

Nordel	2
Report of the Board of Nordel	3
Status of Work in Progress	5
Development of the Nordic Electricity System	6
Events of the Year	10
Members of the Board of Nordel	11
The Planning Committee's Activities	12
The Operations Committee's Activities	14
The Market Committee's Activities	16
The Future Infrastructure of the Nordic Electricity System	18
Statistics	26
Current Nordel Recommendations	48
Nordel Members and Organisation	49
Nordel Organisation Chart	50

Nordel

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

Nordel also serves as a forum for contact and co-operation between the TSOs and representatives of the market players in the Nordic countries. In order to create the right conditions for the development of an efficient electricity market, it is important for the TSOs to meet with the market players for mutual exchange of views.

A Market Forum has been set up within the new Nordel organisation in order to pursue this dialogue.

Nordel's strategy has been formulated in the following vision: Nordel shall:

- Act as one Nordic TSO and be the basis for a harmonised Nordic electricity market
- Be in the front rank in the development of the Nordic electricity market
- Be a strong force in the development of the European electricity market
- Have the ability to react quickly to challenges, make decisions and have a shared commitment to implementing them.

The Nordel vision results in a number of tasks in the following categories:

 System development and rules for network dimensioning, including coordination of grid investments and congestion management

- System operation, operational security, reliability of supply and exchange of information
- Principles of transmission pricing and pricing of ancillary services, including transit solutions
- International co-operation
- Maintaining and developing contacts with organisations and regulatory authorities in the power sector, particularly in the Nordic countries and Europe
- Preparing and disseminating neutral information about the Nordic electricity system and market.

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

Nordel's executive body is the Board, composed of one representative from each of the Nordic TSOs. The Board of Nordel makes initiatives and decisions on topical issues, and implements the decisions taken at Nordel's Annual Meeting. The Board is also responsible for the organisation's external information activities.

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

Report of the Board

Focusing on Security of Supply

In 2003, large parts of the world seriusly focused on the security of supply. Likewise also in the Nordic countries where the dry period with prices as high as ever in the beginning of the year and the spectacular blackout of the system in Southern Sweden/Eastern Denmark in September caused a great deal of media attention. This was not least spurred by the almost simultaneous interruptions in the supply in North America and Southern Europe that flashed up in the faces of the public.

As a consequence of these disturbances, Nordel is in the process of assessing whether the Nordic electricity system is sufficiently dimensioned to live up to society's need for a reliable supply of electricity. As a first step, the rules behind the System Operation Agreement and the grid dimensioning criteria are being reviewed. The outcome of this initial process will be presented at the Annual Meeting in Nordel in June 2004. Following that, Nordel will decide whether the criteria are to be made stricter. One aim of the process is to reduce the risk of new serious interruptions arising in the Nordic electricity system and to ensure faster re-establishment of the system should this adverse situation arise.

At their meeting in late September, the Nordic ministers of energy emphasised the need to expand the collaborative efforts between the TSOs, one of the intentions being to secure the security of supply and to reinforce the functioning of the Nordic electricity market.

Nordel fully supports the stance taken by the ministers of energy and is ready to introduce targeted measures in order to improve the Nordic electricity market to the benefit of customers as well as market players. An essential part of this process is clear political signals and decisions specifying to what extent the individual countries are willing to accept that a common Nordic approach is given a higher priority than national interests.

One of the most important responsibilities of the TSOs is to ensure the relevant framework for an efficient and well-

A TE Balas

functioning market. The Nordic Grid Master Plan 2002 demonstrated that the Nordic countries are building up a considerable energy deficit. In 2003, an ad hoc task force under the auspices of the Nordel Planning Committee conducted an analysis of the infrastructure of the Nordic electricity system. According to the conclusions of the report (published in the spring of 2004) the infrastructure needs to be strengthened through the combined measures of expansion of the production facilities, reinforcement of the transmission grid in selected bottlenecks, and establishment of new interconnections to the neighbouring countries.

The report identifies five cross-sections in the Nordic transmission grid where the Nordel system could benefit from an expansion and the resultant reinforcement of the existing transport channels. The report is further discussed in the article specifically written on this issue in this publication (pp. 18–25).

Key Figures 2003	¥.,		0	+	+	+	٠
		Nordel	Denmark	Finland	Iceland	Norway	Sweden
Population	mill	24,5	5,4	5,2	0,3	4,6	9,0
Total consumption	TWh	388,9	35,2	84,7	8,5	115,0	145,5
Maximum load 1)	GW	57,7	6,0	12,3	1,0	16,1	22,2
Electricity generation	TWh	371,8	43,8	79,9	8,5	107,1	132,5
Breakdown of electricity	generatio	on:	31 A .				
Hydropower	%	47	0	12	83	99	40
Nuclear Power	%	23	-	27	10 -	-	49
Other thermal power	%	28	87	61	0	1	11
Other renewable power	%	2	13	- 0 -	17	0	0

– = Data are nonexistent

0 = Less than 0,5 %

1) Measured 3rd Wednesday in January

Co-operation with Public Authorities and Market Players

In 2003, Nordel's co-operation with the market players, Forum of Nordic Energy Regulators (FNER), and the Nordic Council of Ministers was strengthened.

The Nordel Board convened representatives from the market players in all Nordic regions in the semi-annual Market Forum on two occasions. The discussions conducted in the Market Forum primarily address the trends seen for the Nordic market and the associated models for financing.

The work involved in setting up an action plan on issues on peak production capability and peak load, initiated after a conference held jointly with the Nordic Council of Ministers in the autumn of 2002, is now so far advanced that the results of the project were presented at a joint workshop scheduled for May 4-5, 2004.

The strenuous situation in the Nordic market over the winter was the subject of discussions at several meetings between FNER and Nordel. When FNER and Nordel met in Copenhagen on June 27, there were three items on the agenda. Besides evaluating the winter of 2002/2003 and the Nordic stance on how to handle congestion and grid access, the meeting also discussed the drafts of a joint Nordic transit solution. Later, the Nordic TSOs individually joined ETSO's transit solution.

At a meeting in Helsinki on November 25, 2003, the EU directive on general rules for the internal electricity market that will take effect on July 1, 2004 was discussed. This directive lays down the responsibilities of the TSOs, the DSOs, and the regulators, among other things.

ETSO and Florence Forum

The Florence Forum comprises representatives from the EU Commission, the regulating authorities (joined in CEER), the TSOs (joined in ETSO), UCTE, Nordel, and the European electricity industry and the recurrent meetings of the Forum continue to discuss the development of the European electricity market. The July 9-10 meeting took place in Rome.

Under the auspices of ETSO, the European transit scheme, the CBT mechanism, was revised as per January 1, 2004 and now the Nordic TSOs participate individually in the scheme.

The ETSO and EU Commission conference held on October 2, 2003 in Brussels on market power and congestion management featured several Nordic presentations.

Russia

As part of the electricity market reform in Russia, owners of the transmission grid merged to form one company, Federal Grid Company. This furthers the development of more transparent rules for intersystem collaboration on aspects of transmission technology and operational issues.

The review of the conditions for introducing a synchronous interconnection between the Nordic countries and Russia can continue when the equivalent review work for continental Europe has come to a conclusion. This is also supported by the fact that the present large import options between the Nordic countries and Russia are fully exploited.

Status of Work in Progress

Nordic Grid Master Plan

The plan is being revised and a new version will be published in 2005. A part report on priority cross-sections, which is addressed specifically in a separate article in this annual report, is published in the spring of 2004.

Peak Production Capability and Peak Load

The project is being conducted together with the Nordic Council of Ministers and will close off with reporting in a workshop in May 2004.

Revision of the Criteria for Operation and Grid Dimensioning

The work was initiated based on the system blackout in Southern Sweden and Eastern Denmark on September 23, 2003 and a part report will be presented at the Nordel Annual Meeting in 2004.

Nordic Grid Code

and here

I II

The second

The first Nordic Grid Code will be published in the spring of 2004. The Code lays down rules for planning, operation, connection, and data exchange. The document builds on previous recommendations, the System Operation Agreement, and the Data Exchange Agreement.

System Operation

The joint Nordic regulating power market, which commenced on September 1, 2002, is being further improved, one of the purposes being to enhance the frequency quality.

The Nordic System Operation Agreement is being improved and incorporated in the Nordic Grid Code.

Congestion Management

The Market Committee is in the process of developing a draft for joint rules on congestion management. Calculations have been made providing estimates of the costs and benefits of increased countertrade via Elspot, both in wet and dry years.

Market Place Fee

The Market Committee is investigating the principles of charging and applying a market place fee. The idea is that this fee could be used to pay for common measures in order to further develop the Nordic market, e.g. increased countertrade.

Market for Renewable Energy

The Market Committee is developing an overview of the implementation of EU directives on renewable energy and related aspects. The focus is on clarification of the current and future role of the Nordic TSOs in implementing the EU directives to support an efficient Nordic electricity market.

Development of the Nordic Electricity System

Generally, the dry and cold winter months led to a strained operational situation in the Nordic electricity market, which is dominated by hydro power. The extensive electricity trade between Norway, Sweden and Finland continued, but for several periods, the direction turned compared to previous years. In comparison, the Danish sales in the market experienced a marked increase, and also the import capacity from Russia saw a significant rise. Several ageing coal-fired power plant units experienced a renaissance in Finland and Denmark, and as a result of this the thermal combined heat and power production in Finland landed at an all time high.

Nord Pool Spot AS, which is owned by the Nordic TSOs, sold a total of 119 TWh (EUR 4.5 billion) – compared with 124 TWh and EUR 3.1 billion in 2002. The highest system price (114.61 EUR/ MWh) was recorded on January 6.

Energy Policy

Denmark:

- On May 9, 2003, a massive majority of the parliament agreed to gather the transmission system operation for electricity and natural gas in one independent, state-dominated enterprise. The negotiations for transfer of the ownership between the State and the local grid operators, who have been in charge of system services and owned the transmission grid, were linked to the solution of a number of outstanding problems in relation to the energy supply. There is much to suggest that the negotiations will conclude with a settlement according to which Eltra and Elkraft will merge into a state-owned company by January 1.2005.
- The on-going political negotiations are expected to result in a decision in 2004 to change the conditions for the small local combined heat and power plants (approx. 2,000 MW in all) from

production subject to purchase at a guaranteed price and let them survive on market terms.

 When published in February of 2004, a new report on the possibilities of building a cable connection between Eastern and Western Denmark (a 600 MW HVDC connection under the Great Belt) seemed to gain a political majority.

Finland:

- The Electricity Market Act concerning standard compensations came into effect on September 1, 2003. The distribution network owner must pay compensation to the electricity consumer for power cuts exceeding 12 hours, even if the power cut did not pose an inconvenience to the consumer.
- Finish Pohjolan Voima Oy is investing EUR 600 million in a bioenergy programme that will continue to strengthen the share of bioenergy production in Finland.

Iceland:

- In June 2003, the parliament passed a new energy act on free competition for the production and trade of electricity. The act provides that the transmission system operation and the transmission should continue as a monopoly. The parliament was, however, unable to agree on the tasks of the transmission company and the extent of the transmission grid. A compromise is expected to be put forward at the beginning of 2004. As a consequence of this act, Landsvirkjun is expected to be split up into two enterprises, viz. Production and Transmission. The latter becomes a member of Nordel.
- The Ministries of Industry and of the Environment proposed a framework for a possible future expansion with new power plants based on hydropower or geothermal power. This plan contains 35 different scenarios and

was produced to enlighten the public debate.

