns of transmission. The operating patterns of power plants have also changed considering that they are now generating power in line with fluctuations in market prices.

Nordel has in recent years published a number of articles in its annual reports describing deregulation in the Nordic countries and the introduction of market-based solutions in the electricity supply. In 1996, we wrote about deregulation and the relationship with the Nord Pool power exchange, and in 1998 we produced a feature article on the transition from electricity monopoly to competition and the new challenges facing Nordel. In the 1999 Annual Report we dealt with the basic assumptions and structures of the Nordic electricity market in an article entitled "A free electricity market".

Following the deregulation of the electricity market, new players appeared on the scene who work on entirely different premises. They do not have the same understanding of the situation as it was previously, nor do they have any independent responsibility to ensure supplies of electric power within an area. Instead, they assume that they will have as good as full access to transmission capacity under all circumstances. The altered strategies of the market players are now resulting in plans for new power generation being put aside - if the economics of the projects are not good enough. We have behind us a decade with little expansion in terms of either the grid or power generation.

Social change and development alters the significance of all types of infrastructure over time. Political decisions, industrial development and environmental considerations are examples of factors that affect the significance of various types of infrastructure.

The nuclear power industry may serve as an example. The decommissioning of one of the reactors at the Barsebäck nuclear power plant in Sweden has led to a shortfall in power generation in Southern Sweden. The result has been a change in the flow of power, giving rise to new bottlenecks or reinforcing old ones. The problem was further compounded by the closure of the Karlshamn Power Plant. However, two out of three units have now been bought up as part of the Swedish reserve output. The shutting down of the last Barsebäck reactor is dependent on new generating facilities being established in Southern Sweden or the reinforcement of the network between Central and Southern Sweden.

Another example is the interconnector between Norway and Sweden over Hasle, where bottlenecks often occur. It is now being considered whether to reinforce the network.

Increased emphasis on the need for environmental protection has meant that any plans to expand the network must reckon with a long, exhaustive and often difficult administrative process. At the same time, the industrial and technological developments that have taken place in the Nordic countries have led to a substantially higher rate of electricity consumption and correspondingly large and altered transmission needs. This has in general created increased pressure on the grid, with a rising imbalance between consumption and electricity generation on the one hand and the transmission capacity of the grid on the other.

The transmission system operators (TSOs) are attempting to control long-term developments in power flow by means of tariffs. In the short term, however, other methods must be used.

What are bottlenecks?

Bottlenecks occur when the transmission network is unable to transmit the electric power that the market wants and needs. A bottleneck is not necessarily caused by poor generation capacity locally, but can occur as a result of the trading pattern created by supply and demand in the power market.

Narrow sectors - so-called bottlenecks – arise in all networks wherever line capacity is insufficient to satisfy the electricity transmission requirements of market players. Naturally, the players would prefer there to be no congestion at all in the power grid. It is nevertheless clear that the power grid should be regarded as part of our social infrastructure in the same way as telecommunication lines, roads and railways. In all these areas it is important to expand the equivalent optimum capacity to meet socio-economic needs, since congestion is bound to occur occasionally. Likewise, we cannot build our way out of all grid congestions, and bottlenecks will occur notwithstanding over shorter or longer periods of time.

Bottlenecks may have temporary or structural causes. Temporary bottlenecks occur relatively rarely and may be the result of maintenance work, technical faults or particular market conditions. Structural bottlenecks are a result of the level of expansion of the grid and the localisation of generation and consumption within the grid. Structural bottlenecks tend to occur over longer periods of time or at regular intervals. It is important to differentiate between temporary and structural bottlenecks when selecting methods of managing congestion. It is often difficult, however, to distinguish between the two types of bottleneck.

Different methods of congestion management

The basic requirements and conditions necessary for the creation of an open electricity market were described in the special feature article in Nordel's 1999 Annual Report. Several criteria must be satisfied before we can begin to talk about a free and open electricity market, including the following:

- All consumers must be free to choose their supplier without administrative or legal restrictions.
- There must be equal access to the grid on equal terms for all. The grid is the physical market place.

Table 1: Different methods of managing bottlenecks.

Methods / Characteristics	Own interconnector	Channels, subscription	Explicit auction	Implicit auction = Price area	Counter-trading	Redispatching
Characteristics of the method.	Traditional method in the vertical-integrated model. Capacity available only to owner and user, which are usually the same. Monopoly.	Further development of own interconnectors. Capacity leased out to several players, normally on long-term contracts. Capacity often limited to a few large players Rationing used during congestion.	Transmission capacity auctioned by year, month, week or day. The more auctions, the more market-oriented the method. Important to combine with the 'use-it-or-lose-it' principle, to prevent capacity being blocked.	Grid capacity purchased at the same time as energy trading on the exchange (one-stop shopping). Simple, low-cost method. Effective for managing structural bottlenecks.	Used throughout the market area for temporary bottlenecks. Co-ordinated upward and downward regulation of generation/ consumption. Bought and sold on the power markets.	Co-ordinated upward and downward regulation of generation by a central body. Directions based on marginal generation costs.
Interplay with the market.	No congestion signals given to the market.	No congestion signals given to the market.	Direct interplay between capacity supply and demand. The player ready to pay most gets the capacity.	Long-term signals to players regarding investment needs.	Market signals on localisation not given to players, but to TSOs.	No congestion signals given to the market.
Who pays?	The owner and user.	The party leasing channel capacity or paying subscription.	The party buying capacity at auction.	The user pays through the power exchange price.	The TSO pays for counter-trading.	The involved generators.
Used in the Nordic countries.	Baltic Cable (Sweden-Germany) SwePol Link (Sweden-Poland).	Kontek (Eastern Denmark-Germany), Finland-Russia, Norway-Russia, Russland SwePol Link (10%).	Western Denmark-Germany.	Between the countries. One area: Sweden and Finland. Two areas: Denmark and Norway. Internally in Norway.	Internally within the price areas, and between price areas in the operating phase.	Not used in the Nordic region.

- The owners of the grid must be independent of competitive producer and consumer interests, known as 'unbundling'.
- The day-to-day management of the grid must be independent and impartial. In the Nordic countries, this is the responsibility of the transmission system operators (TSOs).

There are also several other factors of interest involved in the creation of a single European electricity market:

- It is essential that cross-border trade should be possible and not burdened with tariffs.
- Furthermore, the TSOs must have agreed clear procedures for exchanging information.
- Common rules for congestion management must have been agreed.

It is important that bottlenecks should have minimal-economic impact on the electricity market. Bottlenecks must therefore be managed so that transmission capacity is utilised as efficiently as possible. In practice this means that all available capacity in the bottleneck must be fully utilised for as long as possible.

The capacity in the grid must be made available to market players in a non-discriminatory fashion. Utilisation of capacity must be subject to unambiguous and non-discriminatory rules. The rules must be made known to everyone in the market, which demands that clear and exact information about available capacity must be provided. Information must be accessible to all market players and available on equal terms for all.

In practice, this requires the TSOs to manage the capacity in the grid. The method they choose must not only be capable of managing capacity trading in the short term, but also provide incentives to encourage investments in network and generation capacity in the right areas.

Potential methods of congestion management will depend on what stage of the liberalisation process a power system has reached. Market-based methods assume the existence of an electricity market.

In the following we will describe different methods that can be used to manage congestions, and give an account of the methods currently in use in the Nordic power system. A comparative table of these methods is provided in Table 1.

Own interconnectors and channels

Many interconnectors were built originally to fulfil a specific power trading agreement that remained in force for a long period of time. That was the case with the first interconnectors between the Nordic countries, where the individual companies had rights to all or parts of the transmission capacity, and that situation lasted in general up until the 1990s.

The rights to utilise a certain proportion of the capacity in an interconnector can be sold to other market players for a certain length of time. We call this a subscription or channel. For this, the owner charges a subscription fee calculated on a yearly or monthly basis, for example. Market players use these channels to trade electric power.

Such channels have existed right up until now on several of the interconnectors between the Nordic countries, one example being the Skagerrak cable between Denmark and Norway, where the channel system terminated on 1 January 2001.

Other examples of channels are the Baltic Cable between Sweden and Germany, and Kontek between Eastern Denmark and Germany. The interconnector between Finland and Russia has channels with contracts running for many years. The SwePol Link between Sweden and Poland consists partly of channels and partly of free capacity.

Statnett's National Control Centre monitors operational security in the power system and continually supervises the balance between consumption and generation. Photo: Trond Isaksen.

If the total capacity on an interconnector belongs to certain players or is sold on subscription to specific companies, new market players are unable to gain access to utilise the capacity in that interconnector. Channels or subscriptions can therefore block the trading requirements of other players.

The "use-it-or-lose-it" principle

Channels can entail the capacity on an interconnector not being fully utilised. This happens if the players with the line at their disposal fail to use the entire capacity themselves for power trading. Unutilised capacity on an interconnector can be made available for other players by introducing the "use-it-or-lose-it" principle, according to which any market player with an interconnector subscription is fully entitled to utilise its capacity within given time limits. If the interconnector is not fully utilised by the given time limit, the TSO in question makes the residual capacity available on equal terms to all the players in the market.

As the Nordic power market gradually developed, it became clear that the use of channels had more disadvantages than advantages, even if the "use-it-or-lose-it" principle was applied at the same time. The more practical system is to have the TSOs to own the interconnectors and the rights to trade power on them, so that they can make capacity available in different ways to all the market participants.

Explicit auctions

A TSO can choose to auction off the capacity on an interconnector at certain intervals. This is termed an explicit auction, since it separates the management of capacity in the grid from power trading. It is up to the market players to utilise the bought capacity for power transmission after the capacity on the interconnector has been purchased.

The more frequent the explicit auctions, the more dynamic trading becomes and the more players get access to the capacity. Auctions that are held more seldom can be compared with sales of subscriptions and have similar disadvantages. For example, market players have to take the risk of the market developing in a different direction to that forecast when the capacity was purchased.

The interconnector between Western Denmark and Germany is operated according to the explicit auctioning principle, with yearly, monthly and daily auctioning off of unutilised capacity. As long as there is no efficient spot market on the German side of the border, we will not always be able to make optimum use of the interconnector. It is, however, the interconnector between the Nordic countries and the Continent that has progressed furthest as regards flexible utilisation of capacity in the market sense.

Explicit auctions are well suited to managing bottlenecks between two areas that have different market structures, since the regulations governing power trading in the two areas do not have to be the same. However, the time limits must be generous enough to permit players to participate in the market on both sides of the interconnector.

If capacity on the transmission grid is bought either by subscription or in an explicit auction, the players in the electricity market pay a fee for grid hire to the TSOs offering the capacity.

Implicit auctions

In many parts of the world, power exchanges are regarded as competitive market players. That is not the case in the Nordic countries, where the TSOs have assigned the task of managing bottlenecks to the Nord Pool Power Exchange. The Nord Pool Power Exchange is therefore regarded as part of the infrastructure of the market rather than as a market player. Since Nord Pool manages all the trading that goes on between the areas, the liquidity of the exchange increases, resulting in a more credible price determination.

Nord Pool manages bottlenecks using a more advanced form of auction, what is known as an implicit auction. In an implicit auction, all buying and selling of power and auctioning of capacity on an interconnector is performed in one and the same operation. This is also known as one-stop shopping.

An implicit auction requires the power exchange to have a price quotation on both sides of the interconnector, i.e. in both the two areas linked by the interconnector. The market players in both areas now make bids to buy or offers to sell in each of their areas, and the exchange clears the bids and offers in both exchange areas. In an implicit auction, the market players automatically acquire the capacity on the grid needed to transmit the power they have bought or sold at auction. Players in one area can buy or sell electricity in the other area by trading on the joint exchange. The players do not take a position on the interconnector's transmission capacity, but solely on the local price (area price). Implicit auctions therefore generate lower transmission costs for the market players and make it easier to manage the capacity on the interconnector.

Information as to the availability of capacity on an interconnector is extremely important, because it influences the bids and offers made in the areas. The TSO concerned notifies the exchange of the maximum trading capacity on a 24-hour basis. The exchange then publishes these capacity figures for the information of market players each day before trading begins on the spot market. The TSOs in the Nordic countries have entered into an agreement with Nord Pool to guarantee the capacity utilised by Nord Pool. This guarantee ensures that players who trade on the exchange are always able to execute their buying andselling transactions, even in the event of grid faults and breakdowns.

