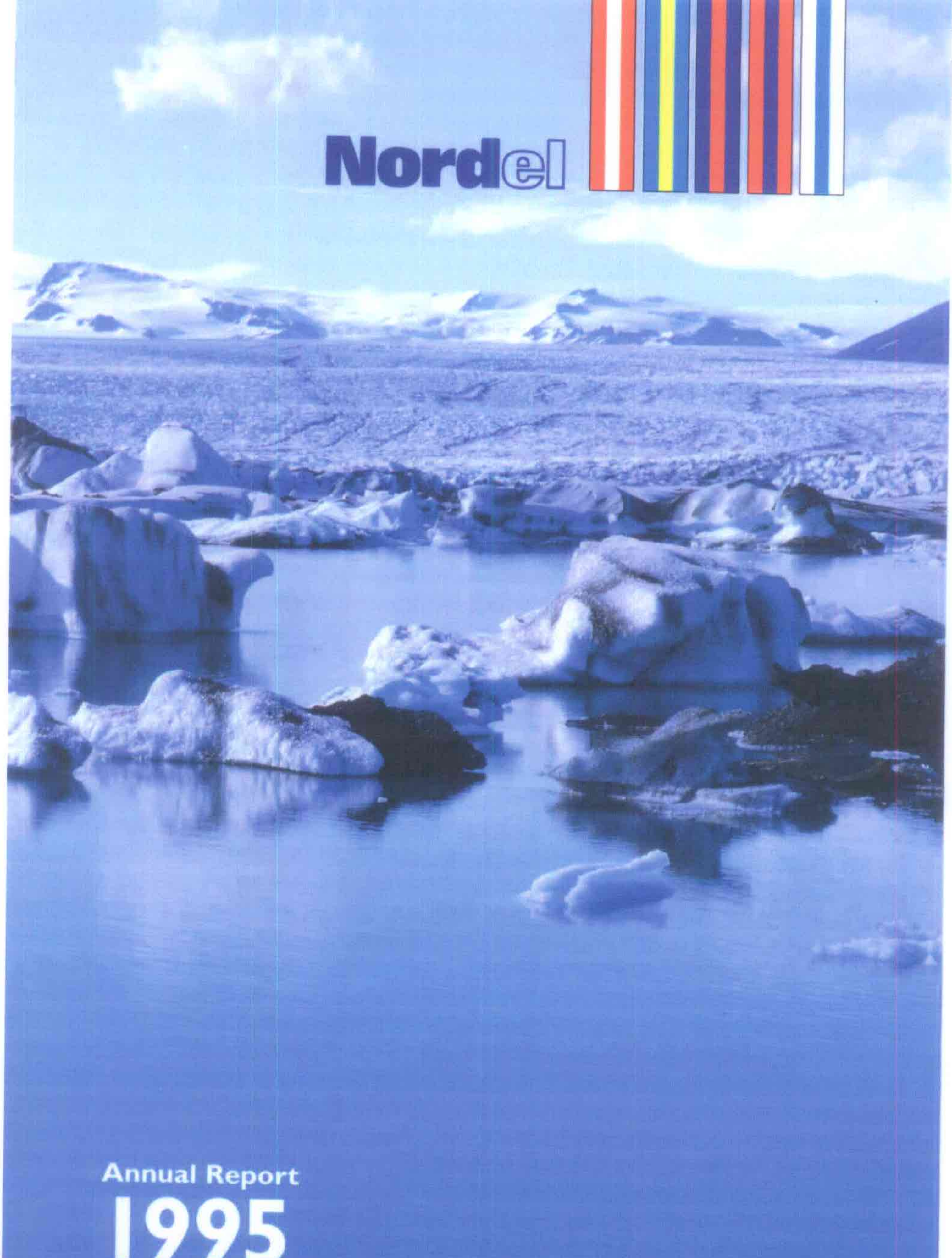


Nordel

Annual Report

1995

COVER PHOTO: IFOT

Nordel's Annual Meeting 1995 was held in Iceland.

Contents

NORDEL

PHOTO: JAN KOFOD WINTHER LUFTFOTO

Nordel, established in 1963, is an association for Nordic electric power cooperation. It is composed of leading individuals within the power supply sector in Denmark, Finland, Iceland, Norway and Sweden. The organisation's statutes and tasks were revised in 1993.

Nordel is an advisory and recommendatory body, whose prime task is to create criteria for efficient utilisation of the Nordic generating and transmission systems. Nordel plays a non-commercial role in connection with electricity interchanges.

Nordel's tasks include:

- Technical coordination of the Nordic generating and transmission systems
- Formulation of technical framework conditions for the Nordic electricity cooperation
- International cooperation
- Contact with other players, organisations and authorities in the electricity sector.

Nordel's chairman is elected for a three-year term. The chairmanship rotates between the member countries. The chairman appoints Nordel's secretary and is responsible for the secretariat.

Nordel has an Executive Board composed of one person from each of the Nordic counties. As Nordel's executive body, the board makes decisions on current matters and implements the decisions made at Nordel's Annual Meeting. The Executive Board also takes care of Nordel's external information activities.

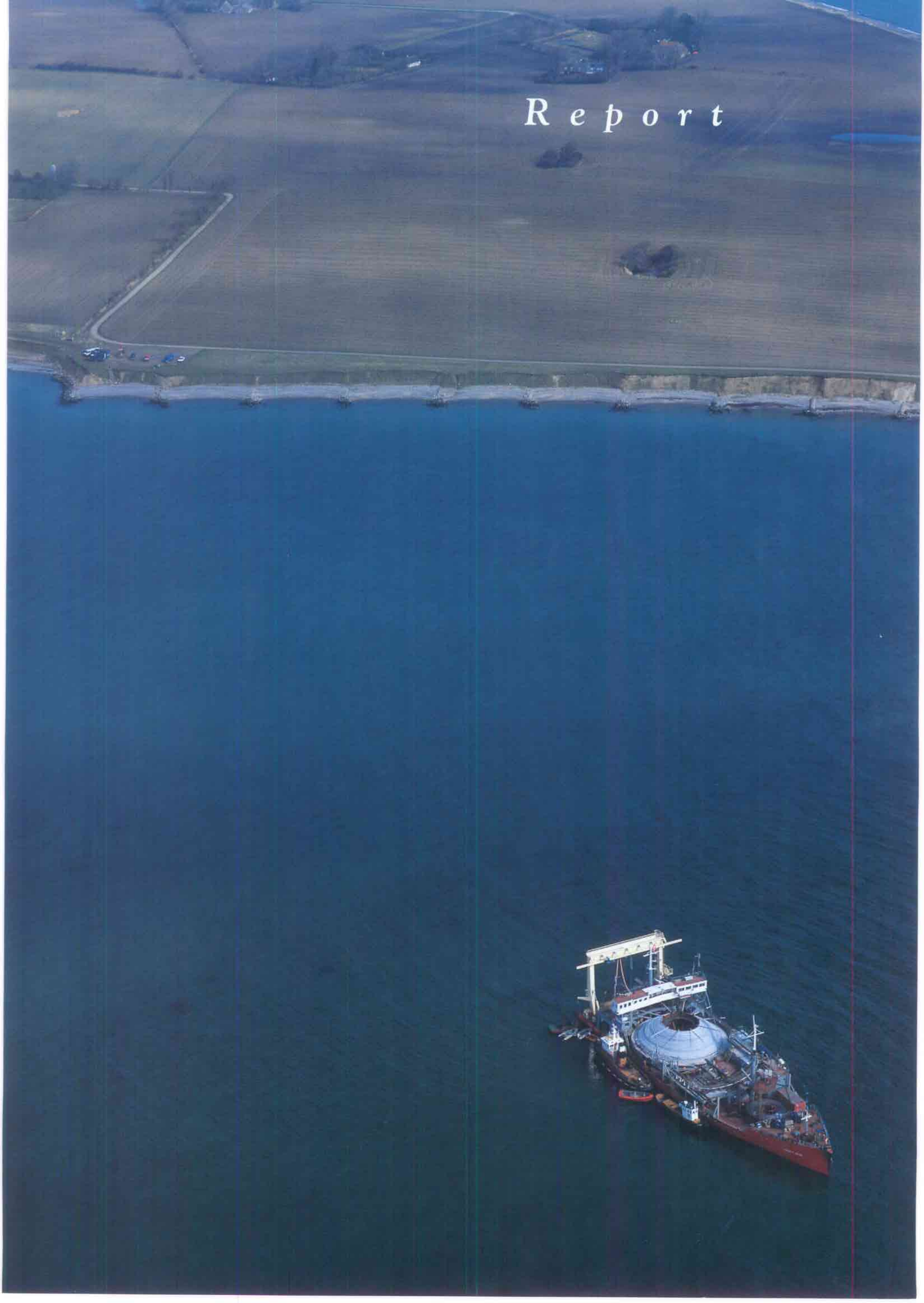
A large part of Nordel's work is carried out by committees and working groups, whose members include specialists on both the generating and the transmission side.