Norway:

- In the spring of 2003, Statnett applied for a concession to build a cable interconnection between Norway and the UK. The Ministry of Oil and Energy rejected the application in view of the uncertainty of the socio-economic benefits of the project.
- In December 2003, the Government presented a white paper to the parliament about the security of the electricity supply. Among other issues, this report discusses, 1) the conditions for a reliable energy supply; 2) contributions to a more resilient power supply; 3) contributions to the management of very difficult situations; and 4) aspects related to hydropower investments.

Sweden:

- Since 2002, the Government has engaged in discussions with the Swedish industry in an effort to produce an agreement about the continued changes of the energy system.
 A separate report on the question of the phase-out of Barsebäck 2 is expected in 2004.
- The Government initiated an investigation of the work at EU level of the internal market in electricity and natural gas in 2002. In December, interim recommendations were submitted with the proposed changes to the legislation required to implement the electricity and gas market directive.
- The Government decided to launch an investigation of the deregulation in the areas of telecommunications, electricity, and postal services. The Government wants to identify the long-term impact of the deregulations on the consumers, and the investigation is to come up with recommentions on how to improve the efficiency of the deregulated markets.



Transmission System Operation Responsibility

Denmark:

- For a number of years, Eltra has been an associated member of the joint electricity body in continental Europe, UCTE. The Danish TSO is now applying for full membership.
- By the end of the year, Eltra and Elkraft System concluded commercial agreements with the producers of ancillary services to replace the politically determined agreements that expired at the end of 2003.

Finland:

 An amendment came into force on September 1, 2003 that extended the system operation responsibility to also include the responsibility to develop the conditions required to ensure an efficient and well-functioning market.

Iceland:

 Landsvirkjun Transmission has entered a co-operation agreement with Statnett to get insight into a number of research projects that Statnett is realising in Norway. Among the issues addressed are efforts to increase the capacity of the Icelandic transmission grid, including the substations.

Norway:

- The commercial players behind the cable project between the Netherlands and Norway have negotiated to end their involvement. Both TSOs (Dutch TenneT and Norwegian Statnett) have taken over the results so far of the project work. Initially, the financial aspects of an open cable interconnection will be analysed.
- In view of the strained power situation in Southern Norway, Statnett planned to install mobile gas turbine units in the western part of the country in January. The situation improved during

the winter to the extent that the plans were abandoned.

When the power supply in the county of Møre og Romsdal approached a threatening situation in the autumn, the plans to introduce mobile gas turbines saw a revival, this time with a location at Tjeldbergodden. Once again, the situation turned to the better and so the plans to hire gas turbines were cancelled in January of 2004.

Sweden:

- Svenska Kraftnät has initiated an analysis of the electricity supply in the greater Stockholm area from a longterm perspective.
- Svenska Kraftnät has concluded agreements for approx. 1,800 MW in peak load resources. These agreements are part of the preliminary transition solution that the parliament has decided in order to ensure the balance between demand and supply in Sweden. After this period, the market players are liable for the adequacy, so that they will fulfil their commercial obligations.

Electricity Market

Denmark:

- All end consumers were given access to the electricity market by January 1, 2003.
- The Danish TSOs and Nord Pool Spot are discussing with the German TSOs and EEX how to link the markets across the Danish-German border.
- The 158 MW Nysted Offshore Wind Farm in the Baltic Sea was commissioned in October – less than 12 months after the commissioning of the 160 MW Horns Rev Offshore Wind Farm in the North Sea. A political decision to invite tenders for a new offshore wind farm of the same size is awaiting the financial political reconsiderations.

Finland:

- Teollisuuden Voima Oy has decided to acquire a 1,600 MW nuclear power plant. This fifth nuclear power plant in Finland is expected to be put into operation in 2009.
- The Energy Market Authority is proposed to undertake the regulatory responsibility vis-à-vis the Finnish CO₂ emissions. The emission quota will be split onto approx. 150 enterprises and approx. 500 energy producers or industrial process facilities free of charge for the period 2005-2007 (a total of 136.5 million tons CO₂). Detailed allocation principles for the period 2008-2012 will be laid down later.

Iceland:

 Landsvirkjun has commenced the construction of a 690 MW hydropower plant at Karahnjukar in Eastern lceland. This plant is to deliver electricity to a new aluminium factory in Eastern lceland for 332,000 tons a year. Both plants are expected to be put into operation in 2007.

Norway:

 In December, Norway was split up into four elspot areas because of the low reservoir levels. By the turn of the year 2002/2003, the reservoirs were down to 49.7% compared to their normal level of 71.5%. By week 23, the split up into spot areas was back to normal. By the turn of the year 2003/2004, the reservoirs were down to 57.1% – i.e. 7.4 percentage points above the previous year but considerably lower than normal.

Sweden

• On May 1, the nationwide system of electricity certificates came into force.

Transmission

Denmark:

- A new 400 kV line between Aalborg and Aarhus (144 km) is about to be completed. This does away with a major bottleneck in the electricity system in Western Denmark. The last section of the line to the HVDC substation at Vester Hassing is expected to be put into operation in September 2004. The line comprises 14.4 km of underground cables.
- Because of a number of leakages in the joints of the KONTEK interconnection in 2002/2003, Elkraft Transmission has initiated discussions with Vattenfall, Vattenfall Europe Transmission, Energi E2 and Elkraft System with a view to refurbish the interconnection to prevent future faults.
- Eltra and Svenska Kraftnät have signed a contract for refurbishment of the KontiSkan 1 interconnection. In connection with the refurbishment, the capacity of the plant will be increased from 270 to 360 MW. This will give KontiSkan 1 and 2 a total capacity of 710 MW when the new facility is put into operation by the end of 2005.

Finland:

- The 400 kV line from Viborg to Kymi was put into commercial operation on January 1, 2003.
- The refurbishment of the 400 kV stations has increased and will further increase the capacity between Sweden and Finland.
- A major operation involving replacement of the aluminium pylons in the 400 kV grid finishes in Ostrobothnia.
- Together with Svenska Kraftnät, Fingrid has launched an investigation of the possibility of doubling the capacity of the HVDC interconnection between Sweden and Finland.
- It has been decided to build a new 400 kV line between Toivila and Vihtavuori, in part to replace the outdated 220 kV grid and in part to meet the increased

transmission demand to Central Finland.

- During the year, a project was initiated to connect the new 1,600 MW nuclear power unit in Olkiluoto. This project includes building a new 400 kV line between Olkiluoto and Huittinen and looping the 400 kV line Rauma-Ulvila to Olkiluoto.
- In southern Finland, another project was initiated for a 400 kV line between Ulvila and Kangasala to expand the regional transmission capacity.

Iceland:

• Two 420 kV-lines are to be built between a new hydropower plant at Karahnjukar and an aluminium factory to be located at Reydarfjordur 50 km from the power plant. There are ongoing considerations to build also a 119 km line (420 kV) in Western Iceland in connection with the expansion of an existing aluminium factory.

Norway:

 Statnett is in the middle of a major expansion of the overall transmission grid, specifically in Mid Norway. The many plans to build wind farms in Northern Norway will add to the need for further reinforcement of the transmission grid.

Sweden:

- A 400 MVAr shunt capacitor for voltage regulation was put into operation at the Sege transformer substation near Malmö. This increases the transmission capacity to Zealand and the Continent.
- At Grundfors, a new system transformer has been put into operation. This has increased the transmission capacity to Norway.
- In connection with the refurbishment of the KontiSkan 1, the substation at Stenkullen is moved to Lindome.
- The last part of the refurbished substation at Hemsjö has been commissioned. The refurbishment has reinforced the Southern Swedish grid.

 Svenska Kraftnät has decided to build a new 400 kV line between Stenkullen and Lindome. This line is expected to be ready for commissioning in 2006, and will increase the security of supply in the Gothenburg area.

System Disturbances

Denmark:

 On September 23, a voltage collapse in Southern Sweden paralysed Eastern Denmark, and also Copenhagen, for up to seven hours. 1,850 MW of load were disconnected.

Finland:

• The Fenno-Skan interconnection was out of operation for two months due to the hard ice packing in the harsh winter.

Norway:

- The whole of the county of Møre og Romsdal and parts of the counties of Sør-Trøndelag and Sogn og Fjordane were affected by an extensive interruption of the supply on August 9 when a faulty line disconnected 900 MW of load. The power was re-established within two hours.
- Half of the capacity of the Skagerrak cable was out of operation from July 9 to December 15 due to a faulty transformer in the HVDC station at Kristiansand.

Sweden:

 On September 23, a stop at unit 3 of Oskarshamn nuclear power plant, followed by a fault in a 400 kV substation in Western Sweden, which put a complete stop to the production of two of the units at Ringhals nuclear power plant, triggered an extensive voltage collapse in Southern Sweden. The voltage collapse immediately spread to Zealand. In Southern Sweden 4,700 MW of load were disconnected for up to six hours.

Events of the Year

January 1

Full market opening in Denmark.

January 1

The new 400 kV line between Kymi and Viborg in Russia is put into operation. This increases the capacity across the Russian-Finnish border at the 400 kV level from 1,000 to 1,400 MW.

January 3

Record high consumption in Finland, 14,040 MW.

March 18

The building of a new 690 MW hydropower plant at Karahnjukar in Eastern Iceland commences.

March 25

Decision made to refurbish the KontiSkan 1 interconnection. The transmission capacity increases from 270 MW to 360 MW with commissioning scheduled for autumn 2005.

April 8

Market Forum, Stockholm.

May 1

The Swedish system of electricity certificates commences.

May 21

Media seminar, Helsinki.

May 26

The technical analyses conducted into the synchronisation between RAO UESR and Nordel are put on hold.

June 2

Norway returns to a state of "normal" price areas (two areas) following the winter 2002/2003 crisis.

June 12

Nordel Annual Meeting, Balestrand, Norway

June 12

Nordel publishes its report "Evaluation Nordic electricity market winter 2002/2003".

July 1

Icelandic Landsvirkjun is split up into two divisions; Production and Transmission. Thordur Gudmundsson takes over the seat of Fridrik Sophusson in the Nordel Board.

July 9

A faulty transformer in the HVDC station in Southern Norway reduces the capacity of the Skagerrak interconnection by 50 per cent from 1,000 MW to 500 MW until December 15.

July 9

The Fenno-Skan interconnection is out of operation until September 18, due to the hard ice packing experienced in the winter 2002/2003.

August 9

Blackout in the county of Møre og Romsdal, Norway. 900 MW for two hours.

August 28

JAD

开刊。

JU

The Nordic competition regulating authorities present a joint report on the market power in the Nordic electricity market ("A Powerful Competition Policy").

Events of the Year

September 1

In Finland, the system operation responsibility is extended to also ensure the conditions required to ensure an efficient and well-functioning market

September 4

The Nordel Board decides that the Nordic countries are to join the ETSO CBT mechanism from January 1, 2004 on an individual basis.