Market splitting, market coupling and price areas

In the Nordic region, the terms 'price areas', 'market splitting' and 'market coupling' are used even if the method actually employed is an implicit auction. This is because it can be easier to explain using these terms and because historically these are the terms that have been used.

When a bottleneck occurs between two areas, the price area model is used. In practice, the actual price setting process consists of several stages, and can be illustrated with an example using two market areas with one interconnector between them. Firstly, the power exchange calculates the system price, which is the price that could have been obtained if it had been possible to accommodate all the transmission demands on the interconnector between the two areas. The exchange then checks whether this price will enable transmission between the areas over and above the capacity on the interconnector. If no restrictions are encountered, the system price will be the valid current price in both areas.

If the transmission demand between the two areas at the system price exceeds the physical capacity of the interconnector, the exchange will split the whole market into two areas and repeat the price calculation in the two areas separately. The price in one area will therefore be higher than in the other. Electricity will be then purchased in the low price area and sold in the high price area. The increased demand in the low price area will in turn raise the price in that area. Correspondingly, the price in the high price area will fall when the amount of available power increases. The amount of electricity bought and sold will now increase until the maximum capacity on the interconnector is reached. Put simply, this can be viewed as the price in the surplus area having to be lowered so that some generators will no longer find it profitable to produce, while the price in the shortfall area will have to be increased in order to make more generators want to produce.

The method is known as market splitting and ensures the maximum utilisation of capacity on an interconnector between two market areas when bottlenecks occur. The method also ensures that the market players who are ready to pay the highest price will automatically have access to the restricted capacity.

The method can also be explained in another way. Initially, the power exchange will clear the trade in two areas independently of each other, and as though there were no interconnector between them. This makes the price in one area higher than in the other. We call such areas price areas. Following this, electricity is purchased in the low price area and then sold in the high price area. The increased demand in the low price area will in turn raise the price in that area. Correspondingly, the price in the high price area will fall when the amount of power increases. The amount of electricity that is bought and sold will now increase until the prices in the two areas are equal – or until the maximum trading capacity on the interconnector is reached. Now the two markets in the two areas are tied as closely together as is physically possible at a specific hour, so the method could with equal justification be termed market coupling.

The method is the same if there are more than two areas with transmission congestion between them.

In the Nordic region, this method is known as the price area method, since bottlenecks on the interconnectors lead to different prices in the different market areas. The price area method has been employed in the Nordic region since the market began to develop at the beginning of the 1990s.

The price area model can be used even if there are channel reservations on capacity between areas. This requires the "use-it-or-lose-it" principle to be applied on channel reservations, so that any unused capacity on them is made available for the power exchange. This was the case, for example, on the Øresund interconnector between Eastern Denmark and Sweden in 2000.

The amount of power that the exchange transmits from the surplus area to the shortfall area is bought at less than the selling price. The resulting 'bottleneck revenues' or congestion fees go to the exchange. In the Nordic countries, these amounts are paid back to the TSOs, which dispose of the funds in various ways, so as to benefit the users of the power grid.

Counter-trading

Counter-trading is in principle a completely different way of managing bottlenecks than price areas. If market players require more power to be transmitted over an interconnector than it has the capacity for, the TSO concerned can employ counter-trading to increase the interconnector's trading capacity.

When that happens, the TSO requests the generators to regulate down a certain amount of generation on the surplus side of the bottleneck, for which they are paid. Similarly, generators on the shortfall side are paid to regulate generation up by the same amount. This amount of power will then flow in the opposite direction to the power the market players wish to transmit, and this extra transmission capacity can be made available to the players. This method is known in the Nordic region as counter-trading.

The effect of a bottleneck on an interconnector can be reduced or removed completely by the use of counter-trading on a sufficiently large scale. The amount of power purchased in counter-trading compensates for the extra trading done by the market players, so that the physical flow over the bottleneck corresponds exactly to the physical capacity. So counter-trading leads to increased trade, but not to increased power transmission over the bottleneck.

In order to identify the lowest-priced counter-trading parties, the TSO employs the power market as well as the real time market (or regulating power market).

In some cases, the TSO will enter into long-term framework agreements for upward and downward regulation by means of counter-trading, which is then applied in the operating phase. The real time market is not affected by this counter-trading.

When purchasing through the real time market, generators and large industrial customers offer upward and downward regulation in their respective areas. The costs incurred by the TSO in counter-trading are the cost of purchasing power (upward regulation) less the revenues from the corresponding sale of power (downward regulation). Counter-trading can also be used across national borders, which requires co-operation between the TSOs on both sides of the border.

In the Nordic countries, counter-trading is used for managing temporary bottlenecks, for example in a situation where an outage on a line gives rise to lower capacity between two price areas than was assumed when prices were set. The agreement the TSOs have with Nord Pool to guarantee available capacity is also a guarantee for the trading that takes place on the power exchange. In a case like this, the TSOs will use counter-trading in the operating phase in order to maintain trading. Counter-trading is also used under the same conditions for managing internal bottlenecks within a price area.

Redispatching

Redispatching requires the existence of a central body to run a continuous overall load dispatch system, in other words a central dispatch. This central dispatch is normally a control centre. It can act whenever a bottleneck occurs between a surplus area and a shortfall area. By directing the upward regulation of generation in a shortfall area and a corresponding downward regulation in a surplus area, an amount of power will flow between the two areas creating an extra transmission capacity for trade between them. The extra transmission capacity can be made available to the market players and thus reduce or completely eliminate the effect of the bottleneck. In many ways, this makes redispatching analogous to counter-trading.

The control centre responsible for redispatch knows the marginal generation costs of all generators and uses this information to find the lowest-priced upward and downward regulation entities. The use of redispatching is therefore based on socio-economic optimisation and not market considerations.

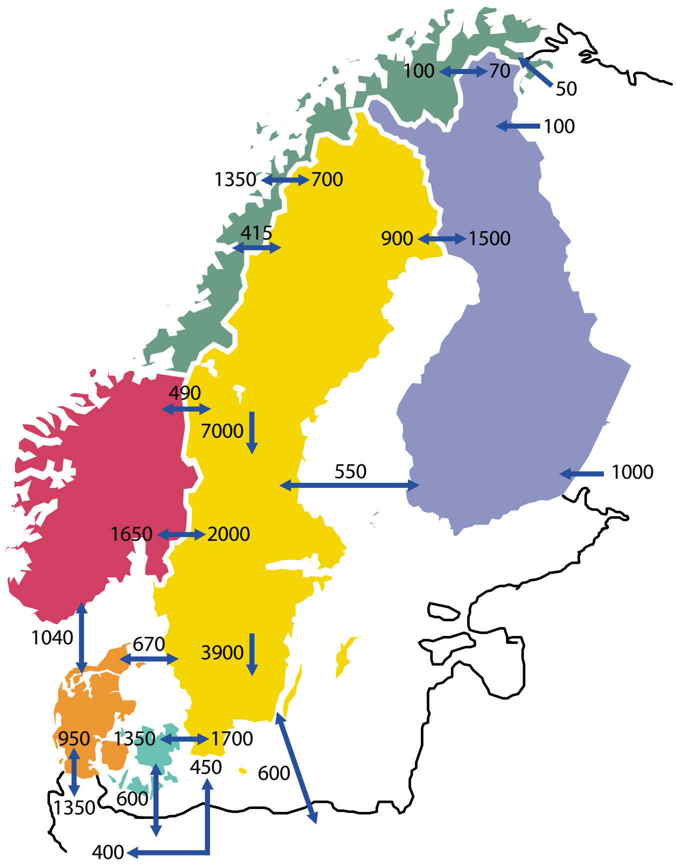
With redispatching, market players do not alter their commercial sales contracts, nor do they get any economic signal concerning the existing bottlenecks and their significance for trading.

As there has never been any centralised load dispatch system in the Nordic region, redispatching has never been used in the overall Nordic system, although the method is employed elsewhere in the world.

Combined solution in the Nordic region

The method currently used for managing internal bottlenecks in the Nordic region is a solution involving a combination of both price areas and counter-trading. This combined solution has a prehistory closely associated with the development of the Nordic power system. The first interconnectors between the Nordic countries were owned and managed by market players. Now, virtually all interconnectors between the countries are owned and managed

Fig. 1. Normally occurring price areas marked in different colours. Available capacity stated for selected transfer corridors.



by the TSOs. Initially, subscriptions or channels were used on these interconnectors, but as the joint power exchange area grew, it was decided to switch to using the price area model for managing bottlenecks between the countries. The Nordic region is now normally divided into six areas for the electricity spot market. Sweden and Finland make up one area each, while Denmark and Norway consist of two areas each. Within each price area, counter-trading is used to handle temporary bottlenecks so as to avoid internal price differences arising in the respective areas. Fig. 1 shows the normal division of the Nordic region into price areas, as well as the capacity normally available between the countries.

The Nordic experience

Market developments between 1996 and 2000

With the removal of border tariffs and the joining of the Swedish and Norwegian power markets in January 1996, the foundations were laid for a flexible trading arrangement in which relatively small differences in price created rapid changes in power generation and consequently the load flow. To begin with, relatively high purchases were reported over the power exchange in the Swedish area. In addition, the transmission capacity between Norway and Sweden was burdened with long term contracts with preferential rights. Bottlenecks with, to some extent, big price differences arose between Norway and Sweden for a short period, although the players adapted to the situation. A contributory factor was also that 1996 was a dry year, so that the large surplus that had been anticipated for sale in Norway did not materialise.

In the summer of 1996, the Norwegian sales requirement was reduced and interest in purchasing electricity increased because of the reservoir situation. This resulted in a change of direction for the power flow between Norway and Sweden, and a bottleneck arose from Sweden into Norway. In general, prices rose throughout the entire joint Nordic market, provoking strong criticism from some market players and analysts who had not expected such a development. However, the general conclusion since then has been that the price levels reached in 1996 provided a good indication of where prices can go when a weak energy balance occurs.

Finnish players gained access to the joint Nordic market at the end of that same year, resulting in more sales in the spot market and a certain fall in electricity prices. The shortfall in Norway caused the bottleneck from Sweden into Norway to remain more or less constant until the spring of 1997, although the price differences were relatively small. The price differences ensured, however, that the available transmission capacity between Sweden and Norway was fully utilised throughout the entire period.

During the latter half of 1997 and again in 1998 and 1999, periodic bottlenecks arose between areas, although the price differences were not big enough to be regarded as posing any great problem for the players, nor was the situation viewed in any way as critical.

The year 2000 was also abnormal, although in the opposite sense – with abnormally high rainfall, huge supplies of energy to the hydropower stations and falling prices in the market. The flow of power was from Norway to Sweden and then on to Finland and to some extent Denmark. In Sweden, large sections of the conventional thermal power generation and some of the nuclear power generation were shut off for certain periods, and bottlenecks arose from Norway to Sweden. The combination of high water flow from the rivers and the reduction in nuclear power output gave little control power, and we experienced the same price fluctuations as with power scarcity, and, to some extent, with big price differences arising between the price areas in the Nordic region and major price variations over a 24-hour period.

The division of the Nordic region into many price areas with to some extent permanent bottlenecks between them, split the joint liquidity of the market during certain periods. The result was some price fluctuations that had previously been registered in small, Norwegian price areas with few players, or where there had been some dominant players in the market with the risk of an abuse of market power.

The market has matured considerably over the course of the last five years. There has been a greater focus on economy than on technical operations, and there has been a strong focus both on market liquidity and on hedging prices. The division of the market into several areas creates lower liquidity, and the need has arisen for hedging products in the market in order to reduce the risk for players.

In the autumn of 2000, Nord Pool set up a system of contracts allowing players to hedge the difference between the system price and the area prices referring back to a number of key nodes in the network.

Weighing up the different methods used in the joint Nordic market

As the Nordic power market gradually developed, it became clear that there were more disadvantages than advantages to using the traditional method of channels, even if the "use it or lose it" principle was applied at the same time, permitting the interconnector to be used in case of need. Even if other players were able to make use of the interconnectors when there was unutilised capacity, it became in practice a question of players being shut out, since the regulations and time limits for allocating capacity were not always compatible. The result was that existing transmission interconnectors were not being used to their optimum. It was more practicable to let the TSOs own the interconnectors and the rights to trade power on them, so that they could make capacity available in different ways to all the market players.

Within the framework of the Nordic power exchange area, it was agreed initially that a division into price areas could be practicable for the continuing integration of the Nordic market, but that in the longer term counter-trading should be introduced throughout the entire Nordic power exchange area. As the Nordic market has been expanded to include more countries, new experience has been gained as regards the most appropriate methods of managing congestion.