Key figures 1995		Nordel	Denmark	Finland	Iceland	Norway	Sweden
Population	Mill. inh.	**23.7**	5.2	5.1	0.3	4.3	8.8
Electricity consumption (excl. electric boilers)	TWh	**355.2**	33.5	68.9	4.7	111.1	137.0
Max. load (measured 3rd Wedn. in January)	GW	**55.0**	5.8	9.9	0.6	17.9	20.8
Electricity generation	TWh	**366.7**	34.3	60.6	5.0	123.5	143.3
Percentage distribution of electricity generation:							
Hydro power	%	**57**	0	21	94	99	47
Nuclear power	%	**23**	.	30	.	.	46
Other thermal power	%	**20**	97	49	0	1	7
Other renewable power	%	**0**	3	0	6	0	0

. Data are nonexistent
0 Less than 0.5 of the given unit

▶ **The Nordic countries are becoming increasingly linked with the Continent. Here, the laying of the Kontek Link, which went into operation in autumn 1995.**

Report



NORDEL'S ACTIVITIES 1995

In most of the Nordic countries the electricity sector is at present changing dramatically in the direction of deregulation and increased competition. Norway carried out an electricity law reform back in 1991, opening up the electricity market for both generators and users, and in 1995 Finland and Sweden decided to deregulate their electricity markets. In Denmark, too, deregulation of the electricity sector is on the political agenda. Norway, Sweden, Finland and Denmark are thus on their way to a single, integrated Nordic electricity market.

A Nordic electricity market that is open to both generators and users calls for new rules of play for the interchange of electricity between the countries involved. Nordel has participated actively in the efforts to establish a new trading system.

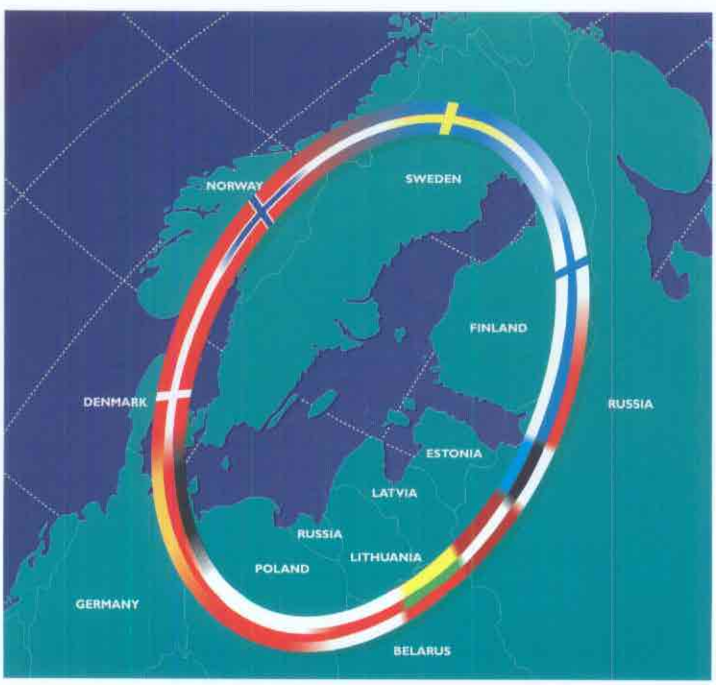
In winter 1994/95 a study was carried out under Nordel concerning the criteria for a Nordic electricity exchange comprising the four coordinating Nordic countries, i.e. Denmark, Finland, Norway and Sweden. The resulting report was considered at an extraordinary meeting of Nordel on 3 May 1995. Together with Statnett and Svenska Kraftnät's status report from March 1995, the report is now being used as a basis for further studies. A Norwegian-Swedish electricity exchange went into operation on 8 January 1996 and a joint Nordic electricity exchange is on the way, although it is not expected to be in place until at least 1 January 1997.

Nordel's Annual Meeting was held in Reykjavik on 24 August 1995. Besides the annual report for 1994, the current power situation in the various Nordic countries and the entire Nordic power situation for the coming three years, the members considered analyses of the Nordel system's power balance in the year 2000 and the transmission capacity between the Nordic countries in that year. The members approved a report on the development of the Nordic electricity cooperation with associated recommendations and recommendations for a standardised procedure for data exchange between control rooms and for technical specifications for combined heat and power plant. The members also approved a proposal for an agreement between Nordel/UCPTE and Eurelectric concerning more structured cooperation.

The development in Europe is characterised by increased internationalisation, entailing a need to strengthen cooperation between the European organisations for cooperation in the electricity supply sector. The close cooperation between Nordel and UCPTE has already proved useful in several areas, including in connection with the deliberations concerning future electricity cooperation with Eastern Europe. The cooperation between Nordel, UCPTE, UNIPEDE and Eurelectric is expected to be strengthened still further in the coming years, and in 1995 Nordel took steps to strengthen relations with the power utilities in the Baltic States.

Closer cooperation with the Baltic States is also a feature of the "Baltic Ring" project, in which a number of power utilities in Denmark, Sweden, Finland and Germany are studying the viability of a linked electricity system and a common market for electricity around the Baltic.

ILLUSTRATION: MIKAEL GORMSEN



A linked electricity supply system around the Baltic is being studied in the "Baltic Ring" project.