September 16

The Norwegian Ministry of Petroleum and Energy rejects the application from Statnett for a concession for a new interconnection between Norway and the UK.

September 23

Blackout in Southern Sweden and Eastern Denmark. A total of 6,550 MW for up to seven hours.

October 1

In Sweden, the act on guarantee of origin of electricity takes effect, based on an EU directive.

October 3

Fire in a transformer in Stenkullen in Sweden. The total capacity of the KontiSkan interconnection reduced from 610 MW to 490 MW until autumn 2005.

October 16

Location of the new Finnish 1,600 MW nuclear power plant decided. It will be located at Olkiluoto. The plant is expected to be put into operation in 2009.

October 21

Market Forum, Copenhagen.

November 4

Svenska Kraftnät and Elkraft System publish a report on the system blackout on September 23.

December 1

Nysted Offshore Wind Farm south of Zealand put into operation, 72 turbines of 2.2 MW each, 158.4 MW.

December 19

In Finland, the act on guarantee of origin of electricity takes effect, based on an EU directive.

Members of the Board of Nordel



Georg Styrbro CEO, Eltra amba, Denmark (Chairman)

Photo: Nils Rosenvold



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



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



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



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



Thordur Gudmundsson Director Transmission, Landsvirkjun Transmission, Iceland Photo: G.Kr. Jóhannesson



Odd Håkon Hoelsæter President and CEO, Statnett SF, Norway

Photo: Trond Isaksen

The Planning Committee's Activities



Øivind Rue Chairman of the Planning Commitee

Objectives and responsibilities

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

The Planning Committee's objectives are:

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

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

- The Planning Committee will draw up future scenarios for the expansion of the Nordic power system with a time horizon of up to 20 years. Working with these basic scenarios, initiatives can be taken to advance the committee's objectives.
- Each year, the Planning Committee will present prognoses for the future energy/power balance. Energy prognoses will focus on normal and dry years. Power prognoses will focus on normal maximum load and extreme maximum load.
- Every second year the Planning Committee will present a summarised Nordic Grid Master Plan, which primarily consists of projects that have an effect on the capacities between the Nordic TSOs.
- The Planning Committee are responsible for the updating of the Nordic Grid Code.
- •The Planning Committee shall ensure the gathering, updating and application of shared grid, consumption and production data.

The Planning Committee's activities

The Planning Committee is organised with two working groups, the Grid Group and the Balance Group, plus any ad hoc groups. The tasks of these two groups are organised so that the working groups do most of the actual analyses and surveys, while the Planning Committee functions as a natural steering group for the work that is carried out. The Grid Group deals primarily with grid-related matters, while the Balance Group deals primarily with matters relating to energy and power balance. The most important tasks in 2003 were:

Prioritised cross-sections

The Nordic Grid Master Plan 2002 pointed out cross-sections Nordel should focus on in order to effect strenathening if possible. In order to further the work of the Nordic Grid Master Plan 2002 an ad hoc group "Prioritised cross-sections" was formed, in which the crosssections in the Nordic Grid Master Plan 2002 are to be looked at more closely. The aim is to analyse whether alternative strengthening measures have positive or negative socio-economic effects and shall form the basis for future decisions concerning such measures within Nordel's area. The results of the socio-economic analyses are expected in June 2004.

The group has introduced the concept 'transport channels'. In the Nordic Grid the energy transportation often are going along typical transport channels, which consist of several cross-sections, and also bind the Nordel-system with surrounding markets. The capacity of these transport channels is important to the whole Nordic market. Strengthening of one cross-section therefore will be related to the whole channel.

The ad hoc group has pointed out the most important transport channels within the Nordic market, and thereby stated the most likely strengthening. The group has focused internal Nordic cross-sections, but has also proved that links out of the Nordel-area are of great importance of possible internal strengthening.

Power balance for the coming winter and three-year period

Power balances for the three-year period up until 2006

The continuous work on reporting the three-year balances to Nordel's annual meeting is carried out each year. The report gave statistical data from 2002 (energy) and winter 2002/03 (effect). Together with this prognosis three-year ahead was reported. The report was published on Nordel's homepage.

Power balances for the winter period 2003-2004

Together with the Operative Group, the Balance Group has made the power balances for the Nordic region as a whole and for each Nordic country separately. The report was published on Nordel's homepage. The Planning Committee has also helped generate prognoses for energy balances for the winter period 2003/04. These studies came as a result of the dry-year situation that partly has occurred since autumn 2002.

Project:

Input data for power balances

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

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

Nordic Grid Code

In order to make the first version of a Nordic Grid Code, an ad hoc group was formed. The Grid Group has laid down the foundations for this ad hoc group, which is currently carrying out the work. The aim is to make a grid code consisting of all existing rules and recommendations also taking into account national regulations and laws. The code will consist of three main elements:

- Superior principles
- Planning Code
- Operational Code
- Connection Code
- Data agreement

In this version of the code different national rules are not harmonised. The main responsibility for the development of a Nordic Grid Code has been assigned to the Planning Committee. The aim is to publish the Nordic Grid Code around June 2004.

Compilation of shared set of data

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

The Grid Group has prepared a PSS/E grid data set for the Nordic power system. Operational and planning models have been prepared based on the prob-

able developments and trends, production expansion, grid strengthening, etc. The operational models cover load flow and dynamic analyses in peak and off-peak situation, while the planning models cover load flow analyses in the years 2005 and 2010. The planning models are adapted to the conditions in the analyses around the Prioritised-Cross-sections.

With support from Powel, the Balance Group has prepared a power balance model, which will constitute references for various system studies. The model is simulating the power market referred 2005 and 2010 and gives important analyses to the work around the Prioritised-Cross-sections. The database built up in the "Samkjoeringsmodel" will be taken further with an improved representation of the transmission grid in the Nordic region. This is achieved by integrating the "Samkjoeringsmodel" with the grid model and the integrated model will be called the "Samlast Model".

The Operations Committee's Activities



Eero Kokkonen Chairman of the Operations Committee

Objective and tasks

The Operations Committee is responsible for issues of a shorter time-horizon, as regards the joint operation of the subsystems, and for setting the technical and market focused framework for grid operation.

The committee leads the operational collaboration between the transmission system operators and its objective, for the requirements of the market, is working towards the best utilization of the interconnected Nordic transmission system, while taking into account the agreed level of technical quality and operational reliability.

System operation

At the beginning of the year, the system operation of the Nordic power system was characterized by a lack of hydropower and the resulting high prices on the power exchange. This was brought about by a very dry and rain-starved autumn. In some areas, reservoir levels during the winter were noted as the lowest on record. Moreover, the winter was very cold, with temperatures corresponding to a 10-year winter.

In Norway, where the risk of energy shortages was greatest, different measures were taken to avoid rationing during the late winter/early spring. In local sectors, the operational reliability (n-0) was reduced during certain periods to maximize the import of energy into deficit sectors. This did not lead to any disturbances in the electricity supply. Due to the exceptional and, to a certain extent, strained operational situation, bottlenecks arose in several places on the transmission network. The most extensive bottlenecks, in the number of hours, occurred between Western Denmark and the rest of the Nordic area. The Swedish transmission network in the Gothenburg sector (the West Coast constraint) restricted the possibility of transmitting power from the south and to Norway. A normal trading capacity between Finland and Sweden could not be maintained in all situations, for stability reasons, on the Finnish network.

A number of measures were taken to reduce the network limitations and to maximize imports into the entire Nordel area, and onward to the deficit sectors. Outages were re-planned, both at production facilities and on the grids. System protection was deployed on KontiSkan 2, in Zealand, in Finland, and on the Hasle interconnector. These measures contributed towards improving the capacity utilization, both on internal links and between elspot areas. The danger of rationing in Norway was over by the end of March.

In spite of very cold weather and the risk of energy shortages, there was a good margin this winter from the point of view of power. This can be explained by the fact that the extremely cold weather did not occur simultaneously throughout the entire Nordel area and that the bulk of the available thermal power was in operation. In Norway, the high elspot prices also entailed a significant reduction in the level of consumption.

Operational reliability and disturbances

The Nordic power system was hit by a number of operational disturbances

which impacted upon the electricity supply and the system operation.

A cable fault on Kontek during the period January 4 to January 19 limited import opportunities from Germany.

A transformer fault at the converter station at Kristiansand meant that the transmission capacity of Skagerrak 3 fell from 1,000 to 500 MW during the period July 9 to December 15.

The transmission capacity of KontiSkan 1 was reduced on October 3 by half due to a transformer fault at Stenkullen. The capacity will be reduced by half until rebuilding of the DC interconnector, with a new connection point at Lindome, is completed in 2005.

Fenno-Skan was out of operation for just over two months between July 9 and October 18 due to a fault caused by the hard winter and the exceptional pack ice conditions. The 5 ton concrete block which protects the DC cable had moved, causing a fault in the cable. Transmissions from Russia to Finland were disrupted on two occasions during the summer by lightning.

The year was characterized, however, by extensive power outages around the world. At the same time, concern over security of supply has risen and reliability is once again in focus.

On September 23, just over 4 million people were without electricity when southern Sweden and parts of Denmark were blacked out as the grid collapsed. The reason for this disturbance was a combination of several technical faults occurring almost simultaneously. A double bus bar fault at the Horred switchyard led to the entire switchyard being disconnected from the grid and, as a result of this, two of the nuclear reactors at Ringhals as well. Shortly before this, the Oskarshamn 3 nuclear power plant had been shut down due to a faulty valve. These strains were too great for the transmission grid, resulting in a voltage collapse. In total, approximately 3,000 MW of production was lost in Sweden and approximately 1,800 MW in Eastern Denmark.

A transformer at Asnæs plant 5 in Zealand was damaged as a result of the disturbance and the plant was off line right up until November 17. This reduced the available power by 600 MW and the power balance in Eastern Denmark was somewhat strained during this period.

Another outage hit Helsinki for a few hours on the evening of August 23. Greater Helsinki was blacked out due to a 3-phase short-circuit in a local network cable. The disruption caused the loss of the biggest production units and transformers in the region.

The reliability of the power systems has caused much debate and given rise to questions regarding whether or not the correct dimensioning rules, and application of them, are in use. With the objective of guaranteeing a high level of operational reliability, Nordel's operational and dimensioning criteria will be reviewed on the basis of the experience gained.

The working groups

The Committee updated and renewed, in April, the mandate for the working groups of a permanent nature. A new working group was established for operational development issues.

The analysis group

The objective of this group is to support the Operations Committee in technical issues within the framework of system operation. In addition to its continual analysis work, the group has assessed the constraints which have been most critical during the year and conducted a survey of the possibilities of further increasing the load limits in the shortterm. Its work did not lead to any concrete measures in the short-term, but the group points out that the increased level of transmissions during recent years has resulted in an increasing need for reactive components in order to protect against voltage collapse.

The operational development group

The group's objective is to contribute towards the evolution of the system operation.

The group has assessed the principles of balance regulation and the system of rules adopted for the Nordic regulation power market in the autumn of 2002. Balance regulation work is now done in a commercially better way with regard to social economics and practical management in the control rooms has been simplified.