The conclusion has now been reached that the most practicable solution is a combination of the two methods described above.

Since the power grid was basically expanded to serve not Nordic but national needs, we must expect to experience congestion problems in an integrated market. However, using the price area model has shown that the Nordic market can be kept together and can also to a great extent exploit the cheapest generation resources. When bottlenecks have arisen, it has proved possible to make maximum use of the grid for transmission in both normal and extreme situations in the power system.

The following paragraphs provide a more detailed account of the price area and counter-trading methods, based on the experience of the Nordic power market.

Importance of locating bottlenecks correctly in relation to physical borders

Before the joint Nordic power market was established in 1996, varying divisions into price areas had been used in Norway as a means of balancing the market in some parts of the country. When the power exchange area was expanded to cover more countries, national borders were used as the boundaries between spot market areas. In Sweden, Finland and Denmark, counter-trading is used internally to handle all bottleneck problems. In those countries, this has led to the boundaries between price areas not being set where the actual physical bottlenecks occur.

When determining the physical trading boundaries between the Nordic countries, some account is taken of the use of counter-trading, so that the set boundaries do not correspond to the physical transmission capacity at the border. The transmission capacity at the border is limited to less than the physical capacity in order not to reinforce internal bottlenecks – which must be handled by counter-trading. These conditions result in price distortion.

Attempting to relieve a bottleneck by division into price areas limits the trading that could have been achieved with sufficient grid capacity. It is therefore important to locate the boundary between price areas at the place where there is a physical constraint, so that we can ensure full utilisation of transmission capacity over the bottleneck with the aid of price mechanisms. Trading will then be restricted as little as possible and the area price differences will also reflect the actual congestion. The price differences that arise in this way can function as signals to the market players and thus help to direct investments in generation and consumption. If, on the other hand, counter-trading is used, the players get no price signals through counter-trading. The TSOs alone get these signals. If the real time market is used for counter-trading, the players can get weak signals indirectly from that market. With counter-trading, the cost of removing bottlenecks is shared among all the players in the market.

Dynamics and size in the price area structure

If existing transmission interconnectors are to be used effectively, it is important that the boundary between the price areas should be located where the physical congestion occurs. The size of the price areas is also important.

When the Nordic market was first opened up, two important changes took place. The individual players gained portfolios that were spread over large geographic areas. Responsibility for power trading and portfolio management was assumed by people who had no background in the physical operations of the power system.

During 1998 and 1999, there were for a period frequent changes in the division into bid areas in Norway. Trading in some areas could also vary greatly over the course of 24 hours, so that bottlenecks arose for parts of the day in one place, only to disappear at other times of the day. Information about price area division over the course of a week became very complicated. Players with portfolios spanning large geographic areas had practical problems in controlling and reporting their trading correctly area for area. In 1999, possible practical solutions to this problem were discussed, and an attempt was made to avoid division into extra bid areas where short-term bottlenecks were expected. The TSOs also tried to avoid creating separate areas where a virtual monopoly situation might arise for a buyer or seller. If a price area becomes so small that the number of players are reduced to only a few, or if one player gains a dominant position in relation to the rest, we may see sharp price fluctuations arising with the current spot market regulations.

The development of counter-trading

In recent years, counter-trading has been used increasingly within the individual spot markets in the joint Nordic market, as a result of an increasing incidence of bottlenecks. In Sweden, for example, the occurrence of bottlenecks between different areas has led to a rise in the costs of counter-trade bidding over the past year. These bottlenecks have tended to occur in the same narrow sector of the power grid. It could therefore be said that what we are actually faced with here are structural bottlenecks of a long-term nature.

The advantage with counter-trading has been that it has enabled trading to be maintained despite the presence of bottlenecks in the grid. One lesson that can be drawn from the circumstances in 2000 is that the market's generation resources have not been utilised rationally enough. This is because the real costs of transmission are not made visible for market players when counter-trading. As an example, in 2000 huge supplies of hydropower arose in Northern Sweden as a result of the heavy rainfall. This led to a demand for massive transmissions to Southern Sweden, where there was a shortfall in generation. Counter-trading was used to reduce the load on the grid. At the same time, Swedish nuclear power was also regulated down for long periods. The generation shortfall was covered by imports from neighbouring countries.

Since the players receive no signal as to where in the grid the congestion is actually located when counter-trading is used, it is up to the TSO concerned to do something about the congestion that occurs, regardless of whether it is of a temporary or structural nature. The recommended solution is the use of price areas for structural bottlenecks and counter-trading for temporary bottlenecks.

Developments in relation to the opening up of the market in Europe

The Nordic countries are connected to Russia, Poland and Germany through a number of interconnectors. The methods used to manage capacity on these interconnectors depends on who owns the interconnector. The market in our neighbouring countries is structured differently to the Nordic electricity market, which has to be taken into account when managing capacity over the interconnectors. In managing these interconnectors, we in Nordel aspire to the principle of reciprocity, in other words we work on the basis that all market players have equal rights on both sides of the border.

Several interconnectors between the Nordic countries and our neighbouring areas have been built and are owned by market players as own interconnectors. On other interconnectors, capacity is sold on subscription or on long-term contracts to market players. Utilising these interconnectors is therefore limited to a small number of players, and this leads to capacity not always being used to the optimum.

On the interconnector between Western Denmark and Germany, the TSOs on both sides of the border have established a co-ordinated explicit auctioning of capacity. Initially, these auctions were held on a yearly and monthly basis, but this meant that the market players risked not being able to make use of the purchased capacity for trading electric power if market developments went in another direction than expected. Since daily auctions were introduced, at which all unused capacity is auctioned off (the "use it or lose it" principle), the dynamics of the interplay between the German and Nordic markets have been considerably better. The volume of trading has increased markedly during the past year. This interconnector is therefore the one that has progressed furthest in terms of the flexible use of capacity, despite the difference between the German and Nordic electricity markets.

The Nordic region within the single European market

In connection with the opening up of the electricity market in Europe, most attention has been devoted to the problem of congestion management, along with rules for cross-border trade and the exchange of information. The European Commission has been working on this, among other things in collaboration with ETSO (Association of European Transmission System Operators) and CEER (Council of European Energy Regulators).

The draft amendment to the Internal Market for Electricity Directive (96/92 EC) presented by the European Commission contains a separate appendix that deals with general guidelines for congestion management in the European electricity market. These guidelines include approaches to congestion management, access to information, capacity constraints, and preferred methods of congestion management.

The general part of the draft states that temporary bottlenecks must be managed in an economically efficient manner, which at the same time will provide incentives for investments in both grid and generation facilities in the right places. In order to minimise the negative effect of bottlenecks on electricity trading, grid capacity must be utilised to the maximum within the secure operation of the power system. The TSOs must state openly and in a non-discriminatory manner the methods of congestion management they intend to use. The price signals given from congestion management must be target-specific, and the aim must be to use the net power flow as the basis, so that capacity can be utilised to the maximum. The "use-it-or-lose-it" principle must be applied. The power grid in Continental Europe is highly meshed. Since using border interconnectors has an effect on at least two sides of a national border, congestion management procedures that can affect the flow in another country may not be determined unilaterally by an individual country.

The TSOs are required to establish an appropriate mechanism for the exchange of information, so that the safe and secure operations of the power system can be guaranteed. Relevant data on interconnector capacities with transmission constraints must be published. A general description of how these capacities are calculated must also be published.

The draft states clearly that congestion problems must be managed with market-based solutions. The preferred methods are those that give the correct price signals both to the market players and the TSOs. The methods must not be transaction-based. The system of price areas or market splitting, such as that used in Nord Pool's market area, is the method of congestion management that best satisfies these requirements.

Until international power exchanges have been established in Continental Europe, explicit auctions or co-ordinated redispatching over national borders are the methods most likely to be used here in the short term. Cutting transmissions to manage congestion should only be used in emergency operations.

Before providing more detailed rules on how explicit auctions should be conducted if that method is chosen, the guidelines end by stating that the method which uses a combination of market splitting for permanent bottlenecks and counter-trading for temporary bottlenecks should be examined as a matter of urgency to see whether it can offer a more permanent way of resolving the problem of congestion.It is interesting to note that the solution being proposed here is identical to the combined solution with price areas and counter-trading that has developed internally within the Nordic market. Our experience has shown that, in practice, the combined solution is robust enough to cope with changed physical framework conditions with big variations in power generation and the composition of generation capacity. The solution has also proved to be robust in the face of the structural changes in the electricity market that have accompanied its continuing expansion, and which have occurred as a result of deregulation.

The combined solution employed in the Nordic region has grown from a starting point where there were a number of different electricity markets in the Nordic countries, and accordingly different views on how to manage congestion. Norway, for example, chose the price area model, while the other countries opted for counter-trading. Gradually as the electricity market has developed, a common understanding has arisen that structural bottlenecks are best dealt with using the price area model, while temporary bottlenecks are best handled by counter-trading.

The market-based congestion management used in the Nordic region rests on a large number of assumptions. The grid is owned and managed in large measure by the TSOs, who are independent of the market players. Border tariffs are being, or will soon be, removed. A joint power exchange, Nord Pool, has been developed to serve the Nordic countries, and the TSOs have given Nord Pool responsibility for resolving the congestion problems between the spot areas. Without this development of the electricity market and this co-operation between the TSOs, market-based congestion management would not have been possible.

The pragmatic development of the electricity market and congestion management that has taken place in the Nordic region appears to have worked more successfully than other solutions used elsewhere in the world, where attempts have been made to resolve all problems theoretically before the market was started up. However, there is still room for improvement in the Nordic market model.

In the Nordic countries, we are currently investigating a new way of dividing up the joint Nordic electricity market according to the structural bottlenecks in the grid, but independently of national borders. The purpose of using such a division is to make differences in area prices reflect the actual physical constraints in the grid, thus providing the market players with better signals as to where surplus and shortfall areas are located.

A new division of the Nordic electricity market may also in the long term enable counter-trading to be used jointly by the TSOs within price areas that overlap national borders, instead of, as the system is today, only internally within an individual country's price areas. This will increase the utilitarian value of co-ordinated system operation in the Nordic electricity market. Such a fundamental change in the Nordic electricity market will naturally take some time to bring about.

This article was written in collaboration between *Kjell Rønningsbakk,* Kraft*Nytt*.no, *Ole Gjerde,* Statnett SF, *Kurt Lindström,* Fingrid Oyj, *Flemming Birck Pedersen,* Elkraft System amba, *Christina Simón,* Svenska Kraftnät and *Torbjørn Sletten,* Statnett SF.

Definitions:

Subscription:
Here: A specific proportion of the capacity in a transmission interconnector that is sold to other market players by the owner of the interconnector for short or long periods.

Clearing:
Here: Co-ordinating bids and offers in spot trading on the power exchange, and through that determining the price and volume traded.

Explicit auction:
Auction of capacity on a transmission interconnector at certain intervals.

Bottleneck:
Congestion or constraint in transmission capacity in an electric power grid.

Channel:
An interconnector built to fulfil a power trading agreement or a specific agreement for the purchase of electric power.

Implicit auction:
An auction where the purchase of the required transmission capacity in the grid and the sale of energy is performed in one and the same operation. This is also known as the price area model. Other terms used are market splitting and market coupling.

ISO:
Independent System Operator. A system operator that does not itself own the grid.

Counter-trade:
Where a TSO buys on the surplus side of a bottleneck and sells on the shortfall side, so that the market's distribution requirement is satisfied while at the same time the physical capacity in the grid is fully utilised.

Area price:
The spot price in a price area. Area prices arise when there are bottlenecks in the transmission grid, so that different prices occur in sub-areas of the market

Price area:
Area with identical spot price in a specific period.

Redispatching:
Co-ordinated upward or downward regulation of generation carried out by a central body, which in a deregulated system is the system operator. The direction is given on the basis of marginal generation costs. The prerequisite for using this method is that all economic data for power generation on the individual units is available to the system operator.

Real time market:
A short-term market where the generators bid to increase or decrease their generation. Similarly, large consumers can bid to reduce their consumption.

Third Party Access (TPA):
Access to the grid for all players on equal terms.

TSO:
Transmission System Operator. A system operator that owns and operates the grid.

"Use-it-or-lose-it" principle:
Market players with the capacity over an interconnector at their disposal must make clear within a given time limit whether they intend to use that capacity. Any unutilised capacity will be made available on equal terms to all the players in the market.