ACTIVITIES OF THE SYSTEM COMMITTEE IN 1995

The System Committee is responsible for more long-term matters related to technical systems. Its work includes

- analyses of the technical collaboration between generators and grid operators
- follow-up on the capacity situation in Nordel in both the generation and transmission sectors and
- analyses of the capacity requirements for transmission between the different systems within Nordel and between Nordel and other countries.

The major part of its work is handled by the two working groups, the Generating Group and the Grid Group, which come under the System Committee.


PHOTO: TORBJÖRN ARVIDSON

The Generating Group has completed the analysis of the power balance in the Nordel system in the year 2000, which was started in 1994. The report comprises a base scenario, supplemented by alternative analyses depicting how various factors affect the power balance in the Nordic region.

Only expansions to generating capacity that have been decided upon are considered in the base scenario. It is assumed that optimum use is made of jointly operated interconnections without business-related, political or other limitations. It is also assumed that no fuel taxes are levied on power generation.

The following additions to the base scenario are examined in the alternative analyses:

- imports from Russia
- an increased number of cables to the Continent
- increased transmission between Sweden and Finland
- greater increase in the level of consumption
- environmental taxes on fuels used for electricity generation.

The report shows that both the power and the energy balance are reasonably strong in the base alternative. If consumption is 5% higher, the balance comes under greater strain, the marginal costs being above the level for coal-fired condensing power and exports to the Continent decreasing.

Generation of condensing power is reduced with present-day environmental taxes. Deliveries to electric boilers in Sweden and Norway are increased.

Denmark is consistently a major net exporter, whilst Finland imports energy from the other Nordic countries. The balance for Sweden and Norway fluctuates sharply between wet and dry years. Interchange with the Continent contributes to improved utilisation of Nordic resources.

The Generating Group has started work on its task of analysing the power balance for the year 2005. Increased emphasis will be put on analyses of the environmental impact of the scenarios.

The Grid Group has analysed transmission capacity between the Nordel countries in a heavy-load situation around the year 2000. The calculations take account of existing installations and those for which a decision has been taken. The report shows that no major changes in the transmission limits will take place between 1995 and 2000. No particular bottlenecks will arise in the system under the conditions defined in the report. However, changed circumstances for example with regard to the interchange of power between the countries may lead to restrictions on transmission, as margins are narrow.

The Grid Group is compiling a survey of environmental aspects related to transmission facilities. A report will be presented to the 1996 Annual Meeting.

The Grid Group and the NOKSY group of the Operations Committee have set up a joint working group to study issues raised by the increasing number of HVDC-interconnections beween the Nordic region and the Continent. Baltic Cable between Sweden and Germany and Kontek between Eastern Denmark and Germany are interconnections that have been commissioned recently, and another three interconnections will probably be commissioned during the first few years of the next decade.

An ad hoc group has revised Nordel's operating specifications for thermal power plants. Members of the System Committee assisted with this work in seminars and working groups, both within Nordel and in association with other organisations.

An important part of the Committee's activities has been, and will continue to be, working towards eliminating restrictions on making the most efficient use possible of the Nordic power generating and transmission system, partly by creating an overall picture of the outcome of different scenarios with regard to generating and transmission capacity.

ACTIVITIES OF THE OPERATIONS COMMITTEE IN 1995

ORIENTATION OF ACTIVITIES

The Operations Committee is responsible under Nordel's statutes for technical system matters with a short time horizon and for the technical framework for Nordic electric power interchanges and day-to-day operation.

The Committee's work has the following primary orientation:

- The Committee is to establish the basis for optimum collective utilisation of the entire Nordic electric power system.
- Particular attention is devoted to the conditions for electricity trading and improved framework conditions and administrative rules for the market contacts between the players involved.
- An open exchange of information should be encouraged in order to ensure good reliability and make it possible for the market to work efficiently.
- The Committee is to be a forum for discussion on operational collaboration in the Nordic electric power system.
- Environmental issues are to be given high priority and are to be handled as an integral part of activities, and the importance of operational collaboration to the environment is to be demonstrated.

Two permanent working groups have been set up under the Operations Committee:

- The working group for system operation (NOKSY) is to carry out analyses, prepare regulations and recommendations and coordinate technical issues related to power systems operation.
- The working group for information technology in power systems operation (NORCON) is to promote effective utilisation of information technology in the operational management of power systems.

PHOTO: STEWEN QUIGLEY

Monitoring nuclear power operation. Forsmark power group

In its activities, the Committee has to respect the energy policies and electricity market structures of the particular countries concerned. The Committee therefore keeps a close watch on developments in the electricity markets of the Nordic countries and the EU.

The Operations Committee has been responsible for the work of a sub-committee with participants from the Operations Committee and the System Committee, which has been asked by the Executive Board to prepare an analysis of the scope for development in Nordel collaboration in view of the new market situation, in order to:

- guarantee a continued high level of supply security
- facilitate efficient trading of electricity between the players in the Nordic countries

A final report containing recommendations on the orientation for work was approved by the Annual General Meeting of Nordel in 1995 as forming the basis for the continued work of the committees.

The Operations Committee has been involved in the Nordel studies concerning a Nordic electricity exchange.

The Committee has been specially tasked with investigating the "Definition and pricing of system services" and how these system services are to work in conjunction with trading on an exchange.

The Committee has recommended that Nordel promote acceptance of Nordel's recommendations and rules by the EU as being applicable in the Nordic region since they are suited to the technical design and particular operating conditions of the Nordel system.

POWER COLLABORATION

The Operations Committee has constantly dealt with issues concerned with operational coordination, reliability, the power situation in the Nordic countries and conditions to be met for the trading of electricity.

The power situation in 1995 was governed by 10-20% lower reservoir levels than normal in Norway and Sweden before the spring flood. A cold spring followed by a period of warm and wet weather meant that the forest and mountain floods coincided, and the floods were exceptionally heavy, causing damage in Norway and Sweden. Good storage facilities on developed rivers meant that the amount of damage caused could be limited.

Nuclear generating capacity was almost fully utilised apart from the prolonged shutdowns at Ringhals 3 for steam generator replacement, at Loviisa for the repair of main circulation pumps and at Oskarhamn 1, which was shut down for the whole year for technical upgrading.

Fossil-fuel power overall was utilised to the normal extent. The expansion of alternative energy sources and conversion to combined heat and power is leading to surplus capacity in Denmark. Coal prices rose during the first half of the year and then declined.

Net exports of power were made in 1995 from Norway to Denmark and Sweden and from Sweden to Denmark, Finland and Germany. The interchanges followed the normal pattern, with hydro power and nuclear power replacing power generated by fossil fuels, resulting in less environmental impact.

The power situation in the Nordel system is regarded as good.

The power and energy balances compiled by the Operations Committee for the next three years, 1996-1998, show that the balances are good apart from Norway, where the energy balance shows deficits in both normal years and dry years and the power balance shows small and declining margins.

The interconnection with the UCPTE system was strengthened during the year when the 600 MW Kontek Link between Eastern Denmark and Germany was commissioned. Baltic Cable between Sweden and Germany is still operating at reduced capacity and it remains unclear when the German permanent connecting line will be ready and it will be possible to raise capacity to 600 MW.