As an element of our task of improving the frequency quality, which has steadily

been worsening, a two week trial period was conducted during weeks 45 and 46, specially focusing on the frequency quality. The commitments made were; improved general and contingency planning, more active regulation, and increased contacts. The period contributed to an improved frequency quality and the group is continuing its work with a number of measures aimed at achieving a high level of quality, also in the long-term.

The operational group

The tasks of the group are day-to-day system operation issues in relation to control room activities. This also includes drafting the power balances for the coming winter season. The power balance for the winter of 2003/2004 is slightly better than that of last year. However, the Nordel area is still dependent on imports from its neighbours.

The group has also had the task of further developing the system operation agreement which is to be implemented as a part of the Nordic Grid Code.

The NORCON group

This group has been working with operational IT issues and IT security. The group also has coordinating responsibility for the Electronic Highway.

Other activities

International collaboration

The annual meeting with the equivalent organisation within UCTE, Operations and Security, was held in October in Oslo.

The meeting concluded that a survey of today's principles and management of the HVDC interconnectors, which link the systems together, must be carried out in respect of agreements, ramping, emergency power and possible exchanges of regulating power.

The Market Committee's Activities



Cecilia Hellner Chairman of the Market Committee

Objective and tasks

The goals of the Market Committee are:

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

Operations during the year

Work has largely focused on further harmonising and improving the rules of play for the players on the Nordic electricity market in order to thus create improved prerequisites for the function and development of the single market. A clearer system of rules, new methods of determining capacity with the aim of optimizing the utilization of the transmission capacity, the development of a joint principle for managing network restrictions, and counter trading are all examples of elements of this work, as are new methods of safeguarding the supply capability during the most strained situations. Below, there is an outline of the work conducted by the Market Committee during the year.

Nordic and European transit solution

During recent years, important steps have been taken towards achieving a

fully developed Nordic model for transit compensation. Ahead of 2002, the Nordic grid operators agreed terms and conditions for compensating each other for the transmission loss costs that are due to transit power. This model was also applied during 2003. There was also an assessment of further developing the model to include compensation for investments.

In parallel with the development of the Nordic model, the European system operators have agreed, through their collaboration organisation European Transmission System Operators (ETSO), principles for transit compensation for the countries of continental Europe. As border tariffs are no longer allowed in the European model, it was also natural for the Nordic system operators to take part in the European system. With this, the Nordic transit system was abandoned.

The European electricity market has been expanded, ahead of 2004, and now encompasses, in principle, the entire EU (except the UK and Ireland), including the majority of the new member states plus Norway and Switzerland. Imports from adjacent countries are also affected. The market players who export electricity from one ETSO country to another are no longer charged any special fees. As a consequence of border tariffs no longer existing, the grid operators' costs/revenues for transit compensation will contribute towards adjusting the grid tariff in each respective country.

Security of supply in strained situations

Deregulation of the electricity markets of the Nordic countries has resulted in an increased awareness of costs among the players on the electricity market. This has, among other things, contributed towards the more cost-effective utilization of resources and unprofitable production plants being closed down. With a reduced production capacity and a demand for electricity that continues to rise, there thus exists a certain level of risk that situations can arise when there is insufficient production capacity to meet the rising demand.

An adequate production capability is thus a fundamental prerequisite for a reliable supply of electricity. Today, there are rather different models for managing the balance between supply and demand in peak load situations in the Nordic area. One prerequisite for the Nordic electricity market's long-term growth is the players in the different countries largely having the same responsibility and incentives as regards investment in new electricity production and demand reduction. During the year, Nordel's Market Committee conducted a project aimed at creating a common basis for a long-term solution that will safeguard the power balance and thus improve the prerequisites for the players to manage the risk of power shortages. One departure point is that the systems of rules will be based on commercial principles.

Work has focused on identifying efforts aimed at promoting price elasticity in electricity consumption as this will enable a reduction in the need to use other measures, and on developing products for hedging during power shortages. The report can be found at www.nordel.org.

Common rules for congestion management

Power trading via the interconnectors has increased since deregulation. One consequence of this is that constrained sectors, known as bottlenecks, have arisen in places where there were no previous problems with transmission limitations.

Nordel is conducting several activities aimed at ensuring that the transmission capacity is used optimally in order to reduce the risk of unnecessary market splitting, and on occasions when this is not possible, to send real signals to the market. A clearer system of rules for congestion management, new methods of determining capacity and increased use of counter trading are all elements of this work. The purpose of the work is to analyse the prerequisites for increased counter trading and to investigate what consequences such a solution might entail as regards, among other things, increased costs, as well as what impact this might have on competition. The possibility of using the spot market for counter trading has also been studied.

One issue arising in this context is what degree of counter trading would be required and how the cost of this would be distributed. A reasonable principle is that those benefiting from increased counter trading should also bear the cost of it. The work is expected to be finalised in the autumn 2004.

Financing of joint measures for developing the Nordic electricity market

Nordel has recently embarked upon an inquiry with the aim of assessing the prerequisites for financing measures for developing the market, using some form of joint marketplace fee.

Harmonisation of the balance settlement rules in the Nordic area

During the past year, the work of assessing the possibilities of harmonising the balance service rules (a harmonised model for pricing and settling balance power) has been concluded. The aim of the study was to analyse what the criteria would be for introducing joint balance service rules based upon the different models in use today. The study established that there are several similarities and dissimilarities between today's models, which is why some alternative development paths were put forward regarding a possible joint Nordic balance service model. Against the backdrop of the study and the referral bodies from the market players, Nordel decided that the issue of harmonising the systems of rules used in the balance service was not a prioritised field of activity and that, for the foreseeable future, this would not be taken any further.

Trading in certificates for renewable energy

During recent years, a market for trading in energy certificates has become established, both nationally and within the framework of the international collaboration known as the Renewable Energy Certificate System (RECS). The aim is to promote the production of renewable energy. In order to meet the requirements of the market, the joint Nordic IT support system (RECSCMO) for issuing and managing certificates, has been further developed in order to be compatible with the systems of other countries. In addition to this, there is a plan to further develop the IT system to include EU requirements as regards guarantees of origin.

Integration of the European electricity market

The Market Committee has a coordinating role in Nordic work vis-à-vis ETSO and the European Commission in issues concerning the long-term development of systems of rules and market conditions and has, during the year, continued to monitor developments within ETSO through, among other things, being represented on the ETSO Steering Committee and work groups, as well as having a close dialogue with the EU.

The Future Infrastructure of the Nordic Electricity System

The development of the future infrastructure of the Nordic electricity system is facing new challenges, and depends on several choices to be made over the next few years. This is a consequence of the framework defined by the competition and the demands placed on the infrastructure by the market – technicaly and economically.

Today, the driving force of the initiatives realised on the supply and demand side is the market price. While the market players determine the increase and decrease in the commercial production capacity, the TSOs ensure the existence of a robust infrastructure in a well-functioning market.

Up through the 1990s, the power and energy balances of the Nordic electricity system suffered a gradual deterioration. This is expected to continue for a considerable period of time and new requirements are expected to maintain the balance in the system.

At the same time there are an increasing number of periods characterised by congestion in the transmission grid which also creates a need for increased transmission capacity. In extreme situations, congestion has been specifically restricting, for instance during the winter of 2002/2003.

Through joint long-term analyses Nordel seeks to create an overview of the future situation in terms of power and energy. This is of vital importance to the decisions to be made with regard to grid expansions.

This article discusses the challenges that the development of the future infrastructure is facing and the work involved on the part of Nordel to manage these challenges.

Challenges

The primary challenges facing the development of the future Nordic infrastructure are: The supply challenge - To what extent can the difficulties involved in ensuring a sufficient supply of energy be handled through expansion of the production facilities and price elastic electricity consumption, and to what extent through grid reinforcements? The core issue here is to determine to what degree the Nordel area is to rely on an approach involving self-sufficiency from internal sources compared to an approach involving interconnections to external sources. This is also a question of creating the right incentives to expand the production capacity and place the facilities strategically correct.

The congestion challenge – To what degree are the bottlenecks to be removed through grid-expansion to create reasonable servicing of the market? In this context the major factors are the wishes of society and the profitability of the projects.

Uncertainty – Will the trends for consumption, production capacity, and

exchange seen during recent years continue or are we facing another scenario? The solutions chosen are to ensure a Nordic infrastructure sufficiently robust to withstand various likely developments.

Coordination – How should the national and bilateral initiatives between the Nordel countries and countries outside the Nordel area be coordinated to the common good of the Nordic region? The approaches opted for are to be in agreement with a long-term Nordic aim and contribute to the future unity of the Nordic electricity market.

To create market solutions with a longterm perspective it is necessary to create a space for national as well as Nordic solutions. The need to reinforce the grids of the Nordel area are subjected to common analyses since expanding the grid in one country will affect the need for expansion in the other countries.



Figure 1 Development in the consumption and production of energi for the Nordel system (excluding Iceland). The historic data come from Nordel's annual reports 1990-2002.

The present situation in the Nordel system

At the time, when deregulation was introduced at the beginning of the 1990s, the production reserves of the Nordic countries were sufficient to ensure local power and energy balances. Due to the low electricity prices experienced for a period after the introduction, commercial production units were mothballed and ageing units decommissioned. During the same period, consumption rose considerably in the Nordel area and the energy balance of the area suffered gradual deterioration, Figure 1. From 2000, the Nordel area has been a net importer.

The period 1992–2002 saw an increase in the energy consumption by 17 per cent. (approx. 1.7 per cent per year) whereas the same period saw an increase in the installed capacity only by approx. 2 per cent (approx. 0.2 per cent per year), when disregarding wind power.

During recent years, mothballed units have experienced a renaissance, partly upon the request of the TSOs. The power balance seen today is less critical than the energy balance [Ref. 1].

The historic interaction within the Nordel area and between the hydropower-dom-inated Nordel system and the continental system dominated by combined heat and power production has led to considerable benefits to all parties. This has led to the expansion of the interconnections between the countries and hence an increased security of supply and reduced costs in the Nordic infrastructure.

Today, the transmission capacity out of the Nordel area is 3,260 MW and into the area 4,760 MW. The transmission capacity between the Nordel countries amounts to approx. 10,000 MW.

The future power and energy balances in the Nordel area depend on the expansion of the local production capacity and the increase in consumption. In particular the amount and the distribution of the production capacity are uncertain



factors. Nordel has therefore analysed alternative trends in consumption and production until 2010. Two of these trends feature the following scenarios:

- a. It is assumed that the energy consumption will increase by approx.
 1.2 per cent a year during the period. This increase is smaller than seen for the sector for the past 10 years. The installed capacity is expected to increase by 0.9 per cent a year, exclusive of wind power. The power and energy balances are expected to deteriorate during the period, although not at the same speed as has been seen historically, Figure 1.
- b.It is assumed that the energy consumption will increase by approx.
 1.5 per cent a year, which more or less continues the historic evolution. The installed capacity is expected to increase by 0.8 per cent a year, exclusive of wind power. Norway and Sweden will see further deterioration of the power and energy balances.

The production capacity is thus expected to expand more over the next few years than has been the case over the past decade.

Today, there is access to some of the interconnections out of the Nordel area on non-discriminating terms, although there are also interconnections restricted by fixed agreements. It is assumed that there will be unlimited market access to the interconnections out of the Nordel area by 2010, although these may be burdened by trade restrictions today.