Statistics

100
90
80
70
60
50
40
30
20
10
0
1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 1.10 1.11 1.12 31.12

Definitions, units and symbols

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.

Imports/exports:
The monthly sums (in GWh) of the physically registered MWh values for each connection between the individual countries, per hour of exchange. Net imports is the difference between imports and exports.

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 on a later occasion; 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 back-pressure generation.

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
-	No value

Calculation of the electricity consumption

Electricity generation
\+ Imports
\- Exports

= Total consumption
\- Occasional power to electric boilers

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

= Net consumption

Responsible for statistical data on the individual countries:
Jørgen Olsen – Elkraft System, Denmark East
Henning Parbo – Eltra, Denmark West
Aki Laurila – Fingrid, Finland
Ólafur Pálsson – Iceland Energy Agency, Iceland
Jan Foyn – Nord Pool ASA, Norway
Lars Munter – Svenska Kraftnät, Sweden

Responsible for processing of the statistics:
Arne Hjelle – Nord Pool ASA, Norway

The present statistics were prepared before the 2000 official statistics for the individual countries had become available. Certain figures in the Annual Report may thus differ from the official statistics.

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

S1 Installed capacity on 31 Dec. 2000, MW

	Denmark [7]	Finland	Iceland	Norway	Sweden	Nordel
Installed capacity, total [1]	11 940	16 576	1 353	27 781	30 894	**88 544**
Hydropower	11	2 938	1 060	27 463	16 229 [2]	**47 701**
Nuclear power	.	2 640	.	.	9 439	**12 079**
Other thermal power	9 548	10 960	121	305	4 985	**25 919**
- condensing power [3]	958	3 912	.	73	448	**5 391**
- CHP, district heating	7 815 [4) 5]	3 692	.	12	2 264	**13 783**
- CHP, industry	487 [6]	2 478	.	185	932	**4 082**
- gas turbines, etc.	288	878	121	35	1 341	**2 663**
Other renewable power	2 381	38	172	13	241	**2 845**
- wind power	2 381	38	.	13	241	**2 673**
- geothermal power	.	.	172	.	.	**172**
Commissioned in 2000	1 039	210	63	33	260	**1 605**
Decommissioned in 2000	186	92	0	0	251	**529**

[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 (700 MW).
[4] Includes the German share of Enstedværket (342 MW).
[5] Includes long-time reserve of Vendsyssleværket (305 MW).
[6] Included industrial generated producer (apr. 35 MW).
[7] New routine of reporting compared with 1999.

S2 Average-year generation of hydropower in 2000, GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Average-year generation 2000	-	12 720	6 380	117 900	64 000	**201 000**
Average-year generation 1999	-	12 716	5 940	117 755	64 000	**200 411**
Change	-	4	440	145	0	**589**
Reference period	-	1961-90	1950-95	1970-99	1950-90	

S3 Changes in installed capacity in 2000

Power category	Power plant	Commiss-ioned MW	Decommiss-ioned MW	Change in average-year generation (hydropower) GWh	Type of fuel
Denmark					
Condensing power	Skærbækværket blok 1		100		Coal / oil
	Vendsysselværket blok 2	305 [1) 2)]			Coal / oil
	Enstedværket blok 3	52 [2)]			Coal / oil
	Herningværket	5			Natural gas
	Others		86		Various
CHP, district heating	Others	21			Biofuel, waste
	Others	11			Natural gas
	Others	1			Various
CHP, industry	Others	38			Natural gas
Wind power	Others	606			
Finland					
CHP, district heating	Naistenlahti	129	54		Natural gas
CHP, industry	Anjalankoski	73	34		Natural gas
	Salo	7			Wood chips, peat
	Turenki		4		Natural gas
Hydropower	Naarkoski	1			
Iceand					
Hydropower	Sultartangi	60		440	
Geothermal power	Kaldbakur	2			
Gas turbines	Various engines for stand by	1			
Norway					
Hydropower	Eid	9		53	
	Mo	10		38	
	Staffi	4		16	
	Fossan	3		13	
	Skotselv	1		2	
	Aas	1		5	
	Tveitafoss	2		7	
	Hellandsfoss	2		8	
	Ramstaddal	1		3	
Sweden					
Hydropower	Rönnöfors (Långan)	4		14	
	Various changes	38	5		
Nuclear power	Forsmark		8		
	Ringhals		5		
Condensing power	Karlstad		4		
CHP, district heating	Lycksele	15			Biofuel
	Umeå/Dåva	15			Biofuel
	Sala	10			Biofuel
	Eskilstuna	37			Biofuel
	Eskilstuna		4		Oil
	Karlskoga		36		Gasol
	Ängelholm		29		Natural gas
	Various changes	8			
CHP, industry	Gruvön	12			
	Skoghall	29			
	Mönsterås	45			
	Various changes	5			
Gas turbines	Gunnarsbo G2		40		
	Uppsala	16			
	Lahall G3 - G4		120		
Wind power	Approx. 55 new aggregates.	26			

1) Long-time reserve.
2) Upward adjusted compared with 1999.

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

Power category	Power plant	Capacity MW	Estimated start-up Year	Average-year generation (hydropower) GWh	Type of fuel
Denmark					
CHP, district heating	Avedøreværket 2	570	2001		Natural gas / Straw / Wood chips / (Oil)
Finland					
CHP, industry	Pietarsaari	240	2001		Peat, waste wood
	Kuusankoski	55	2002		Peat, waste wood
	Jämsänkoski	20	2002		Peat, waste wood
	Äänekoski	26	2002		Peat, waste wood
CHP, district heating	Ykspihlaja	20	2001		Wood chips / waste wood
	Parkatti	15	2002		Peat, waste wood
Hydropower	Kelukoski	10	2001		
Iceand					
Geothermal power	Nejavellir II	16	2001		
Hydropower	Vatnsfell	90	2001	430	
Norway					
Sweden					
CHP, district heating	Helsingborg	60	2001		Biofuel / Natural gas
	Mariestad	10	2001		Biofuel

System load

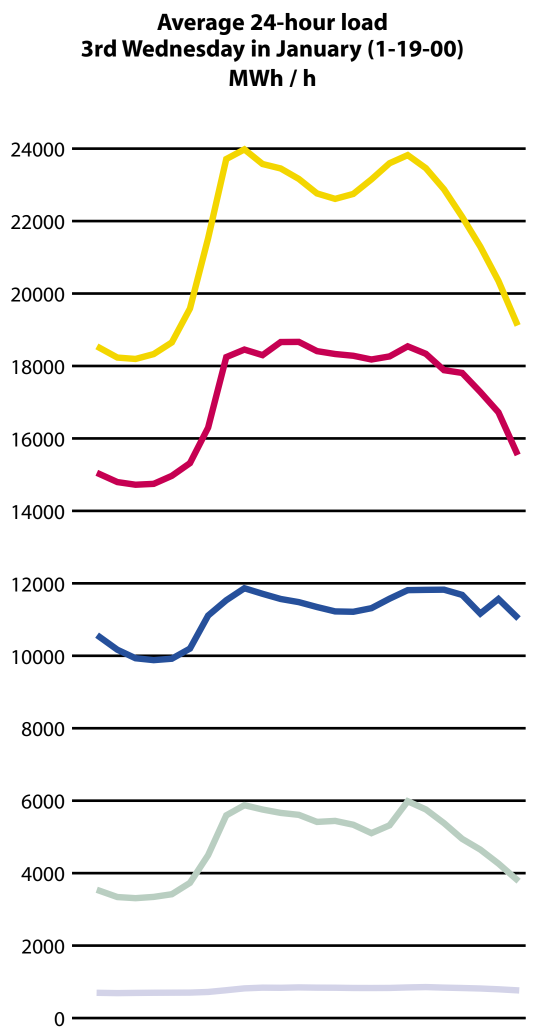
S5 Maximum system load for each country in 2000 [1)]

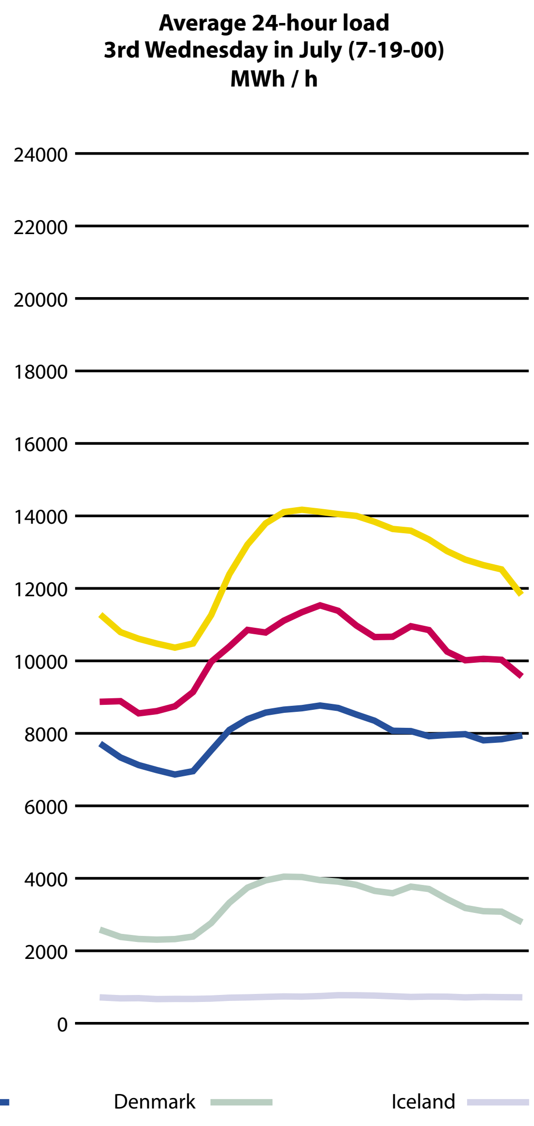
	MWh/h	Date/time
Denmark	6 284	01.24.00 at 05 - 06 PM [2)]
Finland	12 700	01.25.00 at 08 - 09 AM
Iceland	950	12.15.00 at 10 - 11 AM
Norway	20 420	12.31.00 at 05 - 06 PM
Sweden	26 000	01.24.00 at 08 - 09 AM

[1)] The system load is not corrected vs. temperatures.

[2)] Denmark-East: 2660 01.24.00 at 05 - 06 PM, Denmark-West: 3633 01.24.00 at 08 - 09 AM.

System load 3rd Wednesday in January and 3rd Wednesday in July 2000





All hours are local time

	Installed net capacity[1] 12.31.2000 GW	Maximum system load 3rd Wednesday in Jan 2000 5:00 - 6:00 PM (CET) GWh / h	Minimum system load 3rd Wednesday in July 2000 12:00 - 01:00 PM CET GWh / h
Denmark	11,9	6,0	4,0
Finland	16,6	11,8	8,7
Iceland	1,4	0,9	0,8
Norway	27,8	18,5	11,5
Sweden	30,9	23,8	14,1
Nordel	**88,6**	**61,0**	**39,1**

[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.

The grid system in the Nordic countries

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 cable km
Denmark - Norway		**From Denmark**	**To Denmark**		
Tjele-Kristiansand	250/350=	1040	1040	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	70	228	.
Finland - Sweden		**From Sweden**	**To Sweden**		
Ossauskoski - Kalix	220~	1500 [3] (Ossauskoski - Kalix, Petäjäskoski - Letsi, Keminmaa - Svartbyn)	900 [3] (Ossauskoski - Kalix, Petäjäskoski - Letsi, Keminmaa - Svartbyn)	93	.
Petäjäskoski - Letsi	400~			230	.
Keminmaa - Svartbyn	400~			134	.
Raumo - 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	1350 [4]	58	.
Røssåga - Ajaure	220~	415 [5]	415 [4,5]	117	.
Linnvasselv, transformer	220/66~	50	50	.	.
Nea - Järpströmmen	275~	490 [5]	490 [5]	100	.
Lutufallet - Höljes	132~	40	20	18	.
Eidskog - Charlottenberg	132~	100	100	13	.
Hasle - Borgvik	400~	1650 [5] (Hasle - Borgvik, Halden - Skogssäter)	2000 [5,6] (Hasle - Borgvik, Halden - Skogssäter)	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 cable km
Denmark - Germany		**From Nordel**	**To Nordel**		
Kassø - Audorf	2 x 400~	1200	1200 [3]	107	.
Kassø - Flensburg	220~			40	.
Ensted - Flensburg	220~			34	.
Ensted - Flensburg	150=	150	150	26	5
Bjæverskov - Rostock	400=	600	600	166	166
Finland - Russia		**From Nordel**	**To Nordel**		
Imatra - GES 10	110~	.	100	20	.
Yllikkälä - Viborg [2]	2 x 400~	.	1000	67	.
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 Kärrstorp - Herrenwyk	450=	600 [1]	600 [1]	250	220
Sweden - Poland (SwePol Link)					
Stärnö - Slupsk	450=	600	600	256	256

[1] The transmission capacity is currently limited to 450 MW from Nordel and 400 MW to Nordel due to limitaion in the German network.
[2] Back to Back HVDC (+85 kV =) in Viborg.
[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 as per design rules MW	Total length of line km	Of which cable km	Estimated commissioning Year
Denmark - Denmark (Storebælt/The Great Belt) Eltra - Elkraft System	400=	500-600	ca 70	ca 70	[1]
Finland - Russia Kymi - Viborg	400~	400	132		2003
Norway - The Netherlands (NorNed Kabel) Feda - Eemshaven	±450=	min 600	ca 570	ca 570	2004
Norway - Germany (Viking Cable) Feda - Brunsbüttel	500=	min 600	580	580	2004

[1] According to plans, the Great Belt connection will be in operation in 2004. The capacity can be less than 500-600 MW. The Minister of the Environment and Energy has the authority to decide on the connection.