The technical conditions for collaboration on electric power can be improved by a planned increase in transmission capacity between Finland and Sweden in the north by 300 MW, and the possibility of increasing transmission capacity between Sweden and Eastern Denmark to 2000 MW is being analysed.

On the other hand, the Committee has noted that the design of the Swedish point tariff for interchange of power between Sweden and Eastern Denmark creates a barrier which has the effect of reducing trade.

The Committee's NORCON working group has been asked by the Committee to draw up a proposal for a standardised communication procedure to be applied in the exchange of plans, charging data and so on directly between the information systems of the operating centres. Nordel approved the recommendation at its 1995 Annual Meeting.

The Operations Committee and NOKSY have assisted in the compilation of a special article in the 1995 annual report entitled "Strengthened interconnection between Nordel and Continental Europe", for which the chairman of NOKSY acted as the coordinating author.

The Committee has been involved in describing Nordic technical and commercial collaboration as a contribution to the CIGRE analysis entitled "Examination of the different types of organisations for interconnected power system operation throughout the world", coordinated by its secretary.

A joint meeting was held between UCPTE and the Operations Committee during the spring of 1995, at which operational matters and issues concerning the development of the electricity market in the UCPTE countries and in the Nordic region were discussed.

RELIABILITY

The Nordel system operated without any serious operational disturbances in 1995.

The Committee has started analysing two overriding issues relating to reliability:

- National requirements for reliability and supply security have differed but have chiefly affected the national market. A common Nordic view of reliability and supply security for the whole of the common Nordic market should be established in a stronger integration of the national markets.
- The integrated Nordic power system and its capacity and reliability are the platform for the Nordic market. There is an interaction between the system reliability and utilisation of the system by the market which should be analysed so that reliability conditions for free trading in electricity are surveyed as the basis for the organisation and operation of power trading.

The NOKSY working group has been asked by the Committee to summarise four recommendations on operating reserves and grid protection and has made the necessary additions and revisions. The new recommendation will be presented to the 1996 Annual Meeting of Nordel.

NOKSY has also been asked by the Committee to focus on such tasks as:

- Analysing the new criteria for grid sizing and comparing the related safety requirements with those applied in practical operation
- Comparing operational recommendations and rules applied in UCPTE and Nordel
- Assessing the frequency quality of the Nordel system and analysing the interaction between the requirement for frequency quality, the requirement for regulating power and routines for the control of generation
- Establishing data for an operating grid for NOKSY's operational analyses
- Defining and documenting the transmission capacity of the cooperated interconnections
- Formulating an improved presentation of system operation with regard to frequency, utilisation of reserves, disturbances etc.
- Analysing disturbances and events of interest in the Nordel system.

DEVELOPMENTS IN 1995

PHOTO: MOGENS CARREBYE

The Nordic countries are enjoying stable economic growth, although the rate of growth is somewhat slower than previously expected. In 1995 GNP rose by 3.1% in Denmark, 4.2% in Finland, 2.8% in Iceland, 4.5% in Norway and 3.0% in Sweden.

In the case of Denmark, the growth of the economy was primarily driven by domestic demand, while net exports made only a small contribution to activity. Unemployment fell by just over 50,000 persons in 1995, resulting in an average for the year of about 290,000, corresponding to about 10% of the workforce.

In Finland, economic growth in 1995 was primarily due to growth of production in industry and closely related sectors. Domestic demand continued to rise very slowly and unemployment fell slightly - from 18.2% in 1994 to 17% in 1995. Total unemployment in 1995 averaged 420,000 persons.

The improvement in Iceland's economy, which began in 1994, continued in 1995. Most of the improvement was due to improvements in the export markets for fish products, which are Iceland's principal production category. Unemployment rose slightly in 1995, averaging 4.8% against 4.4% in 1994.

The Norwegian economy is enjoying a period of expansion, gathering momentum in the second half of 1993 with strong growth in private consumption, housing investments and exports of traditional goods. In 1995 the upturn gained a broader footing and was particularly strong in industry, with a substantial increase in investments during the year. Unemployment in Norway in 1995 was about 5%.

Economic growth was fairly good in Sweden in 1995, primarily as a result of rapidly rising exports and strong growth in investments. Domestic demand is weak, due in part to fiscal measures and an unemployment level of 8%, which is high by Swedish standards.

Total electricity consumption (excl. consumption for electric-boilers) for the five Nordel countries amounted to 355 TWh in 1995 - a rise of 2.1% in relation to 1994. The rise in electricity consumption in the individual countries was as follows: 1.0% in Denmark, 1.2% in Finland, 3.7% in Iceland, 2.6% in Norway and 2.3% in Sweden.

Total electricity generation in the five Nordel countries amounted to 367 TWh in 1995 - a rise of 3% in relation to 1994.

- In 1995 hydro power was the biggest generation source, contributing 207 TWh or almost 57% of the total electricity output. This represents a rise of 11% in relation to 1994, when generation was affected by low precipitation and thus low levels of water in the Norwegian and Swedish reservoirs.
- Nuclear power was the second largest generation source, contributing 85 TWh, corresponding to 23% of total output. Production from nuclear power plants was thus about 4 TWh below the 1994 level.
- Conventional thermal power plants contributed 73 TWh, corresponding to 20% of total output. This represents a fall of 8% in relation to 1994.
- Renewable energy sources, comprising wind power and geothermal power, contributed 1.5 TWh, corresponding to just under 0.5% of total output.

Exchange of electricity between the Nordel countries amounted to 17 TWh. To this must be added 11 TWh interchanged with Germany and Russia. Norway was the biggest net exporter, at 6 TWh, and Finland was the biggest net importer, at 8 TWh (including 5 TWh imported from Russia).

The Swedish-Norwegian electricity exchange Statnett Marked went into operation at the commencement of the year 1996

PHOTO: SVEIN ERIK DAHL

▶ A new small-scale CHP plant on the island of Masnedø - part of a major expansion of cogenerating capacity