Expansion of the Transmission Grid or the Production Capacity?

Apparently, the energy supply situation of the Nordel area will be a critical factor in future, Figure 1. During the past two years, the annual energy production in the Nordel area has not been able to meet the demand, and compared to previous years, increasing quantities of electricity have had to be imported from the neighbouring areas [Ref. 1]. An increasing exchange between the Nordic countries and with external areas is expected. The areas will also become increasingly integrated and dependent on the resources of each other. In many cases this will mean that Nordic solutions will be more important than national solutions. Targeted efforts have already been launched to establish common Nordic solutions. In relation to the production there is close collaboration with the Nordic Council of Ministers. In relation to transmission, Nordel has compiled an integrated set of rules in the Nordic Grid Code.

From an overall point of view, the Nordic countries are expected to suffer from an energy deficit. It is therefore imperative either to create the proper incentives to expand the production capacity of this region or to further activate price elastic demand. At this point it has been decided to invest in 2,328 MW new production capacity over the period until 2010. Alternatively, the transmission capacity to Nordel's neighbouring countries should be increased in order to be able to increase imports.

It is not possible to ensure the future power and energy balances in the Nordel area by expanding the internal grid. Reinforcement of the internal Nordel grid is required anyhow in view of various aspects in relation to market conditions and the operational reliability.

As has also been the case previously, hydropower will continue to give rise to variations in the energy balance due to hydrological variations. Furthermore the significant expansion with wind power causes increased variations in the need for exchange between subareas. In addition, the distance to the reserves is extended during operational disturbances. As a result of this the transmission capacity is subjected to other and larger requirements than previously. If the interconnections out of the Nordel area are reinforced, the transports will also change and increase.

Whether the transmission capacity is sufficient is directly reflected in the price of electricity on both sides of a bottleneck in the transmission grid. As can be seen, the need for reinforcement is dependent on the assumed division into subareas. It is essential that this is in agreement with the physical bottlenecks, which is not always the case today.

The Need for Robust Solutions

Irrespective of the developments for production and consumption, it is likely that the Nordel area will be facing an energy deficit in 2010.

According to the Nordic analyses there are subareas where the production is larger than the consumption (grey areas), Figure 2. There are also subareas whose production is smaller than the consumption (blue areas). For both situations, this foresees an import belt in the southern part of Sweden and in Mid Norway. The large energy exporting subareas are found specifically in the southern part of Norway, in Mid and Northern Sweden and in Denmark.

These "deficit" and "surplus" areas primarily arise as a result of market related factors determining which production facilities are put into operation. This means that from a resource point of view Finland could balance without imports from Russia and Sweden could balance if the domestic combined heat and power production is used extensively.

However, the price differences between the elspot areas lead to a transport of energy. In addition, international transports via interconnections out of the Nordel area will contribute to making the need for expansion of the grid even stronger.

The need for imports to the Nordel area will be approx. 9-13 TWh/year during normal years and approx. 25-30 TWh/ year during dry years, depending on how things develop. This is the equivalent of e.g. the transport through two or three additional 600 MW interconnections. It is uncertain whether the Nordel area is capable of importing such vast



amounts of energy and whether the neighbouring areas are able to deliver such vast quantities.

The Nordel area will experience serious congestion between subareas. Irrespective of the expected scenario, the bottlenecks arise at practically the same places in the grid. Congestion is specifically known to occur at the KontiSkan and the Skagerrak interconnections between Western Denmark and Sweden/Norway respectively, at the Fenno-Skan interconnection between Finland and Sweden, and at the domestic connection lines. Also the interconnections between Norway and Sweden experience serious congestion.

The development illustrated in Figure 2b shows the largest number of bottlenecks and this could lead to a greater need for reinforcement of internal as well as external transmission lines.

The capacity of the transmission grid has been expanded, and the TSOs have utilized the capacity to an increasing degree. To ensure the servicing of the market and the reliability of the Nordic electricity system in future, congestion of the system should be reduced. Regardless of the scenario to come true there will be transports through the system requiring reinforcement of the transmission grid over the period until 2010. The challenge lies in developing robust solutions.

Experience demonstrates that building a production facility typically lasts 2-3 years whereas it takes 5-10 years to build a large-sized transmission system.

During the past few years, Europe and the USA have suffered from a number of black-outs and regional disturbances in the electricity supply. After a number of years when focus has been on market issues, the question of security of supply is increasingly imperative. Just recently, the blackout in Sweden and on Zealand on September 23, 2003 gave rise to considerations to reinforce the transmission grid.

Nordic Solutions for Production Capacity

Decisions to invest in new power plants are made on a purely commercial basis. The investments are made if an investor believes that the future prices are sufficiently high to warrant a reasonable contribution margin, including operational costs, return on invested capital, and compensation for the risks involved in investing.

Up until now, the prices in the Nordic electricity market have reflected the ruling situation that the production capacity has been sufficient. Hence the price has often just covered the operational costs of the Nordic base load units. For new investments to be interesting the prices have to - on average - cover both operational costs and investments costs. To achieve this the prices have to be higher in general or the prices have to be very high during the few hours of peak load. Possibly the investments made will not be significant until the investors see clear signals of scarcity in energy and/or power.

In situations with peak load and high prices there will most likely be consumers that prefer to alter their consumption patterns rather than paying the high price and hence contribute to financing a peak load unit. Consequently, price elastic electricity consumption is an alternative to peak load production. The ability of the consumers to mobilise flexible resources are decisive to the long-term viability of the Nordic electricity market. This could also affect the size of an energy and power deficit in this area. Figure 3 Priority cross-sections included in the Nordic socioeconomic analyses.

- 1. Skagerrak (HVDC)
- 2. Kattegat N-DK (HVDC)
- 3. Kattegat N-S (HVDC)
- 4. KontiSkan (HVDC)
- 5. Haslesnittet (AC)
- 6. Nea-Järpströmmen (AC)
- 7. Snit 4/Vestkystsnittet (AC)
- 8. Fenno-Skan (HVDC)
- 9. Øresund (AC)
- 10. Storebælt (HVDC)
- 11. Finmarkssnittet (AC)

4) the development of new financial products to cover the risks involved in peak load situations

Investment Incentives

Society will benefit economically from linking areas characterised by few and costly resources with areas characterised by many and low cost resources. An investor in new production capacity will analyse the profitability based on the same relative scarcity in an area that could encourage new transmission capacity.

An investor would know that the scarcity in resources that renders a potential new production investment profitable can also be alleviated by a new transmission line. As a result of this, investments in production capacity can be postponed.

TSOs are considering whether to invest in new transmission capacity and this affects the profitability of new investments in production capacity. The major challenge to the TSOs lies in ensuring that decisions to establish new transmission capacity do not adversely affect the decisions of the market players to invest with a commercial perspective.

Nordic Solutions for Transmission Capacity

The joint analyses of the Nordel system [Ref. 2] have identified 11 cross-sections with bottlenecks in the Nordel area, where high marginal values can be achieved from an expansion, Figure 3. The selected cross-sections represent interconnections with both alternating current (AC) and direct current (DC). The need to increase the transmission capacity in these cross-sections has been analysed in a Nordic socio-economic profitability assessment.

The need for reinforcements within the Nordel area depends on the power and energy balance of the area. In that way it also depends on the need for imports and the utilization of interconnections out of the Nordel area. In this context the existing interconnections to the Continent and their expansion is a core issue to the situation of the Nordel area. The reason for this is that the plans to increase the capacity of a direct interconnection from Norway to Germany (600 MW) have been abandoned. An interconnection to the Netherlands (600 MW) has been on hold for a number of years, but is now being reconsidered.

situation with surplus production capacity to a balanced situation. On the one hand investments will be made in peak load resources (both production and consumption) only if high prices can be expected as a result of the scarcity. On the other hand, such a scarcity situation without the required peak load resouces could lead to forced disconnection of consumption.

A dilemma arises when going from a

To ensure that transitional solutions contribute to a transition to market conditions rather than a return to a centrally controlled electricity system, the procurement and activation of the resources must interfere as modestly as possible with the electricity market. The collaborative efforts between Nordel and the Nordic Council of Ministers to ensure the best possible transition focus on four different issues:

- 1) establishment of price elastic electricity consumption
- 2) transitional solutions for peak load resources harmonised with the deregulated Nordic electricity market
- review of legislation and regulations to safeguard the consistency with the long-term development of the deregulated Nordic electricity market



A direct interconnection (1,200 MW) between Norway and the UK has been abandoned because the Norwegian authorities rejected an application for concession.

Transport channels

In the Nordic transmission system, transmission is often conducted along characteristic stretches that constitute important transport channels in the Nordic electricity market, Figure 4. The transmission via a transport channel may be constrained by the capacity of the individual cross-sections included in the channel. One transport channel may comprise several cross-sections with bottlenecks, and as a result of this the reinforcement of selected cross-sections must be seen in the context of the transport channel.

The capacity of the transport channel is essential to the entire Nordic electricity market. Hence their reinforcement is of particular interest to Nordel – both the cross-sections within the Nordel area and the interconnections out of the area.

All transport channels have bottlenecks. The channels featuring bottlenecks of the largest significance to the Nordic electricity market are typically found in the southern part of the Nordel area, Figure 4. It is the channel between Norway/Sweden and Germany via Western Denmark, a), the channel between Norway and Germany/Poland via Sweden and Eastern Denmark, b), and the channel between Norway and Russia via Mid Sweden and Finland, c).

The interconnections out of the Nordel area are innate parts of the transport channels. They provide access to other markets – e.g. the Continent and Russia. In addition, they also make it possible to benefit from fluctuations in the production caused by variations in the hydrological resources and wind-based resources within the Nordel area.

Previously, north-south transports dominated the Nordic electricity system. In future, also east-west transports will become significant. Reinforcement of the transport channels a) and b) would strengthen the link between the Continental markets and the Nordel area, whereas reinforcement of the transport channel c) would more likely strengthen the internal transmission grids in the area.

Instead of reinforcing the existing transport channels, new ones could be built across the Kattegat, i.e. between Norway and Eastern Denmark or between Norway and Sweden, Figure 5a. A possible future Great Belt connection in Denmark would form part of the parallel north-south transport channels, Figure 5b. With this connection alternative transport routes could be established between the Nordic countries and the Continent.

Reinforcing one cross-section of a transport channel will affect the need for reinforcement in other cross-sections. As an example, reinforcement of the Skagerrak interconnection between Norway and Denmark West in channel a) would impact on the need for reinforcement of the KontiSkan interconnection between Sweden and Denmark West and vice versa. Reinforcing these

two cross-sections that form part of the same transport channel constitute mutual alternatives and therefore perhaps they should not both be expanded. Expansion of the Skagerrak interconnection is an alternative to expanding the cross-section along the western coast in channel b. Reinforcement of cross-section 4 in Sweden is to some degree an alternative to establishing a Great Belt connection in Denmark.

5b)

Considering Nordic Socioeconomics

An essential question when discussing expansion of the transmission lines is the extent to which economics should be taken into consideration as oppsed to a reliable operation of the electricity system.

Nordel has developed six criteria to be used as a collective measure of a Nordic assessment of the utility value of expanding the transmission capacity of a cross-section. These criteria are used to support the selection of the crosssections where reinforcements will be beneficial.