Transmission lines

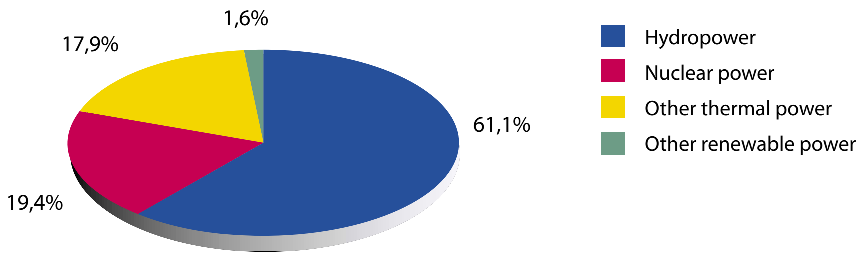
S9 Transmission lines of 110-400 kV in service on 31 Dec. 2000

	400 kV, AC and DC km	220-300 kV, AC and DC km	110, 132, 150 kV km
Denmark	1 318 [1]	504 [2]	3 992 [3]
Finland	3 926 [4]	2 510	15 050
Iceland	94 [6]	508	1 315
Norway	2 144	5 639 [2]	10 463
Sweden	11 063 [5]	4 602 [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 2000

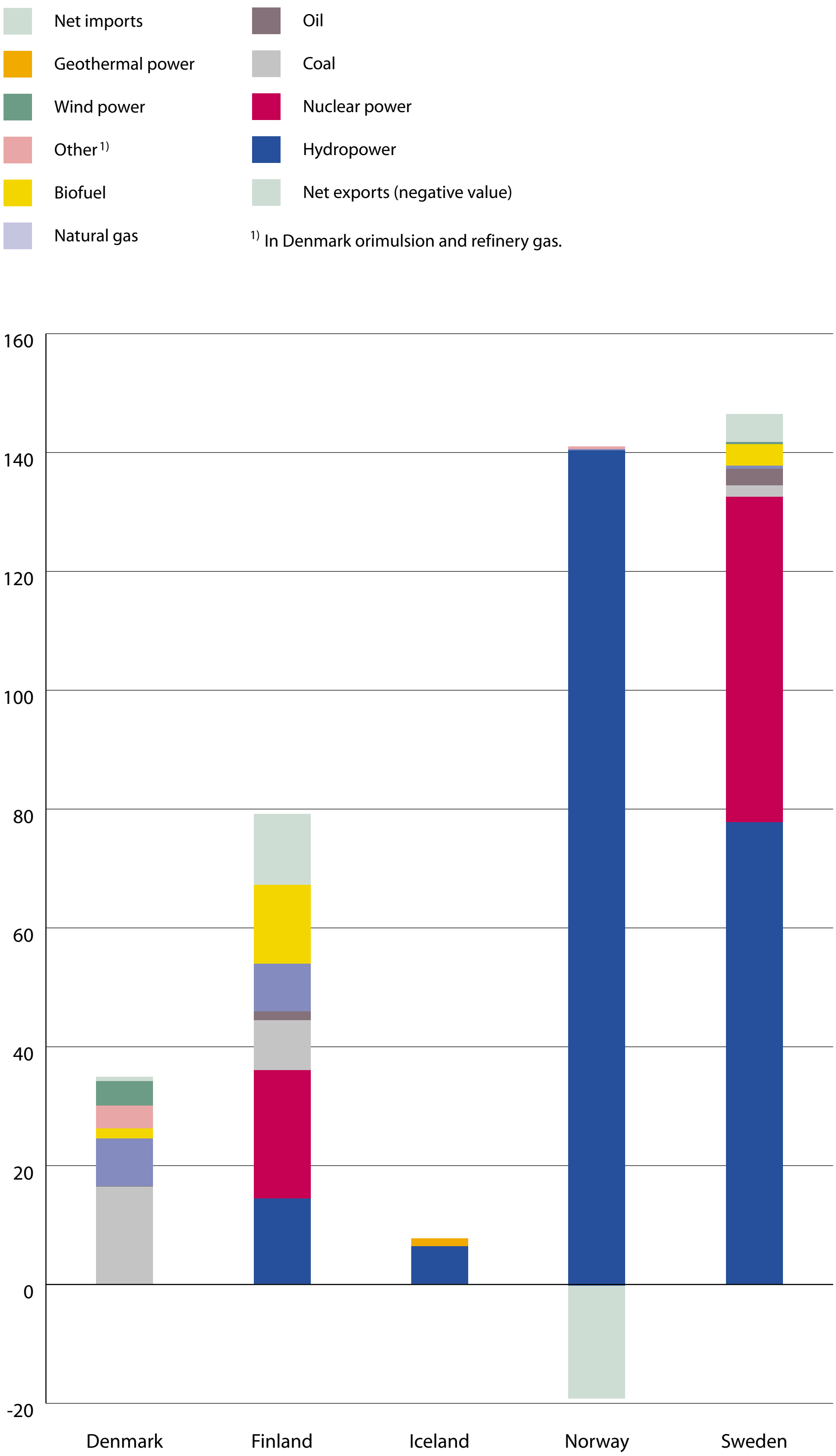


S11 Electricity generation 2000, GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total generation	34 230	67 190	7 678	142 847	141 894	**393 839**
Hydropower	30	14 360	6 352	142 134	77 845	**240 721**
Nuclear power	.	21 573	.	.	54 757	**76 330**
Other thermal power	29 957	31 178	4	684	8 854	**70 677**
- condensing power	..	6 542	.	157	261	**6 960**
- CHP, district heating	27 751 [1]	12 756	.	.	4 231	**44 738**
- CHP, industry	2 206	11 879	.	315	4 333	**18 733**
- gas turbines, etc.	-	1	4	212	29	**246**
Other renewable power [2]	4 243	79	1 322	29	438	**6 111**
Total generation 1999	36 835	66 655	7 184	122 874	150 510	**384 058**
Change as against 1999	-7,1%	0,8%	6,9%	16,3%	-5,7%	**2,5%**

[1] Includes generation in combined heat and power stations.
[2] Wind power and, for Iceland, geothermal power.

S12 Total electricity generation by energy source, and net imports and exports 2000, TWh

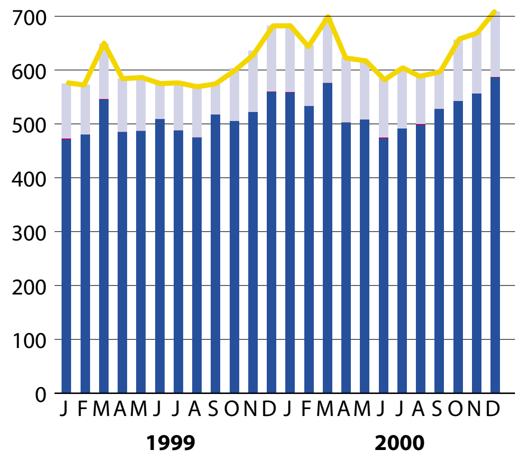


[1] In Denmark orimulsion and refinery gas.

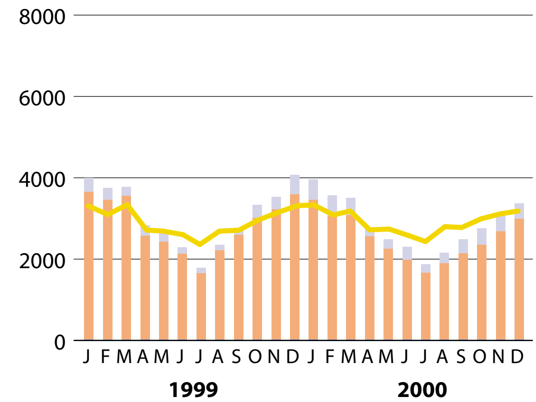
S13 Monthly generation and total consumption of electricity 1999-2000, GWh

- Total consumption
- Wind power or geothermal power
- Nuclear power
- Other thermal power
- Hydropower