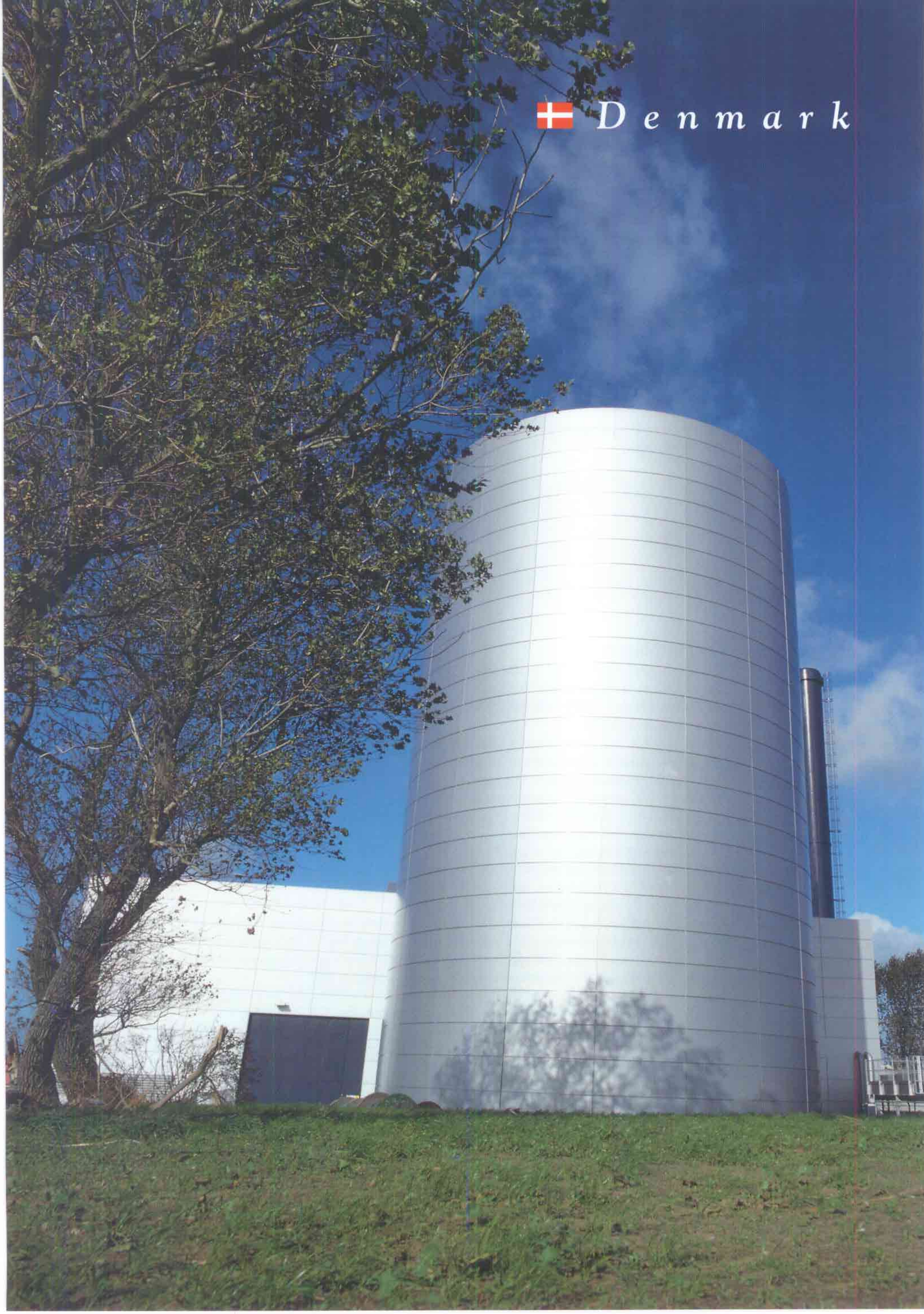

Denmark

PHOTO: JØRGEN SCHYTTE

Biomass is an increasingly important feature of Danish energy policy.

ENERGY POLICY

Danish energy policy is based on the objectives set out in 1990 in the action plan "Energy 2000", a key element of which is a 20% reduction of CO_2 emissions by the year 2005.

To maintain this ambitious CO_2 objective the Danish government introduced a number of new energy policy measures in 1995. The main measure is "green taxes" on energy consumption in industry.

In addition, in December 1995, the Danish Parliament passed a bill requiring the power utilities to purchase electricity produced at small-scale CHP plants. Under the new act the electricity produced must be billed at a price corresponding to the long-term costs of electricity supply, including power fee. The bill was tabled and passed because of a decision by ELSAM's board not to enter into any new contracts with small-scale CHP plants for the time being. The reason for this decision is a rapid expansion of small-scale and industrial CHP capacity in the ELSAM region, which is going to result in more electricity being produced than is actually needed.

In 1995 the Danish Parliament also passed a bill amending the Power Supply Act to enable Danish power utilities to build up capital reserves for investment as ordinary risk capital in collateral activities, e.g. generating plants in other countries and energy consultancy. The utilities can build up these reserves from savings from rationalisation measures and similar instead of passing them on to the consumers in the form of lower electricity prices.

At the end of 1995 the Minister of Energy and Environment published a discussion paper on Denmark's long-term energy policy entitled "Denmark's Energy Future", which includes an analysis of the theoretical possibilities of reducing energy consumption and of large-scale incorporation of renewable energy production capacity in the Danish energy system. In the coming months "Denmark's Energy Future" will form the basis for debate between the political parties and the energy sector. The government will then, before summer 1996, present a new energy action plan to replace the now 6-year-old "Energy 2000".

During the continued discussions in the EU on a coming council directive on the single electricity market, Denmark has called for particular priority to be given to effective care for the environment and for the member states to be able to impose public service obligations on the power utilities with respect to protection of the environment and supply security.

ELECTRICITY CONSUMPTION

In 1995 total electricity consumption in Denmark amounted to 33.5 TWh - almost the same as in both 1993 and 1994.

Industry, the domestic sector and trade/service sector each accounted for about 30% of the total consumption, with agriculture etc. accounting for the remaining 10%.

ELECTRICITY PRODUCTION

In 1995 domestic electricity production amounted to 34 TWh, 84% of which was produced at primary power stations. The remaining 16% was produced at small-scale plants and renewable energy facilities, where production rose by 30% in relation to 1994.

Total imports from Norway and Sweden amounted to approx. 4 TWh, while total exports reached almost 5 TWh, of which more than 3 TWh went to Germany. Thus, for the year as a whole, Denmark was a net exporter by about 1 TWh.

Coal is still the main fuel used at Danish power stations, accounting for about 86% of total fuel usage in 1995. Use of natural gas has increased in the last few years and accounted for about 3.5% of fuel usage in 1995.

In 1994 SK Power decided to establish a new multifuel CHP unit at Avedøre Power Station with a capacity of 460 MWe and 480 MJ/s heat. The new unit will be based on a technologically advanced concept offering great flexibility and a very high efficiency. Application has been made for permission to establish the new unit and is now under consideration by the authorities.

In the ELSAM region two new high-efficiency convoy units are under construction - at Skærbæk Power Station and Vendsyssel Power Station, each with a capacity of about 400 MWe and about 400 MJ/s heat. The Skærbæk unit, which will use natural gas, is due to go into operation at the end of 1997, and the coal-fired Vendsyssel unit will be commissioned one year later.

ELSAM has also decided to build a fluid-bed CHP plant in Århus with a capacity of approx. 100 MWe and 125 MJ/s heat, fired with coal, wood chips and straw.

Expansion of small-scale CHP production capacity is proceeding at a rapid pace, and in 1995 alone, small-scale CHP units with a total capacity of about 500 MW were commissioned in the ELSAM region.

In 1995 SK Power continued test-firing of Orimulsion, which is being introduced as a supplement to coal. Orimulsion, which is being used at Asnæs Power Station's largest unit, offers both financial and environmental benefits.