 In future, also east-west transports will become significant. Reinforcement of
 two cross-sections that same transport change



The six benefit criteria

- [1] Production optimisation and energy conversion.
- [2] Reduced risk of power failure.
- [3] Changes in losses.
- [4] Lower risk of energy rationing.
- [5] Trade in regulating power and ancillary services.
- [6] The values of a better-functioning market.

Utility Criteria

"Production optimisation and energy conversion" [1] estimates the value of the production and consumption surplus and the congestion income for the entire Nordic region. This is the most important socio-economic aspect of an expansion.

By calculating the socio-economic value at Nordic level the joint benefit becomes more evident. Investments in infrastructure shift much larger amounts between the consumers and the producers than the actual investment. In a joint Nordic assessment the reallocation typically goes from producers to consumers.

Analyses suggest that with the current system the value of "Reduced risk of power failure" [2] is limited in the Nordic region from a socio-economic point of view.

"Changes in losses" [3] calculates the change in active losses in the Nordel system as a result of an expansion. An expansion would in effect reduce the losses, but due to the increased transports in the system, the net result would be increased losses.

"Lower risk of energy rationing" [4] quantifies the added socio-economic benefit achieved by avoiding rationing during dry years. This criterion is particularly relevant to Norway where the energy situation is determined by the precipitation.

"Trade in regulating power and ancillary services" [5] is assessed by relating the need for regulating power and other services for a single subarea to the market value of providing regulating power at lower costs.

In the wake of the deregulation the focus has been on how the market power is being exercised based on specific cases. The energy and competition authorities in the Nordic countries have conducted a joint project analysing the market power in the Nordic electricity market [Ref. 3]. The analysis gives air to concerns in view of the concentration of ownership among the producers in the Nordic market and it recommends that the legislation on competition in the electricity sector should be strengthened.

Perfect competition and fully open connection lines between the areas are assumed as basis. Then "The value of a better-functioning market" [6] can be assessed by looking at examples of the individual ability of the reinforcement measures to reduce the opportunities of the producers to exercise market power. Expansion of the transmission grid normally leads to restricted market power but it does not solve the problems involved in market power. However, there is also a risk of increased market power if the expansion reduces the competition between producers on the same side of the connection line.

Conclusion

In future, there must be a robust Nordic infrastructure which is capable of withstanding various developments and the uncertainty of the future production capacity. It must also safeguard an efficient market and a secure electricity system. The four challenges: The supply challenge, the congestion challenge, the uncertainty, and the coordination, do not lead to one simple, unambiguous answer to what to do about the infrastructure in the Nordel area. Therefore, the long-term solutions must combine the expansion of:

- The production capacity within the Nordel area
- The interconnections out of the Nordel area
- The transmission lines for important cross-sections within the Nordel area.

Nordel and the Nordic Council of Minister agree that the Nordic electricity market presents a robust model that can secure the best balance between consumption, production, and investment in the long run. Nordel is in the process of ensuring the transition from a surplus situation to a balanced situation.

Nordel's current role is to provide advice and recommendations in relation to grid expansions in a joint Nordic perspective, whereas the decisions and the financing of the specific projects are national/bilateral matters. Since reinforcing a single place in the Nordel area can have a serious impact on the benefit of expansions elsewhere in the system a common Nordic investment strategy as part of a joint Nordic planning of the infrastructure will be of current interest.

To obtain a common aim for the expansion of the transmission capacity joint analyses of important cross-sections within the Nordel area are vital. Fixed and transparent routines and procedures for the investment decisions contribute to a reduction of the uncertainty of the future interconnections. Common objectives have not been set up for the interconnections out of the Nordel area. It is imperative that all TSOs make an effort to reinforce these interconnections and to increase the capacity available to the market.

According to Nordel's analyses for 2010, the Nordel area could benefit

from reinforcing five possible crosssections, Figure 6. This involves the following expansions; the Great Belt in Denmark, cross-section 4 in Sweden and the existing cross-sections Skagerrak between Western Denmark and Norway, Fenno-Skan between Sweden and Finland, and, a more local crosssection, the Nea-Järpströmmen connection between Norway and Sweden.

Reinforcing these interconnections, apart from the Nea-Järpströmmen connection, helps to secure the Nordel area a competitive edge in the international electricity market because it strengthens the intra-Nordic market and enhances the opportunity of expanding the interconnections between the Nordic electricity market with the Continental and Russian markets.

The criteria used in the selection of these five cross-sections are primarily the six utility criteria. To this should be added other technical and environmental considerations not included in these six criteria. The infrastructure enjoys an integral robustness that considers the uncertainty of the production capacity and consumption of the future. Considerations regarding the market interaction between systems dominated by hydropower and wind/thermal energy, respectively, and operational considerations where some subareas could be more fragile than others. There are also the assessments of an acceptable number of hours with system congestion - specifically during extreme periods such as wet and dry years.

Transport channel a) through Jutland would benefit from a reinforcement of the Skagerrak cross-section and can be regarded as being part of a reinforcement to the Continent, Figure 4. This interconnection will be of importance to the market interaction between hydropower systems and systems dominated by thermal power and to the security of supply in Norway during dry years.

Expansion of the Fenno-Skan and cross-section 4 in transport channel c) is of particular significance to the secrity of supply in Southern Sweden and Norway.



Figure 6 The five intra-Nordel cross-sections where reinforcement is considered up until 2010.

The establishment of a Great Belt link would also be of importance to the supply of Southern Sweden. To this should be added the local cross-section Nea-Järpströmmen, which is of importance to the security of supply in Mid Norway.

The creation of Nordic solutions where needed is secured through close collaborative efforts in Nordel and in the Nordic Council of Ministers. This for instance concerns continued collaboration to harmonise the rules and regulations regarding national security of supply and transitional approaches.

Under the auspices of Nordel the collaborative efforts involved in developing grid master plans on a regular basis should be further developed. This would be part of the efforts to keep the Nordic electricity market united as one single market.

References

[Ref. 1] "Priority Cross-sections" (available in Danish). Socio-economic analyses of important cross-sections of the Nordel system.

- Nordel 2004, www.nordel.org. [Ref. 2] Nordic Grid Master Plan 2002.
- [Ref. 3] »A powerful competition policy«. June 2003. The Nordic Competition Authorities.

www.ks.dk.

Writers

Jytte Kaad Jensen	Eltra
Rikke Bille Jørgensen	Eltra
Jens Pedersen	Eltra
Ole Graabæk	Elkraft System
Mikko Koskinen	Fingrid
Trond Carlsen	Statnett
Trygve Borg	Statnett
Magnus Danielsson	Svenska Kraftnät



Statistics

Definitions, units and symbols	28
Installed capacity	29
System load	31
The transmission grid in the Nordic countries	33
Interconnections	34
Electricity generation	36
Water reservoirs	39
Exchange of electricity	40
Electricity consumption	43
Total energy supply	45
Prognosis	45
Spot prices	46

Definitions, units and symbols

Units and symbols

kW	kilowatt					
MW	megawatt	=	1000	kW		
GW	gigawatt	=	1000	MW		
J	joule					
kJ	kilojoule					
PJ	petajoule	=	1015	J		
kWh	kilowatt-hour	=	3600	kJ		
MWh	megawatt-hour	=	1000	kWh		
GWh	gigawatt-hour	=	1000	MWh		
TWh	terawatt-hour	=	1000	GWh		
~	Alternating curre	ent	t (AC)			
=	Direct current (DC)					
-	Data are nonexi	ste	ent			
	D · · ·					

- .. Data are too uncertain
- 0 Less than 0.5 of the unit given

Calculation of the electricity consumption

Electricity generation

- + Imports
- Eksports

= Total consumption

- Occasional power to electric boilers
- = Gross consumption
- Losses, pumped storage power etc.
- = Net consumption

Gross consumption

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

Electricity generation (net generation)

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

Exchange of electricity

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

Installed capacity (net capacity)

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

Generation of condensing power

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

Net consumption

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

Transmission capacity

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

Pumped storage power

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

Losses

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

Occasional power to electric boilers

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

Total consumption

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

Combined heat and power (CHP) generation

Generation at a steam power plant where some of the energy of the steam is used for electricity generation and some for another purpose, e.g. for district heating or as process steam for industry. Previously known as backpressure generation.

Responsible for statistical data on the individual countries

Lars Christian Caspersen, Elkraft System, Denmark East Lars Byberg, Eltra, Denmark West Jussi Matilainen, Fingrid, Finland Ólafur Pálsson, Statens Energistyrelse, Iceland Jan Foyn, Nord Pool ASA, Norway Agata Persson, Svenska Kraftnät, Sweden

Responsible for processing of the statistics

Jan Foyn, Nord Pool ASA, Norway The statistical data can also be read on Nordel's Internet pages at www.nordel.org



	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Installed capacity, total ¹⁾	12,830	16,893	1,476	28,081	33,361	92,641
Hydropower	11	2,978	1,151	27,676	16,143 ²⁾	47,959
Nuclear power	-	2,640	-	-	9,441	12,081
Other thermal power	9,704	11,225	123	305	7,378	28,735
• condensing power 3)	-	3,852	-	73	2,108 ⁶⁾	6,033
 CHP, district heating 	8,978 ⁴⁾	3,665	-	12	2,572	15,227
• CHP, industry	456 ⁶⁾	2,830	-	185	979	4,450
• gas turbines, etc.	270	878	123	35	1,719 ⁶⁾	3,025
Other renewable power	3,115	50	202	100	399	3,866
 wind power 	3,115	50	-	100	399	3,664
 geothermal power 	-	-	202	-	-	202
Commissioned in 2003	313	71	2	119	1,140	1,645
Decommissioned in 2003	115	44	-	58	42	259

S2 Average-year generation of hydropower in 2003 - GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Average-year generation 2003	-	13,045	6,790	118,312	65,000	203,147
Average-year generation 2002	-	13,022	6,790	118,179	65,000	202,991
Change	-	23	0	133	0	156
Reference period		1961-1990	1950-2000	1970-1999	1950-2000	-

S3 Changes in installed capacity in 2003

Power category	Power plant	Com- missioned MW	Decom- missioned MW	Change in average -year generation (hydropower) GWh	Type of fuel
Denmark - East					
CHP	Amagerværket blok 2		45		Strawpills
	Asnæsværket blok 5	20			Coal
	Avedøreværket blok 2		10		Gas/Oil/Biofuel
	H. C. Ørstedværket blok 8	24			Gas
	Decentral & local CHP		56		Other
Vind power	Vindmills	170			
Denmark - West					
CHP, District heating	Decentral CHP	19			Household waste
	Decentral CHP	5			Natural gas
	Decentral CHP		1		Other
	Local CHP	3			Other
CHP, Industry		1	3		Natural gas
		14 ¹⁾			Furnace coke
Wind power	Vindmills	57			
Finland					
Hydropower	Valajaskoski	28		23	
	Various	2			
CHP, Industry	Kotka	17	7		Peat
CHP, District heating	Savonlinna	17	7		Peat, waste wood
Condensing power	Turku		30		Coal, Oil
Wind power	Various	7			
Iceland					
Hydropower	Bonde Kraftværk	1	a series and a series of the		
Gas turbines	Engines for stand by- diesel	1			Oil
Norway					
Hydropower	Bjølvo	99	54	52	
	Various	17	4	81	
Wind power	Vikna	3			
Sweden					
Condensing power	Stenungsund G3 + G4 $^{2)}$	510			Oil
Condensing power	Bråvalla	240			Oil
Condensing power	Various changes	2			
Hydropower	Various changes	73	27		
CHP, District heating	Kristinehedværket	10			Waste
CHP, District heating	Sjölund KVV	18			Waste
CHP, District heating	Various changes	62	10		
CHP, Industry	Various changes	23			
Nuclear power	Various changes	22	5		
Wind power	Various changes	60			
Gas turbines	Hallstavik G3 + G4 ²⁾	120			Oil

1) Without grid connection - previously left out.