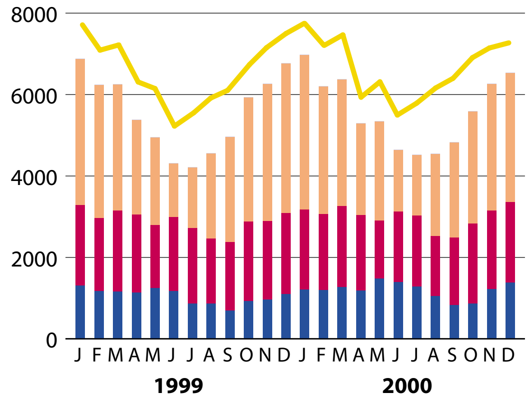
Iceland



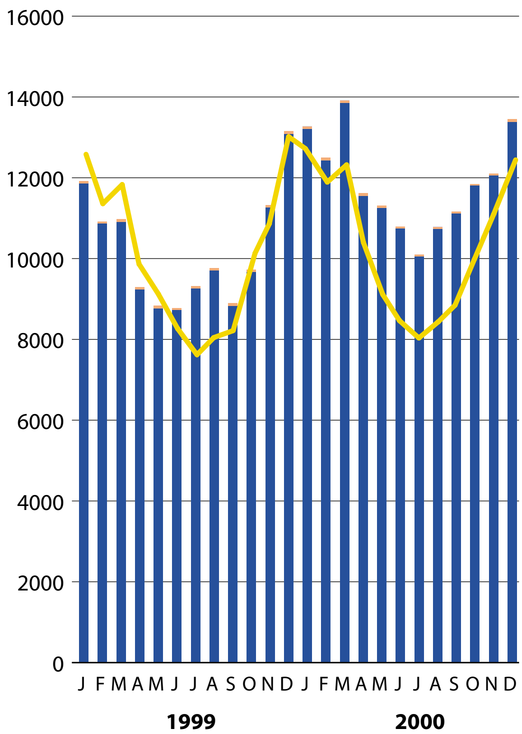
Denmark



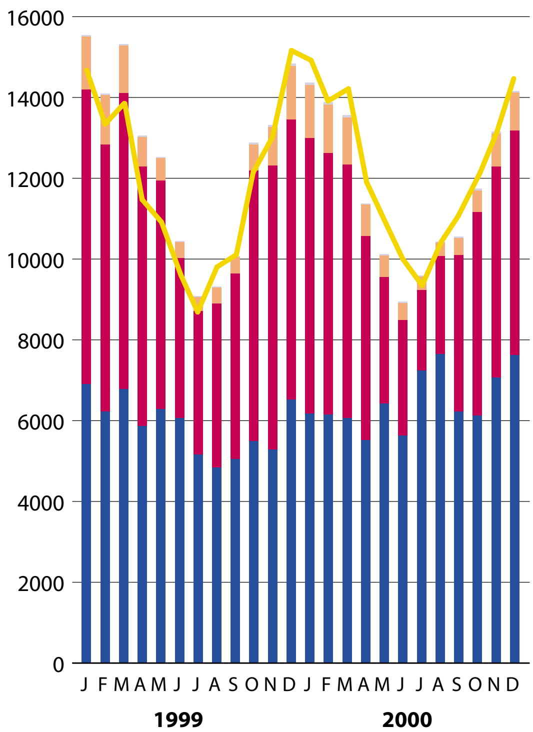
Finland



Norway

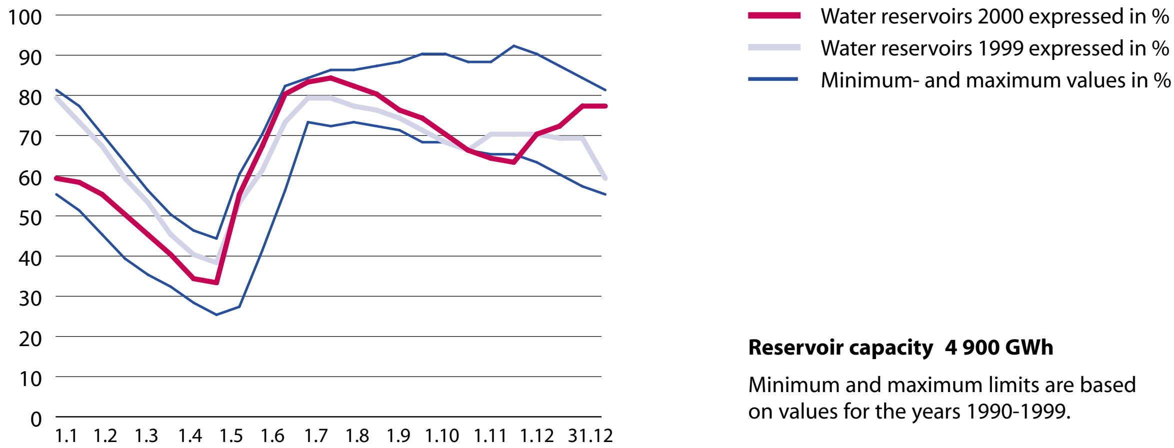


Sweden



S14 Water reservoirs 2000

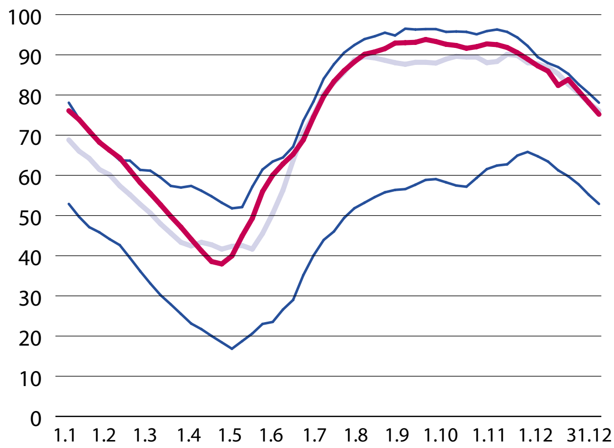
Finland



Reservoir capacity 4 900 GWh

Minimum and maximum limits are based on values for the years 1990-1999.

Norway

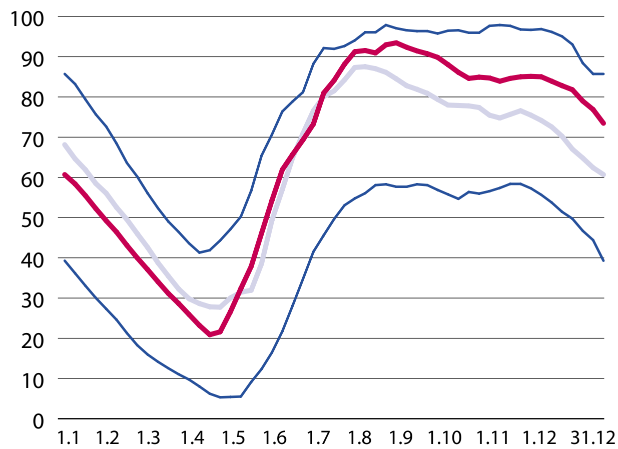


Reservoir capacity

1.1.2000	**81 893 GWh**
31.12.2000	**81 729 GWh**

Minimum and maximum limits are based on values for the years 1990-1999.

Sweden

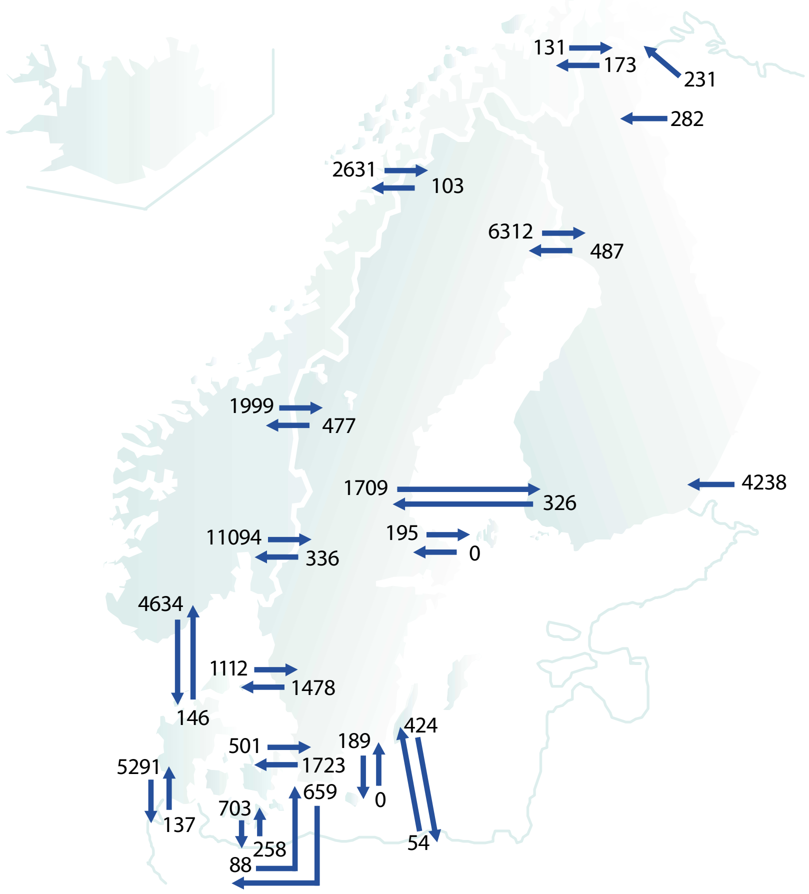


Reservoir capacity 33 748 GWh

Minimum and maximum limits are based on values for the years 1950-1999.

Exchange of electricity

S15 Exchange of electricity 2000, GWh



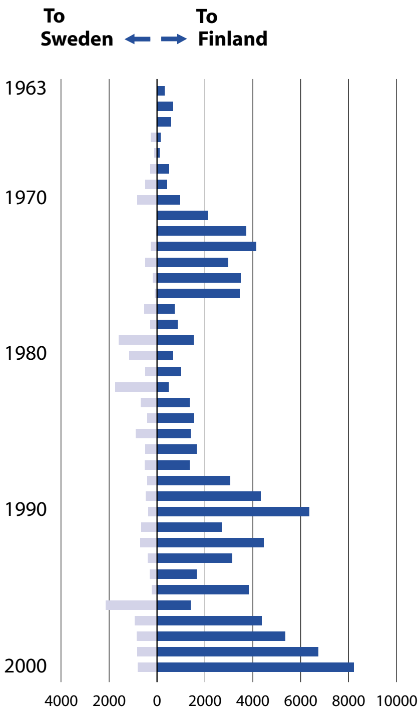
S16 Imports and exports 2000, GWh

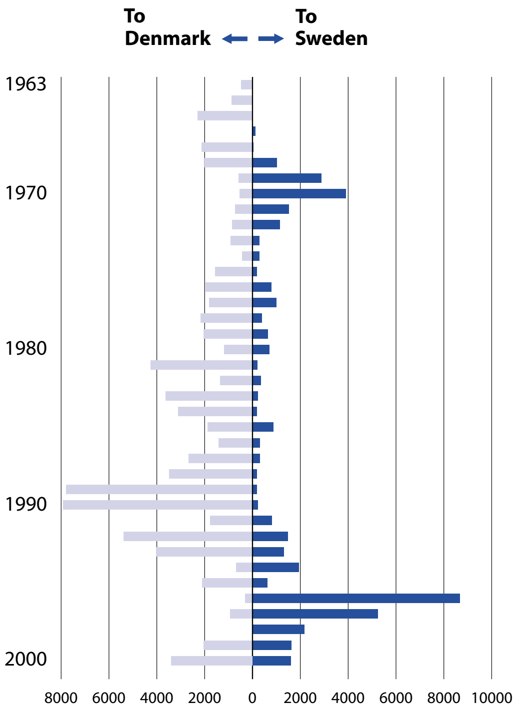
Exports from:	**Imports to Denmark**	**Finland**	**Norway**	**Sweden**	**Other countries[1]**	**S Exports**
Denmark	.	.	146	1 613	5 994	**7 753**
Finland	.	.	173	813	.	**986**
Norway	4 634	131	.	15 724	.	**20 489**
Sweden	3 390	8 216	916	.	1 083	**13 605**
Other countries[1]	395	4 520	231	142	.	**5 288**
S **Imports**	8 419	12 867	1 466	18 292	7 077	**48 121**

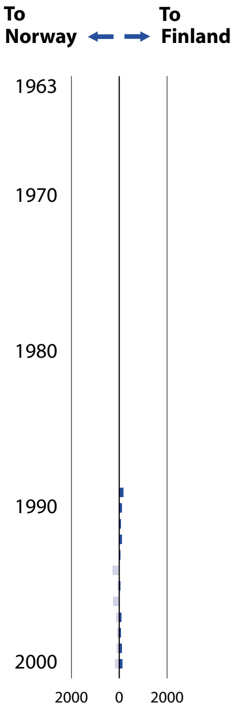
	Denmark	**Finland**	**Norway**	**Sweden**	**Nordel**
Total imports	8 419	12 867	1 466	18 292	**41 044**
Total exports	7 753	986	20 489	13 605	**42 833**
Net imports	666	11 881	-19 023	4 687	**-1 789**
Net imports / total consumption	1,9 %	15,0 %	-15,4 %	3,2 %	**-0,5 %**

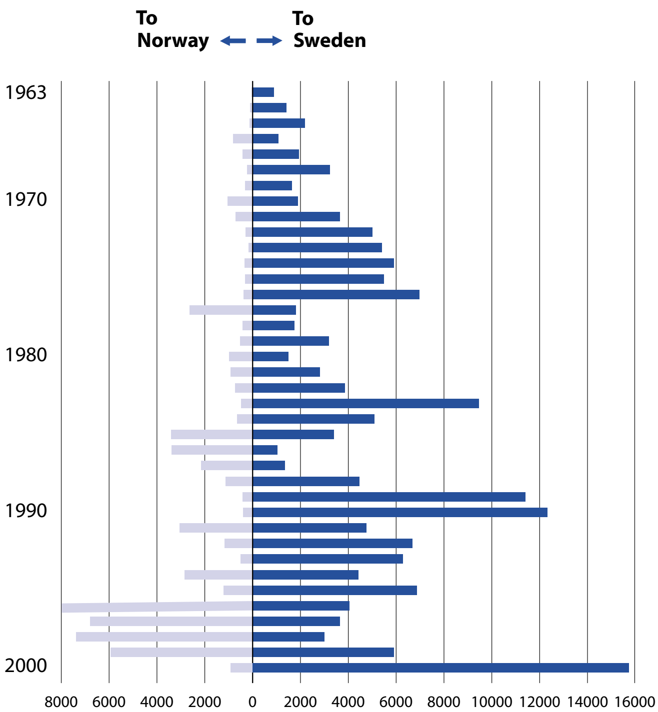
[1] Germany, Russia and Poland.