In the biomass sector, the power stations in Denmark are working on both combustion technology and gasification technology. Major projects in-

PHOTO: JØRGEN SCHYTTE

Skærbæk Power Station's new unit 3, which is expected to go into operation in 1997

PHOTO: MOGENS CARREBYE

Converter station on the Danish side of the Kontek Link

PHOTO: JUHANI ESKELINEN

clude the construction of a straw-fired boiler at Ensted Power Station which will burn 120,000 tonnes of straw and 30,000 tonnes of wood chips per year, and an outline project for a similar-sized straw-fired boiler at Asnæs Power Station.

THE MAIN TRANSMISSION GRID

The new Kontek Link, which connects Eastern Denmark's electricity system with Germany, went into operation in autumn 1995. The interconnection consists of an underground DC cable link from Bjæverskov to Gedser (about 100 km) and from there an approx. 50 km submarine DC cable to Margrafenheide north of Rostock. The Kontek Link has a transmission capacity of about 600 MW.

ELECTRICITY PRICES

From the beginning of 1995 to the beginning of 1996 electricity prices excl. taxes rose by DKK 0.015-0.020/kWh. The average user price with an annual consumption of 3,500 kWh is DKK 0.472/kWh. Incl. taxes and VAT, the price is DKK 1.176/kWh. With an annual consumption of 15,000 kWh, the corresponding user prices are DKK 0.392/kWh and DKK 1.044/kWh.

The prices for industrial customers with an annual consumption of 2.5 GWh average DKK 0.342/kWh (excl. taxes) and DKK 0.401/kWh (with taxes but excl. VAT).

Finland

◀ **A work of art in nature. Environmentally sound electricity pylons designed by Antti Nurmesnieme.**

ENERGY POLICY

New Electricity Market Act

The Finnish Parliament passed the new Electricity Market Act in February. The Act was ratified in March and went into force on 1 June 1995. With effect from November 1995, all grid owners are obliged to transmit electricity to customers whose purchases exceed 500 kW. The output limit for an obligation to transmit electricity will be repealed in January 1997, with the effect that the electricity market will also be opened to smaller consumers. Those customers who to date have been affected by competition in the distribution grids have not changed suppliers to any great extent, despite having shown an interest in doing so.

The Electricity Market Act requires grid services to be priced according to point tariffs. The pricing of transmission services should also be pitched at a reasonable level. The customer is to be given an opportunity to reach an agreement on all transmission with a single grid owner and should have an opportunity to trade throughout the grid. The construction of main grids (voltage level 110 kV or more) necessitates a separate building permit for each line. The distribution grids are given regional monopoly rights with associated obligations.

A new authority was also created in conjunction with the statutory reform, the Electricity Market Central Authority, which is to monitor the activities of the grid companies.

Guidelines for energy policy and savings programmes

On 14 December 1995 the government took a decision in principle on energy policy and the implementation of energy savings within the framework of its energy policy programme. The government incorporated the Finnish Parliament's disapproval of nuclear power expressed in 1993 into its formulation of energy policy and decided to set a target of increasing the use of biomass energy by 25% by the end of 2005. The emphasis in the programme for promoting biomass energy is on making increased use of energy from wood. Biomass energy and other renewable energy is also supported by publicly funded research and commercialisation activities.

No changes were made to energy taxes for 1996. However, the government has decided to shift the emphasis in electricity taxation away from environmental taxes on fuel to taxing consumers, but without altering the overall level of taxation. Decisions on precisely how the taxation will be oriented will be taken during 1996. It was also agreed that an alternative tax model for industry should be prepared. This model can be put to use if the competitiveness of industry so requires. This provides a way of alleviating the burden of taxation.

The government also decided on a programme for energy saving, under which the growth in energy consumption, which has been estimated at 30% by the year 2010, will be cut to 15-20%. The intention is that energy savings should have an impact in such sectors as construction, manufacturing industry and transport. A decision will be made in 1996 on detailed procedures for putting the savings measures into effect.

Toppila Power Station at Uleåborg

PHOTO: KEIJO WESTERBERG

ENVIRONMENT

The environmental permits and environmental law committees issued a joint interim report. The committees are tasked with harmonising Finnish environmental legislation with the principles of the EU's IPPC Directive and improving coordination in the consideration of applications for environmental permits. This work will be completed during the spring of 1996.

Preparations were started for the establishment of a new committee, to be tasked with assessing the need for measures with the aim of further limiting SOx and NOx emissions, which cause acidification. The committee is due to issue its report in autumn of 1997.

The Ministry of the Environment presented a proposal for a tax on waste in conjunction with the autumn budget negotiations. This waste tax would also be levied on ash and residual products from desulphurisation dumped on public landfill sites. General principles and tax levels are currently under examination.

Imatran Voima Oy (IVO) and Industrins Kraft Ab (TVO) set up a joint company, Posiva Oy, to deal with the final storage of spent nuclear fuel from the Loviisa and Olkiluoto power stations. Posiva's activities began at the start of 1996. Posiva is continuing the geological surveys which TVO has conducted at Euraåminne, Kuhmo and Äänekoski. A preliminary investigation of the bedrock at Loviisa is also to be carried out.

ELECTRICITY CONSUMPTION

Electricity consumption in Finland amounted to 69.0 TWh in 1995, which represents an increase of 1.1%. The increase in temperature-adjusted terms was 2.1%. Industry's share of electricity consumption was around 53%. The increase in consumption

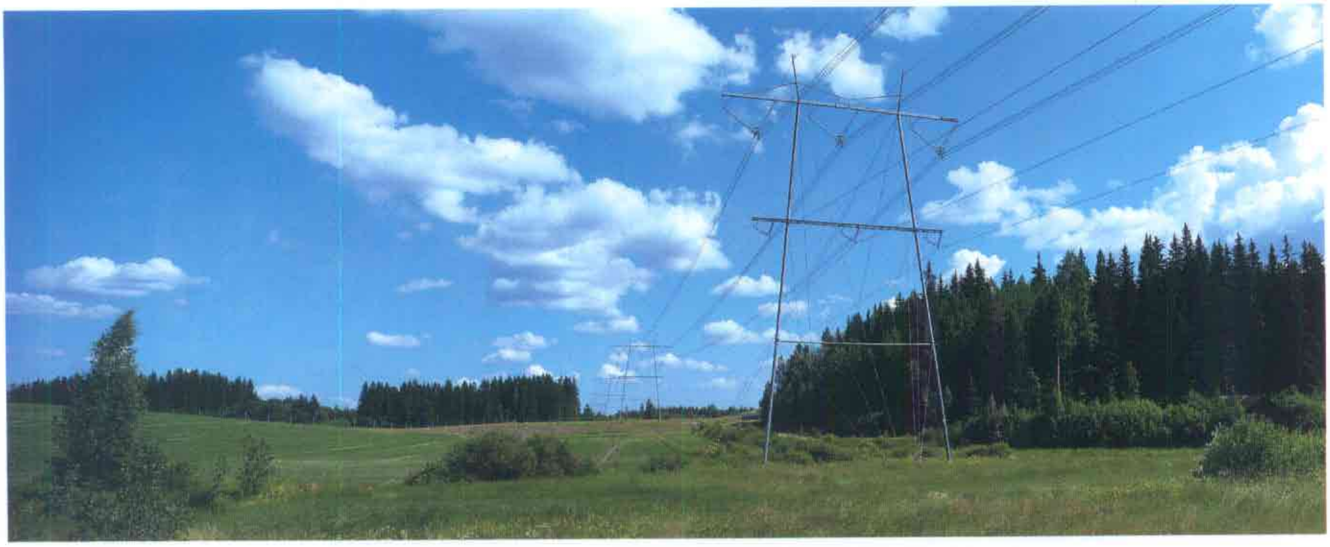


PHOTO: JUHANI ESKELINEN

in the industrial sector slowed to just over 2%, compared with 6% in 1994. Generating capacity was fully utilised in many sectors and no new capacity came on stream. However, reduced demand at the end of the year led to generation in the forestry industry being limited. The recession in the building industry and continued restructuring of the service industries meant that the increase in electricity consumption in the housing and service sectors was small. Consumption outside the industrial sector remained unchanged from the previous year owing to the mild winter. The equivalent change adjusted for temperature was +1.5%.