2) Included in the Swedish power reserve that has previously been in mothballs.

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

Power category	Power plant	Capacity MW	Estimated start-up Year	Change in average -year generation (hydropower) GWh	Type of fuel	
Denmark - East						
Denmark - West						
Finland						
CHP, Industry	Pietarsaari	140	2004		Waste wood	
Hydropower	Seitakorva I	20	2004	14		
	Petäjäskoski II-III	32	2005-06	42		
Nuclear Power	Olkiluoto 3	1,600	2009			
Iceland						
Hydropower	Kàrahnjùkar	630	2007	4,450		
						THURSDAY
Norway						
Hydropower	Tyin (net increase)	168	2004	230		
	Nygard	56	2004	74		
	Øvre Otta	171	2006	525		
	Blåfalli-vik	150	2006	106		
Sweden						
Nuclear Power	Forsmark	130	2004-06			
Condensing power	Marviken	200	2004		Oil	
CHP, district heating	Ryaverket	260	2006		Natural gas	

System load

S5 Maximum system load for each country in 2003 ¹⁾

	MWH/h	Date	Time	
Denmark - West	3,780	2003-01-09	05.30-05.45 PM	
Denmark - East	2,665	2003-01-07	05-06 PM	
Finland	14,040	2003-01-03	05-06 PM	
Iceland	1,024	2003-02-04	06-07 PM	
Norway	19,984	2003-01-06	09-10 AM	
Sweden	26,400	2003-01-31	08-09 AM	

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



System load 3rd Wednesday in January and 3rd Wednesday in July 2003

Maximum load 3rd Wednesday in January and 3rd Wednesday in July 2003 $\ensuremath{\mathsf{All}}\xspace$ hours are local time

	3rd Wednesday in January 2003, 05-06 PM - MWh/h	3rd Wednesday in July 2003, 12-01 PM - MWh/h	
Denmark	6,047	3,959	
Finland	12,325	8,619	
Iceland	1,004	879	
Norway	16,130	10,283	
Sweden	22,228	13,189	
Nordel	57,735	36,929	

Statistics

The transmission grid in the Nordic countries



Interconnections

S6 Existing interconnections between the Nordel countries

Countries/ Stations	Rated voltage/kV	Transmission capacity as per design rules ¹⁾ MW		Total length of line/km	Of which cabel/km	
Denmark West - Norway		From Denmark	To Denmark			
Tjele-Kristiansand	250/350=	1,040	1,040		240/pol	127/pol
Denmark East - Sweden		From Sweden	To Sweden			
Teglstrupgård - Mörarp 1 and 2	132~	350	²⁾ 350	2)	23	10
Gørløsegård - Söderåsen	400~	800	2) 800	2)	70	8
Hovegård - Söderåsen	400~	800	2) 800	2)	91	8
Hasle (Bornholm) - Borrby	60~	60	60		48	43
Danmark West - Sweden		From Sweden	To Sweden			
Vester Hassing - Göteborg	250=	290	270		176	88
Vester Hassing - Lindome	285=	380	360		149	87
Finland - Norway		From Finland	To Finland			
Ivalo - Varangerbotn	220~	100	120		228	_
Finland - Sweden		From Sweden	To Sweden			
Ossauskoski - Kalix	220~	7			93	-
Petäjäskoski - Letsi	400~	1,600	³⁾ 1,200	3)	230	-
Keminmaa - Svartbyn	400~				134	-
Raumo - Forsmark	400=	550	550		233	200
Senneby - Tingsbacka (Åland)	110~	80	80		81	60
Norway - Sweden		From Sweden	To Sweden			
Sildvik - Tornehamn	132~	50	120		39	-
Ofoten - Ritsem	400~	700	1,350	4)	58	-
Røssåga - Ajaure	220~	415	5) 415	4, 5)	117	-
Linnvasselv, transformator	220/66~	50	50		-	-
Nea - Järpströmmen	275~	600	5) 600	5)	100	-
Lutufallet - Höljes	132~	40	20		18	-
Eidskog - Charlottenberg	132~	100	100		13	_
Hasle - Borgvik	400~		5	5 6)	106	_
Halden - Skogssäter	400~	2,200	2,200	5, 6)	135	_
1) Maximum permissible transmission.	3) In certain	situations, the transmissic	on capacity can be 5) The tra	ansmission capacity can in cert	ain situations

lower than the limit given here. 2) Thermal limit. The total transmission capacity is 1.775 MW to Denmark and 1.700 MW to Sweden.

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	Trans capac	mission :ity/MW	Total length of line/km	Of which cabel/km	
Denmark West - Germany		From Nordel	To Nordel			
Kassø - Audorf	2x400~			107	-	
Kassø - Flensborg	220~	1,200	1,200	3) 40	_	
Ensted - Flensborg	220~			34	-	
Ensted - Flensborg	150~	150	150	26	5	
Denmark East - Germany						
Bjæverskov - Rostock	400=	600	600	166	166	
Finland - Russia		From Nordel	To Nordel			
lmatra - GES 10	110~	-	100	20	-	
Yllikkälä - Viborg ²⁾	2x400~		1 400	2 x 67	_	
Kymi - Viborg ²⁾	400~			132	-	
Nellimö - Kaitakoski	110~		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	269	257	
Sweden - Poland		From Nordel	To Nordel			
Stärnö - Slupsk	450=	600	600	256	256	
 The transmission capacity is currently limited MW from Nordel and 390 MW to Nordel. 	 transmission capacity is currently limited to 460 Back to Back HVDC (+85 kV =) in Viborg and synchronous operation of NWPP power plant. The transmission capacity is limited to 800 MW in northern direction due to internal restrictions in Denmark West 					

S8 Interconnections: decisions taken

Countries/ Stations	Rated voltage/kV	Transmission capacity/MW	Total length of line/km	Of which cabel/km

At present no new interconnections have been decided.

S9 Transmission lines of 110-400 kV in service on December 31, 2003

	400 kV, AC og DC/km	220-300 kV, AC og DC/km	110,132,150 kV/km	
Denmark	1,300	500	4,100	
Finland	4,000	2,400	15,300	
Iceland	100 1)	500	1,300	
Norway	2,100	5,600	10,500	
Sweden	11,100	4,600	15,000	

1) At present in service with 200 kV.

Electricity generation

S10 Total electricity generation within Nordel 2003



S11 Electricity generation 2003 - GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total generation	43,754	79,855	8,495	107,122 ²⁾	132,547	371,773
Hydropower	20	9,305	7,084	106,002	52,976	175,387
Nuclear power	-	21,819	-	-	65,458	87,277
Thermal power	38,174	48,645	5	900	13,482	101,206
 condensing power 	_	19,966	-	221	1,697	21,884
 CHP, district heating 	36,016 ¹⁾	15,798	-	-	6,406	58,220
• CHP, industry	2,154	12,865	-	379	5,254	20,652
• gas turbines etc.	4	16	5	300	125	450
Other renewable power	5,560	86	1,406	220	631	7,903
• wind power	5,560	86	-	220	631	6,497
 geothermal power 	_	-	1,406	-	-	1,406
Total generation 2002	37,260	71,617	8,404	130,591 ²⁾	143,250	391,122
Change as against 2002	17,4%	11,5%	1,1%	-18,0%	-7,5%	-4,9%

Includes generation in combined heat and power stations.

2) Gross production.



S12 Total electricity generation by energy source, and exchange of electricity in 2003 - TWh

S13 Monthly generation and total consumption of electricity 2002-2003 - GWh



Water reservoirs

S14 Water reservoirs 2003





Reservoir capacity 5,530 GWh.

Minimum and maximum limits are based on values for the years

Norway



Reservoir capacity

81,729 GWh.

1990-2002.

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

Minimum and maximum limits are based on values for the years 1990-2003.





Reservoir capacity 33,758 GWh.

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



S16 Exchange of electricity 2003 - GWh

From	То	Denmark	Finland	Norway	Sweden	Other countries ¹⁾	Σ From
Denmark		-	-	4,526	7,484	3,697	15,707
Finland		-	× ~-~	165	7,250	- ``	7,415
Norway		708	84	-	4,794	-	5,586
Sweden		1,413	846	8,599		580	11,438
Other countries ¹⁾		5,042	11,332	182	4,839	-	21,395
Σ To		7,163	12,262	13,472	24,367	4,277	61,541 Nordel
Total to		7,163	12,262	13,472	24,367		57,264
Total from		15,707	7,415	5,586	11,438		40,146
Net imports		-8,544	4,847	7,886	12,929		17,118
Net imports/total consump	otion	-24,3%	5,7%	6,9%	8,9%		4,4%

1) Russia, Germany and Poland.



S17 Exchange of electricity between the Nordel countries 1963-2003 - GWh

41



S18 Monthly exchange of electricity between the Nordel countries 2003 - GWh

Electricity consumption

S19 Net consumption of electricity 2003, by consumer category



S20 Electricity consumption 2003 - GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total consumption	35,210	84,702	8,495	115,008	145,476	388,891
Occasional power to electric boilers	-	56	192	2,465	520 ¹⁾	3,233
Gross consumption	35,210	84,646	8,303	112,543	144,956	385,658
Losses, pumped storage power	2,463	2,795	413	9,655	10,956	26,282
Net consumption ²⁾	32,747	81,851	7,890	102,888	134,000	359,376
• Housing	9,600	20,445	703	35,215	41,859	107,822
• Industry (incl. energy sector)	9,550	45,208	6,128	43,610	59,240	163,736
Trade and services (incl. transport)	10,817	15,343	703	22,363	25,931	75,157
Other (incl. agriculture)	2,780	855	356	1,700	6,970	12,661
Population (million)	5,387	5,220	0,289	4,565	8,976	24,437
Total consumption per capita kWh	6,536	16,226	29,394	25,193	16,207	15,914
Total consumption 2002	35,205	83,540	8,404	120,918	146,608	394,675
Change as against 2002, %	0,0%	1,4%	1,1%	-4,9%	-0,8%	-1,5 %

1) Only electric boilers at district heating plants shown.

2) Estimated net consumption.