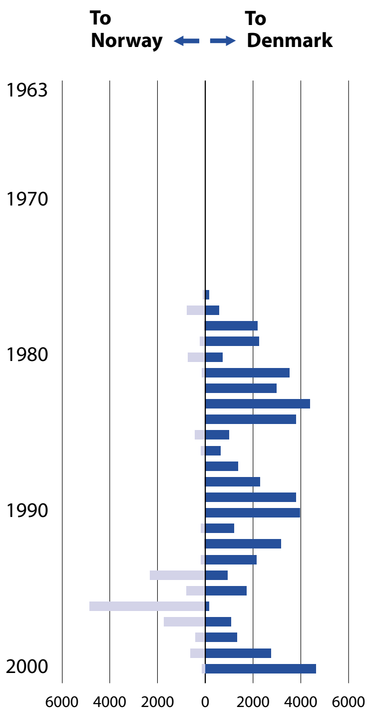
S17 Exchange of electricity between the Nordel countries 1963 - 2000, GWh



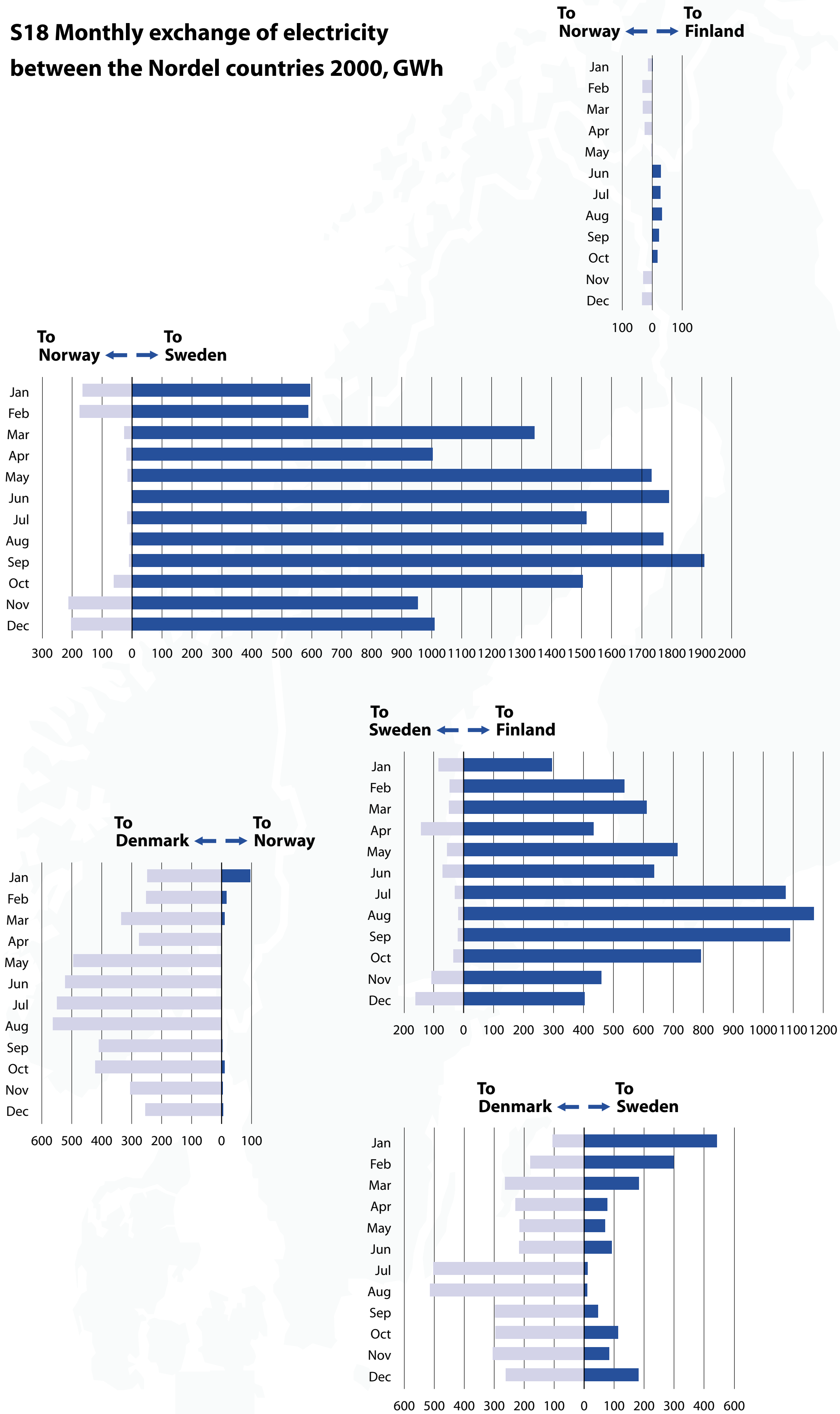






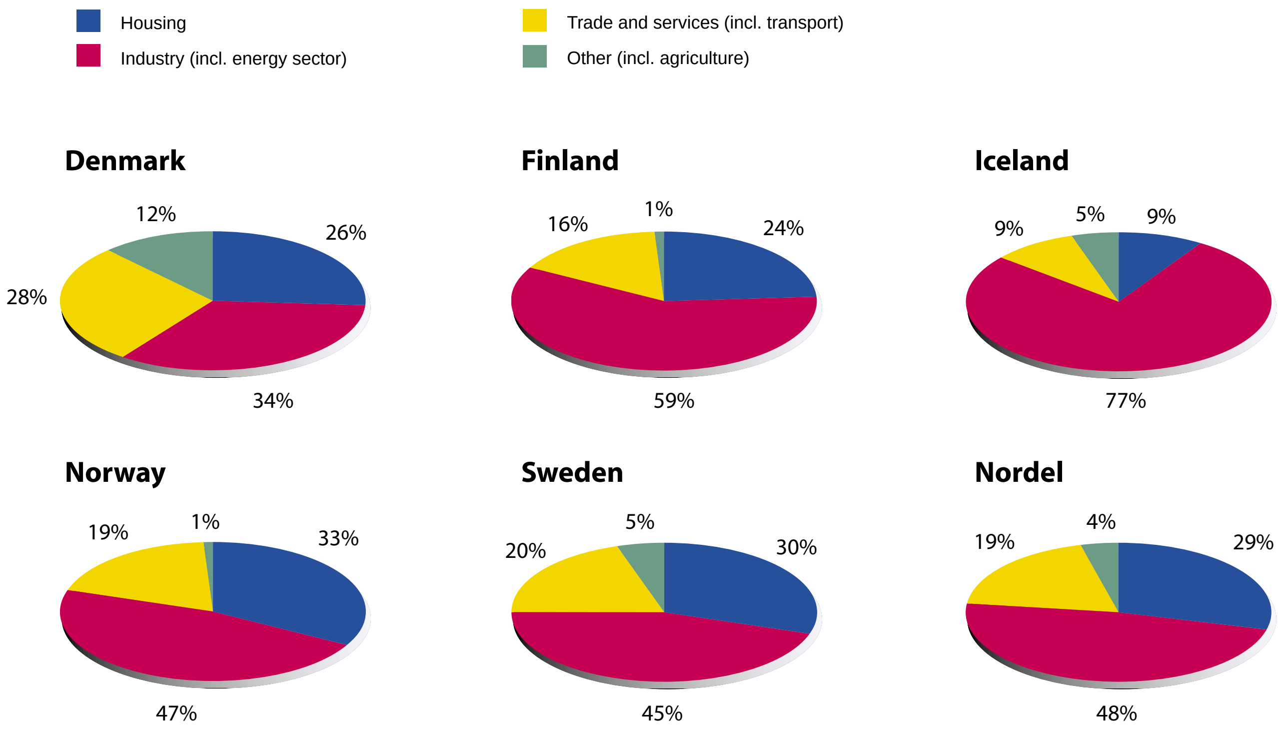


S18 Monthly exchange of electricity between the Nordel countries 2000, GWh



Electricity consumption

S19 Net consumption of electricity 2000, by consumer category

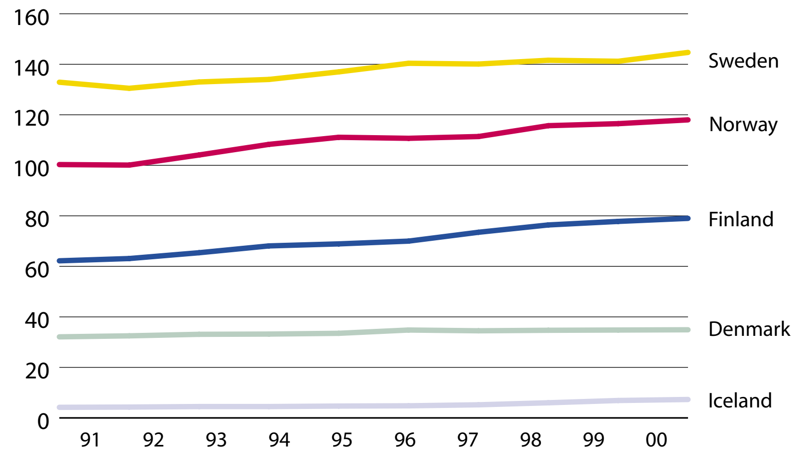


S20 Electricity consumption 2000, GWh

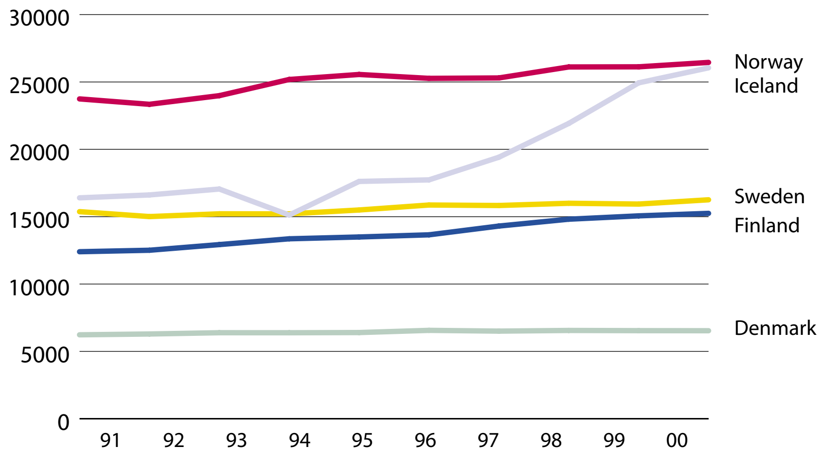
	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total consumption	34 896	79 071	7 678	123 824	146 581	**392 050**
Occasional power to electric boilers	.	77	332	5 847	1 900 [1]	**8 156**
Gross consumption	34 896	78 994	7 346	117 977	144 681	**383 894**
Losses, pumped storage power	2 148	2 901	411	10 256	11 707	**27 423**
Net consumption	32 748	76 093	6 935	107 721	132 974	**356 471**
- housing	8 560	18 098	624	35 332	40 500	**103 114**
- industry (incl. energy sector)	11 190	45 026	5 330	50 198	60 300	**172 044**
- trade and services (incl. transport)	8 930	12 119	616	21 006	25 500	**68 171**
- other (incl. agriculture)	4 068	850	365	1 185	6 674	**13 142**
Population (million)	5,340	5,181	0,282	4,460	8,900	**24,163**
Gross consumption per capita, kWh	6 535	15 247	26 050	26 452	16 256	**15 888**
Gross consumption 1999	34 701	77 705	6 908	116 516	141 863	**377 693**
Change as against 1999, %	0,6 %	1,7 %	6,3 %	1,3 %	2,0 %	1,6 %

[1] Only electric boilers at district heating plants shown.

S21 Gross consumption 1991 - 2000, TWh



S22 Gross consumption per capita 1991 -2000, kWh

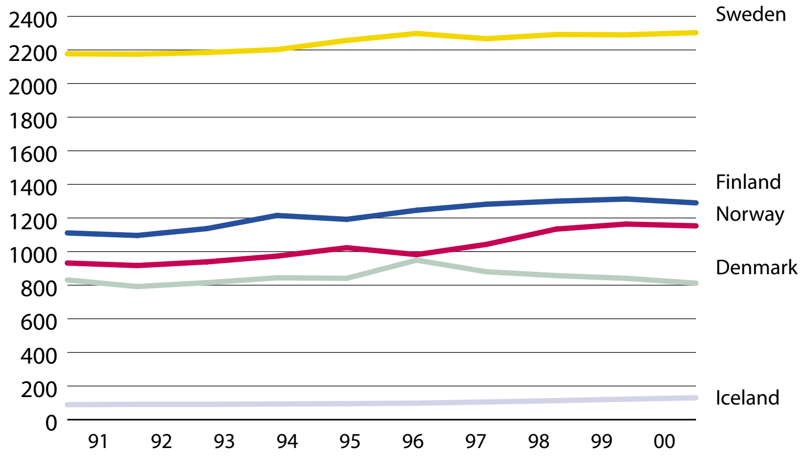


S23 Total consumption 2000, GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Generation 2000	34 230	67 190	7 678	142 847	141 894	**393 839**
Net imports 2000	666	11 881		-19 023	4 687	**-1 789**
Total consumption 2000	34 896	79 071	7 678	123 824	146 581	**392 050**
Generation 1999	36 835	66 655	7 184	122 874	150 510	**384 058**
Net imports 1999	-2 165	11 124		-1 883	-7 588	**-572**
Total consumption 1999	34 670	77 779	7 184	120 991	142 922	**383 546**

Total energy supply

S24 Total energy supply 1991 - 2000, PJ



Prognoses

S25 Gross consumption of electricity 2000 and prognoses for 2001, 2005 and 2010, TWh

	Denmark	Finland	Iceland	Norway	Sweden
2000 [2]	35	79	7,3	118	145
2001	35	81	7,7	129	147 [1]
2005	36	87	8,1	130	149 [1]
2010	37	93	8,4	134	153 [1]

[1] Prognoses based on data from Statens Energimyndighet.
[2] The consumption is not corrected vs. temperatures.