The peak output for the year was 11,000 MW, which was registered during a day when the temperature was -15°C. The peak output in 1994 was 300 MW higher.

ELECTRICITY PRODUCTION

Demand for electricity rose by 0.6% during the year to 69.3 TWh. Imports of electricity rose most sharply, by 30% to 8.7 TWh, which is equivalent to around 13% of Finnish electricity supply. Electricity was imported from Russia (4.8 TWh, down 4%), Sweden (3.8 TWh, up 130%) and Norway (0.1 TWh).

Hydro power generation was slightly above average and amounted to 12.8 TWh (up 10%). 18.1 TWh was generated at nuclear power stations, which represents a decrease of approximately 1%. The availability factors for the units at Loviisa were 83.5% and for the units at Olkiluoto, 94.1%, which gives an average of 90%. An outage at Loviisa during the autumn meant that around 0.5 TWh was lost. The seals of the main circulation pumps which were replaced with a new model as part of the overhaul were found to leak and had to be replaced by seals of an earlier type.

Generation of back-pressure power rose by 3% compared with the previous year, while the increase in imports and hydro power reduced the need for condensing power by 27%.

Generating capacity increased by a total of 220 MW. The new capacity consisted of hydro power, combined heat and power and industrial back-pressure power.

At the end of 1995, a total of approx. 1,000 MW of new generating capacity was either under construction or at the stage where projects had been given the go-ahead. After the decommissioning of old power plants, the net increase is approximately 900 MW. About half the increase is accounted for by the gas-fired CHP station at Nordsjö, Helsinki, which will be commissioned in 1997.

ELECTRICITY PRICES

A large proportion of purchasers of crude power signed new contracts in 1995. The ten-year contracts, which are based on what is known as the H/85 tariff system, expired in November 1995 and are being replaced by new, more flexible contracts.

The more stringent energy taxation and structural changes in the crude power market affected prices charged to end-users, which rose by an average of 8-10% during the year. The average taxed consumer price at the start of 1995 was FIM 0.58/kWh in apartment blocks, FIM 0.50/kWh in detached houses, FIM 0.38/kWh in houses with direct electric heating and FIM 0.32/kWh in houses with electric storage heating.

The average taxed transmission price for medium-sized industry stood at FIM 0.085/kWh. However, the price level varied sharply between areas, from FIM 0.06 to FIM 0.12/kWh.

MAIN GRID

In accordance with the new Electricity Market Act, point tariffs went into effect in all grids from November. IVO Transmission Services Ltd (IVS) and Teollisuuden Voimansiirto Oy (Industrial Power Transmission Ltd, TVS) took a decision to apply a uniform point tariff throughout the main grid.

The Ministry of Trade and Industry, IVO and Pohjolan Voima Oy (PVO) signed a framework

Animation of the planned basin at Vuotos

PHOTO: MATS WIBE LUND

agreement in December on the establishment of a joint nationwide main-grid company. It is planned that the new company will commence activities on 1.9.1996, but no later than 1.1.1997. The main grids of IVS and TVS and IVO's connecting lines to Sweden, Norway and Russia will pass into the ownership of the new company. Some other companies also hold small grid shares which will also pass to the new company.

No group of owners will have a dominant position in the new company. IVO and PVO will become part-owners with a holding of around 30% each and the Finnish government will have a holding of around 10%. The company is also looking for a few domestic institutional investors to become part-owners. The share capital of the new company amounts to FIM 1.3 billion. The remainder of the purchase is being financed by loans.

IVS did not commission any additions to the grid during the year. In the autumn a decision was taken to build a new 400/220 kV transformer station at Pyhänselkä on the River Ule and a 20 km 400 kV line for the section from Pyhänselkä to Pikkarala. The station and the line are due to be completed in autumn 1997. The 400 kV line from Koria to Kymi (40 km) is under construction and will be commissioned in the summer of 1996, initially carrying a voltage of 110 kV. Because of the increase in taxation, IVS has decided to increase the output of the 400/110 kV transformers at the Raumo and Alapitkä stations.

Reliability was high throughout the year, and no serious disturbances occurred in the main grid.

SYSTEM RESPONSIBILITY AND BALANCING

A system of agreements relating to technical interconnected operation recommended by Sähkövaltuuskunta was applied in 1995. Sähkövaltuuskunta is the collaborative organisation of the electricity sector, composed of representatives of generators and main-grid companies. Besides the agreement with IVS and TVS on parallel operation of main grids and grid services, the system also covered agreements between the main-grid companies and the generators with regard to holding reserves of grid capacity for disturbances and agreements on maintaining technical generating reserves.

Sähkövaltuuskunta prepared its proposal with regard to system responsibility during the year. An agreement was also entered into on transitional arrangements for system responsibility and balancing during 1996.

Suomen Voimatase Oy (Finska Kraftbalans Ab) was established at the end of 1995 to be responsible for regulating power in the Finnish electricity system and the balance between generation and consumption. The company is commencing operations in stages during 1996. The part-owners of Suomen Voimatase Oy are IVO and PVO and the grid companies IVS and TVS. The company's ownership base may also be expanded in the future.

Suomen Voimatase Oy purchases regulating power and deals with continuous regulation. The company does not at present have any permanent staff and instead purchases the services it needs, primarily from its part-owners.

MISCELLANEOUS

The restructuring of the pattern of ownership in the industrial sector in electricity generation continued. As a consequence of the new Electricity Market Act, the electricity-selling function of TVS was transferred to a new company, Teollisuuden Sähkönmyynti Oy, which has been created for the purpose. This company, whose owners include UPM-Kymmene, Enso and Kemira, began operation in July.

The generating company Sydfinska Kraft was merged with PVO, making the City of Helsinki, Päijät-Hämeen Voima and Vanda Elverk shareholders in PVO. The distribution activities which PVO acquired as part of the merger were split and sold off to four local distributors.