S21 Total consumption 1994-2003 - TWh



S22 Total consumption per capita 1994-2003 - kWh

S23 Total consumption 2003 - GWh

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Generation 2003	43,754	79,855	8,495	107,122	132,547	371,773
Net imports 2003	-8,544	4,847		7,886	12,929	17,118
Total consumption 2003	35,210	84,702	8,495	115,008	145,476	388,891
Generation 2002	37,260	71,617	8,404	130,591	143,250	391,122
Net imports 2002	-2,055	11,923		-9,673	5,358	5,553
Total consumption 2002	35,205	83,540	8,404	120,918	148,608	396,675

Total energy supply

S24 Total energy supply 1993-2003 - PJ



Prognosis

S25 Total consumption of electricity 2003 and prognosis for 2007 – TWh

	Denmark	Finland	Iceland ³⁾	Norway	Sweden
2003 ¹⁾	35	85	8.5	115	145
2007 ²⁾	38	93	11.3	131	152
1) The consumption is not corrected vs. temperatures.	2) Prognosis	2) Prognosis is based on data from the Balance Group in			based on data from the

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

S26 Maximum system load 2003/2004 and prognosis - winter 2007-2008 - MWh/h

	Denmark-West	Denmark-East	Finland	Iceland ³⁾	Norway	Sweden
2003/2004 ¹⁾	3,780	2,665	14,040	1,024	19,984	26,400
2007/2008 ²⁾	4,019	2,933	14,560	1,718	22,650	27,600
1) The consumption is not corrected vs. temperature	s. 2) Prognos Nordel a to 2 year	 Prognosis is based on data from the Balance Group in Nordel and shows the maximum system load according to 2 years winter temp 			based on data from the	e Energy prognosis

S27 Prognosis for available production capacity for the market - winter 2007-2008 - MWh/h

	Denmark-West	Denmark-East	Finland	Iceland ²⁾	Norway	Sweden
2007/2008 ¹⁾	4,421	3,240	13,765	2,106	23,215	27,415
	0) D					

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

Spot prices

Nord Pool Spots spot market - average system price and turnover per week GWh EUR/MWh Max. price Min. price System price Turnover 13 17 29 33 37 21 25 29 33 37 45 49

Nord Pool Spots ELBAS-market - turnover and prices per week 2003

S28 Spot prices and turnover on the Nordic electricity exchanges 2002-2003







The Finnish electricity sector set up a new load record with 14,040 MW on Friday January 3, 2003.

A damaged disconnector in the Horred switching substation was an essential cause of the voltage collapse in Southern Sweden and Eastern Denmark on September 23, 2003.

> In Autumn 2003, another large Danish offshore wind farm was commissioned outside of Nysted on Falster. The wind farm includes 72 wind turbines of 2,200 kW each - totaling 158.4 MW.

Iceland has built the highest dam (193 metres) in Europe to provide water for the new 690 MW hydropower plant Karahnjukar in Eastern Iceland. The dam project also includes 73 km tunnels.

> In many water reservoirs the water level reached an alarmingly low level before the spring flood started a new inrush to the water reservoirs.

Current Nordel Recommendations

- Availability Concepts for Thermal Power. September 1977
- Localisation of System Oscillations Equipment *August 1992*



Network Dimensioning Criteria
 October 1992



Common Disturbance Reserve
 February 1992



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



- Operational Performance Specifications for Small Thermal Power Units August 1995
- Standardised
 Communication Procedure
 August 1995
- Recommendations for Frequency, Time Deviation, Regulating Power and Reserves. *August 1996*



 Summery of recommendation May 1997



• Trade with Reserves within the Nordic Countries August 1998



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

Symbols:



Nordic version

English version

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

Nordel Members and Organisation

The Board of Nordel

Georg Styrbro CEO, Eltra amba, Denmark (Chairman)

Jan Magnusson Director General, Svenska Kraftnät, Sweden (Vice Chairman)

Flemming Wibroe Senior Projekt Manager, Eltra amba, Denmark (Secretary)

Bent Agerholm Managing Director and CEO, Elkraft System amba, Denmark

Timo Toivonen President and CEO, Fingrid Oyj, Finland

Fridrik Sophusson Director General, Landsvirkjun, Iceland (until June 30, 2003)

Thordur Gudmundsson Director Transmission, Landsvirkjun Transmission, Iceland (from July 1, 2003)

Odd Håkon Hoelsæter President and CEO, Statnett SF, Norway

Nordel's Secretary

Flemming Wibroe, Senior Projekt Manager, Eltra amba, Denmark (Secretary of Nordel) Liasion Group

Flemming Wibroe Senior Projekt Manager, Eltra amba, Denmark (Secretary)

Jens-Erik Fischer Pedersen Manager, Executive Staff, Elkraft System amba, Denmark

Kurt Lindström Director, Fingrid Oyi, Finland (until August 31, 2003)

Anders Lundberg Specialist, Fingrid Oyj, Finland

Thorgeir J. Andresson Head of Relations INT/EXT, Landsvirkjun Transmission, Iceland (from July 1, 2003)

Ole Gjerde Senior Adviser, Statnett SF, Norway

Tania Pinzón M. Sc. M. E., Svenska Kraftnät, Sweden

Information Group

Per Andersen Head of Information, Eltra amba, Denmark

Tor Inge Akselsen Director of Corporate Communications, Statnett SF, Norway

Kaare Sandholt Head of Corporate Communications, Elkraft System amba, Denmark

Kaija Niskala Manager, Electricity Market, Fingrid Oyj, Finland

Thorsteinn Hilmarsson Head of Corpoate Communications, Landsvirkjun, Iceland

Mårten Norgren Head of Corporate Communications, Svenska Kraftnät, Sweden

Hartvig Munthe-Kaas Head of Corporate Communications, Nord Pool ASA, Norway (Correspondent)

Lene Egeberg-Gjelstrup, International Co-ordinator, Eltra amba, Denmark (until September 2003)

Jacob Tanggaard Madsen, M. Sc. (Econ), Eltra amba, Denmark (from September 2003) Jan F. Foyn, Head of Statistics, Nord Pool ASA, Norway

For contact information se cover











Organisation Chart



Kvikne's Hotel - Balestrand, Sognefjorden, Norway, provided the setting for the Nordel Annual Meeting 2003.

Photo: Per Andersen

Members and Organisation

Members of Committees Operations Committee

Eero Kokkonen Managing Director, Fingrid Oyj, Finland (Chairman)

Anders Lundberg Specialist, Fingrid Oyj, Finland (Secretary)

Hans-Henrik Clod-Svensson Director, System Operation, Elkraft System amba, Denmark

Carl Hilger Head of Operation Division, Eltra amba, Denmark (until October 31, 2003)

Per Sørensen Head of Operation Division, Eltra amba, Denmark (from November 1, 2003)

Ivar Glende Executive Vice President, Statnett SF, Norway

Mikael Engvall Director of Operations, Svenska Kraftnät, Sweden

Nils Gustavsson Manager, System Operation, Landsvirkjun Transmission, Iceland (Correspondent)

Planning Committee

Øyvind Rue Executive Vice President, Statnett SF, Norway (Chairman)

Arne Egil Pettersen Senior Engineer, Statnett SF, Norway (Secretary)

Paul-Frederik Bach Deputy Director, Eltra amba, Denmark

Hans Henrik Lindboe M.Sc. (Engineering), Elkraft System amba, Denmark

Pertti Kuronen Planning Manager, Nättjänst, Fingrid Oyj, Finland

Eymundur Sigurdsson System Manager, Landsvirkjun Transmission, Iceland

Bo Krantz Director, Grid Technology, Svenska Kraftnät, Sweden

Market Committee

Cecilia Hellner Director, Market Administration, Svenska Kraftnät, Sweden (Chairman)

Christina Simón B. Sc. E., Svenska Kraftnät, Sweden (Secretary)

Peter Jørgensen Head of Market Division, Eltra amba, Denmark

Lene Sonne Director, Market Administration, Elkraft System amba, Denmark

Juha Kekkonen Executive Vice President, Fingrid Oyj, Finland

Gudmundur Ingi Asmundsson Head of System Operation, Landsvirkjun Transmission, Iceland

Bente Hagem Executive Vice President, Statnett SF, Norway

Market Forum Market participants

Hans Erik Kristoffersen Senior Consultant, the Confederation of Danish Industries, Denmark

Klaus Winter Hansen Head of Production Optimization, Elsam A/S, Denmark

Jørgen Holm Westergaard Managing Director, Energi Denmark-DISAM A/S, Denmark

Torben Franch Production Manager, Energi E2 A/S, Denmark

Rami Vuola Nordic Operations Manager Etelä-Pohjanmaan Voima Oy, Finland

Mikko Rintamäki Vice President, Outokumpu Oyj, Finland

Risto Vaittinen Managing Director, Oy Turku Energia, Åbo Energi Ab, Finland

Hannu Linna Managing Director, Vaasan Sähkö Oy, Finland Edvard G. Gudnason

Edvard G. Gudnason Head of Marketing, Landsvirkjun Produksjon, Iceland Thorleifur Finnsson Director of Development and New Products, Reykjavik Energi, Iceland

Eiríkur Briem Deputy managing Director, Statens Elverk, Iceland

Karl A. Eliassen Director, Production, BKK Produksjon AS, Norway

Ada Solberg Back office Manager, E-CO Vannkraft AS, Norway

Finn-Bjørn Ruyter Senior Vice President, Elkem ASA, Norway

Sam Syvertsen Director of Business Development, Markedskraft, Norway

Per Möller President and CEO, Dalakraft AB, Sweden

Curt Lindqvist Head of Strategy and Analysis, Sydkraft Nät AB, Sweden

Stefan Brolin Head of Generation Management, Vattenfall AB, Sweden

Magnus Grill President, Öresundskraft AB, Sweden

TSO representatives

Georg Styrbro CEO, Eltra amba, Denmark (Chairman)

Jan Magnusson Director General, Svenska Kraftnät, Sweden

Flemming Wibroe Senior Project Manager, Eltra amba, Denmark (secretary)

Bent Agerholm Managing Director and CEO, Elkraft System amba, Denmark

Timo Toivonen President and CEO, Fingrid Oyj, Finland

Thordur Gudmundsson Director Transmission, Landsvirkjun Transmission, Iceland

Odd Håkon Hoelsæter President and CEO, Statnett SF, Norway



Nordel's Secretariat (until June 9, 2004)

Eltra amba

Postal address: P.O. Box 140, DK-7000 Fredericia Denmark

Visiting address: Fjordvejen 1-11, Fredericia, Denmark Flemming Wibroe Senior Project Manager (Secretary General of Nordel)

Lene Egeberg-Gjelstrup International Co-ordinator, Eltra amba (until September 2003)

Jacob Tanggaard Madsen M. Sc. (Econ), Eltra amba (from September 2003)

Jan F. Foyn Head of Statistics, Nord Pool ASA, Norway Telephone:+4576224000Telefax:+4576245180

Internet: www.nordel.org

E-mail: nordel.secretariat@eltra.dk

WAGNERSEN INTERACTIVE A

Nordel's Secretariat (from June 10, 2004)

Svenska Kraftnät

Postal address: Box 526, S-162 15, Vällingby Sweden

Visiting address: Jämtlandsgatan 99, Vällingby Sweden Christina Simón, B. Sc. E., Svenska Kraftnät Sweden (Secretary General of Nordel) Lena Norén, Assistant, Svenska Kraftnät Sweden Jan F. Foyn Head of Statistics, Nord Pool ASA, Norway Telephone:+4687397800Telefax:+468378405

Internet: www.nordel.org

E-mail: nordel.secretariat@svk.se