S26 Maximum system load 2000 and prognoses for 2001, 2005 and 2010, MW

	Denmark	Finland	Iceland	Norway	Sweden
2000 [4]	6 284	12 700	1 040	20 420	26 000
2001 [1]	6 468	13 600 [2]	1 140	23 400 [2]	26 700 [3]
2005 [1]	6 616	15 100	1 180	23 700 [2]	27 100 [3]
2010 [1]	6 856	16 100	1 200	25 200 [2]	27 800 [3]

[1] Includes supply to electric boilers only for Iceland.
[2] Prognoses according to 10 years winter temp.
[3] Prognoses based on data from Statens Energimyndighet.
[4] The consumption is not corrected vs. temperatures.

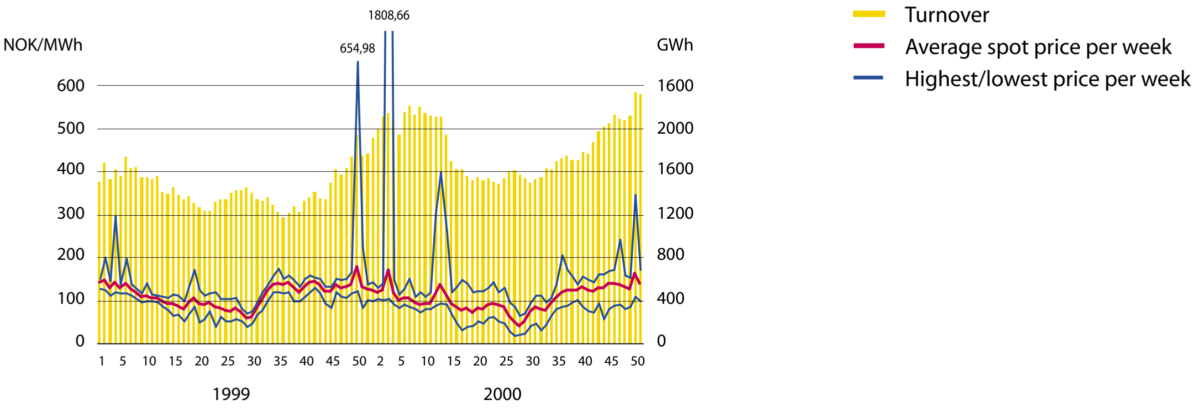
S27 Installed capacity [1] 2000 and prognoses for 2001, 2005 and 2010, MW

	Denmark	Finland	Iceland	Norway	Sweden
2000	11 940	16 576	1 353	27 749	30 894
2001	11 941	16 800	1 440	27 781	31 000
2005	13 102	[2]	1 470	28 200	31 100
2010	14 240	[2]	1 520	30 100	31 800

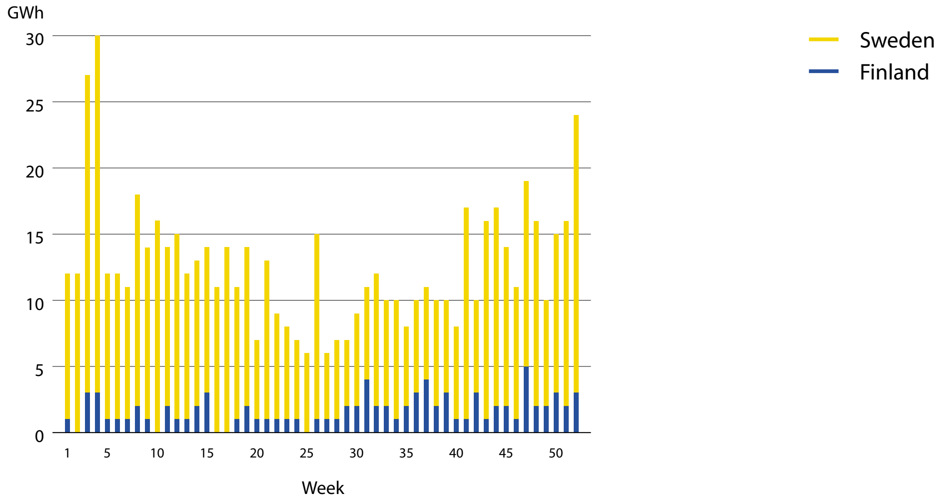
[1] Refers to the sum of the rated net capacities of the individual power plant units in the power system, and should not be considered to represent the total capacity available at any single time.
[2] Prognoses not available.

S28 Spot prices and turnover on the Nordic electricity exchanges 1999-2000

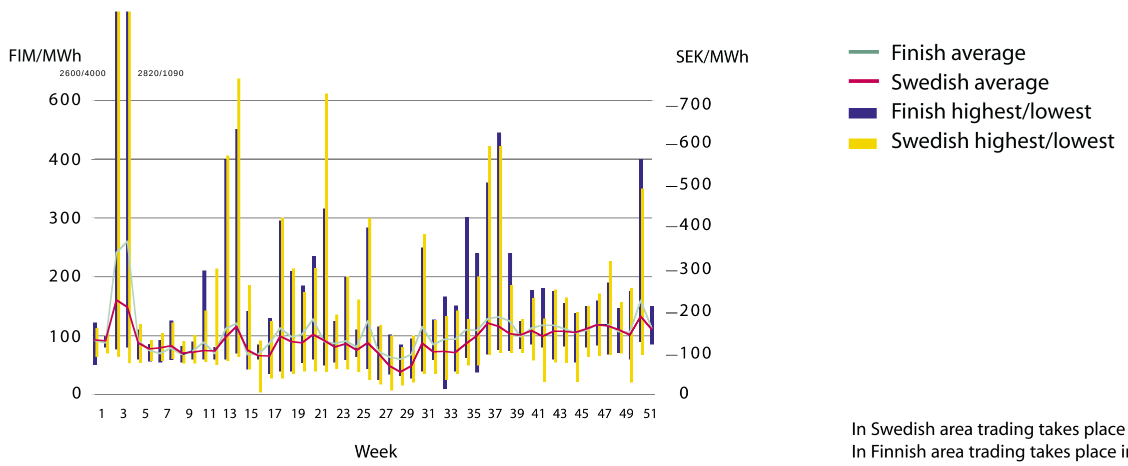
Nord Pool ASA spot market - average systemprice and turnover per week



ELBAS market - turnover per week 2000



ELBAS market - price per week 2000



In Swedish area trading takes place in SEK.
In Finnish area trading takes place in FIM.

Information on the environment

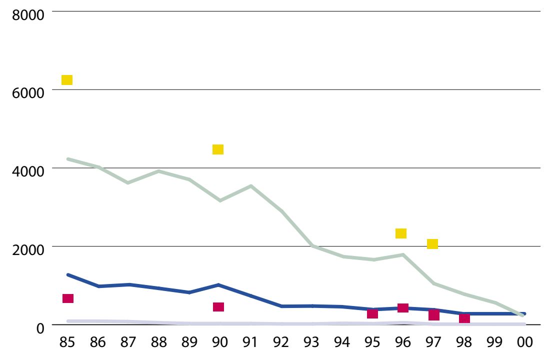
Environmental aspects play a central role in the electricity sector. Actors in this sector take an active part in the work under way within the European Union for development of programmes and rules in order to limit emissions harmful for the environment. Similarly, long-range measures have been taken to reduce emissions from power generation by introducing new combustion and purification techniques and by utilising CHP plants of high efficiency. The active trade in power between the Nordel countries has also helped reduce environmental impacts by ensuring that effective use is made of production resources.

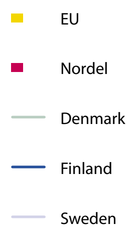
The diagrams below show the emissions of SO_2, NO_2 and CO_2 in relation to total electricity generation in each country. The high proportion of thermal power in the Danish and Finnish systems increases the emission figures in these countries. The Norwegian and Icelandic emissions are negligible because virtually all electricity generation is based on hydropower and geothermal power.

The emissions show a steady downward trend in the long term. The year 1996 was an exception because the unusually dry weather conditions led to a sharp increase in the consumption of fossil fuels. However, the data for 1997 to 1999 show that the general trend follows the previous pattern.

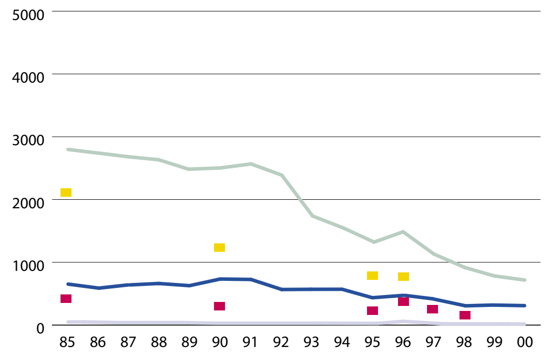
Average emissions within the EU and within Nordel are given for some reference years. On the whole, emissions from the Nordel countries seem to be somewhat lower. However, the diagrams should merely be considered as indicating a trend because, for instance, the exact proportions of emissions from combined heat and power generation cannot be defined without ambiguity. The charts are to be viewed as indicative, in part because different calculation methods have been employed in preparing them. When electricity and heat are produced for distribution at the same thermal power plant, significantly greater fuel energy conversion efficiency is achieved. There is no single internationally recognized method for apportioning plant emissions due to electricity or heat production. In this presentation we have used a total energy approach, in which electricity and heat are viewed as equal products. This method assigns electricity the full benefits of heating.

SO_2 - mg/kWh

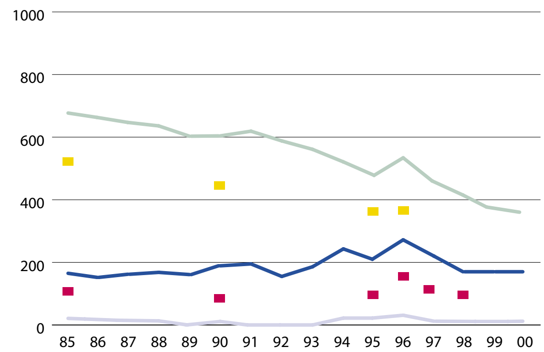




NO_2 - mg/kWh



CO_2 - g/kWh



Current Nordel recommendations

- **Availability Concepts for Thermal Power**
  September 1977

- **Localisation of System Oscillations Equipment**
  August 1992

- **Network Dimensioning Criteria**
  August 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

During the autumn 2001 all the recommendations will be available from the Nordel website www.nordel.org

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Photo: Gro Berglund, Statnett SF.

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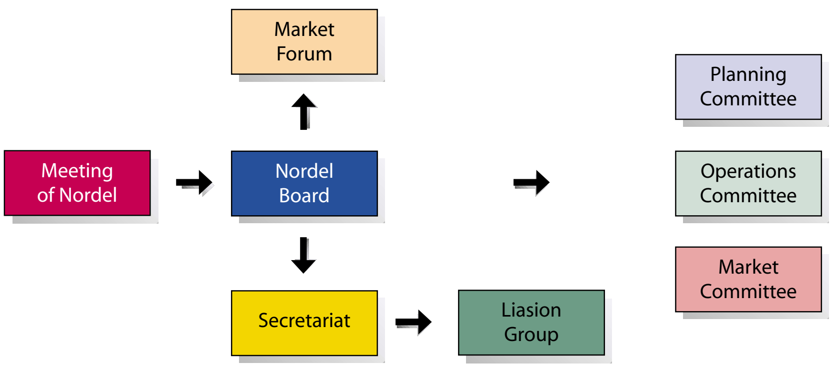
Organization Structure



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