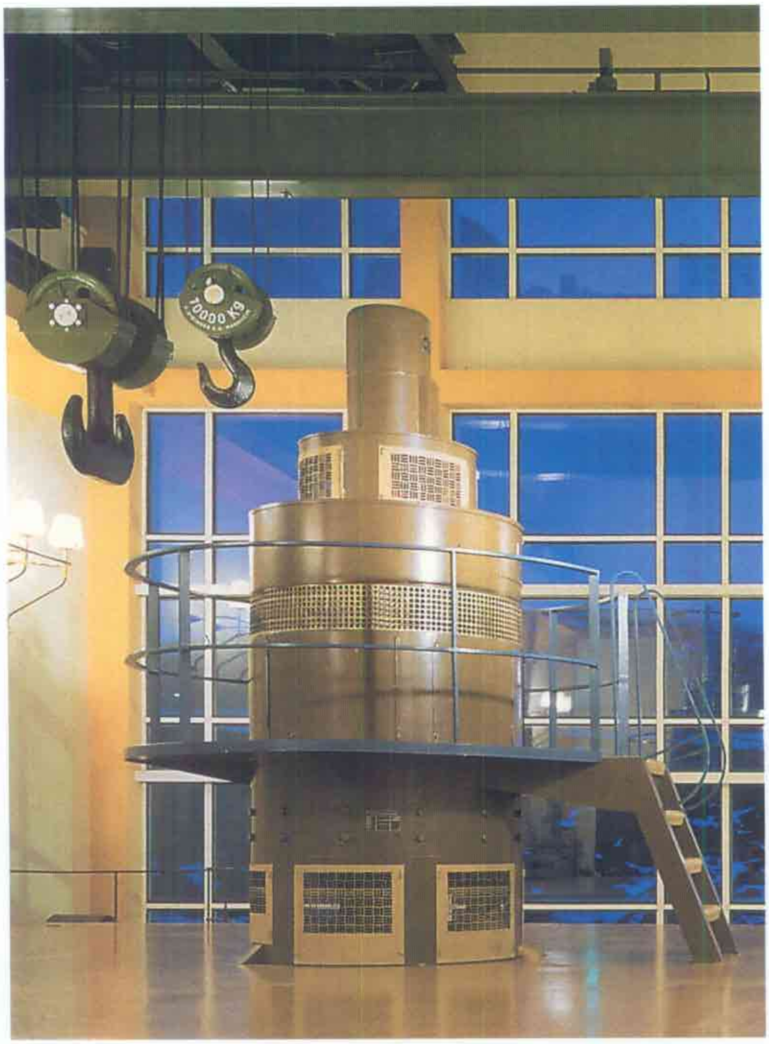
Other redistributions of ownership and structure were also made in the distribution sector. Lojo El and Vihdin Sähkö, owned by IVO, and the electricity distribution part of the Paloheimo company were merged on 1 November, their activities being split into a sales company (Nylands Energi) and a grid company (Nylands Elnät). This solution was the first of its kind in Finland.

The Swedish power company Vattenfall acquired over 90% of the shares in Lapuan Sähkö and Hämeen Sähkö, which is one of the largest distributors in Finland.

In February 1995 the Ministry of Trade and Industry published a white paper on the conditions for trading on a power exchange in Finland. It was noted in the white paper that an electricity exchange could be created in Finland but that the goal should be Nordic collaboration on an electricity exchange. When deregulation came into effect in November, 45 small power stations started mutual trading on a power exchange (Voimatori) on a small scale through their purchasing companies. In the autumn the option broking firm of Suomen Optionmeklarit Oy (SOM) presented its proposal for electronic power-exchange trading, which was to be based on the power-exchange program of the Swedish OM Gruppen. Most major players have expressed an interest in the proposal, and it is planned that trading on the exchange will commence in the summer of 1996.


Iceland

PHOTO: S. JONSSON



Scene from a hydroelectric power station in North Iceland

ENERGY POLICY

Following the general election in April 1995 a new, coalition government comprising the Independence Party and the Progress Party took power in Iceland. Finnur Ingólfsson, Progress Party, was appointed Minister of Industry, Energy and Trade.

Concerning energy policy the new government declared in its programme that it would work for continued industrial expansion and that it would revise the legislation concerning foreign investments in Iceland with a view to attracting foreign capital.

◀ Reykjavik with the island of Videy and Mount Esja in the background and Reykjavik District Heating Station's hot water storage tanks with the restaurant "Perlan" in the foreground

The Minister of Industry is now preparing a revision of Iceland's Energy Act from 1967. He has announced that a committee will be set up with people from the ministry, the Icelandic Energy Agency and interested parties to assist him in the revision of the act, which is expected to start in the first quarter of 1996.

ENLARGEMENT OF SMELTER AT STRAUMSVIK

On 16 November 1995 the Minister of Industry and representatives of the Swiss Alusuisse-Lonza Group in Zürich signed a contract on an expansion of the capacity of the Group's aluminium smelter at Straumsvik south of Reykjavik from 100,000 tonnes to 162,000 tonnes per annum. The enlargement is expected to be completed at the end of 1997. It will absorb the present surplus capacity of the Icelandic power system but will lead to only a minor expansion of this. At the same time, Alusuisse-Lonza and Landsvirkjun signed a power supply contract for the enlarged smelter.

Negotiations are in progress between the Icelandic authorities and the American company Columbia Aluminium Company on the construction of a small smelter, capacity 60,000 tonnes per annum, in south-west Iceland. The negotiations are nearing their conclusion and CAC is expected to decide whether to site the works in Iceland or elsewhere in the first quarter of 1996.

Negotiations with the so-called ATLANTAL Group on a new aluminium smelter with a capacity of 210,000 tonnes per annum in Iceland stood still in 1995 but are expected to be resumed in January 1996.

ELECTRICITY CONSUMPTION

Electricity consumption in Iceland in 1995 amounted to 4,977 GWh gross, i.e. including transmission and distribution losses and the power stations' own consumption. In 1994 consumption stood at 4,733 GWh. Consumption has thus increased by 4.3%. It consisted of 3,954 GWh firm-contract power and 1,023 GWh unguaranteed power.

Of the total consumption, 50.1% went to industrial customers (50.4% in 1994). Ordinary consumption increased by 4.9% without correction for deviations from normal temperature. Including this, the increase was 4.3%.

ELECTRICITY PRODUCTION

Electricity production, which is equal to gross consumption since Iceland neither imports nor exports electricity, was 4,977 GWh against 4,773 GWh in 1994. Of this 4,679 GWh or 94.0% was hydro power (94.5% in 1994), 290 GWh or 5.8% was geothermal power (5.4% in 1994) and 8 GWh or 0.2% came from diesel or gas turbines (0.1% in 1994).

Installed capacity at public power stations was 1,049 MW at the end of 1995 (1,043 MW at the end of 1994).

ELECTRICITY PRICES

Landvirkjun's bulk sales tariff to the distributors remained unchanged in 1995. The main distributors' retail tariffs also remained unchanged throughout the year.

The market price for crude aluminium rose strongly from 1994 to 1995, and with it, the price charged by the Landvirkjun for power supplied to the Icelandic aluminium company ISAL. The price lay at USD 17.2M/kWh in both the first and the fourth quarter of 1995, corresponding to SEK 0.114/kWh based on the price of the dollar on 31 December 1995.

PHOTO: S. JONSSON

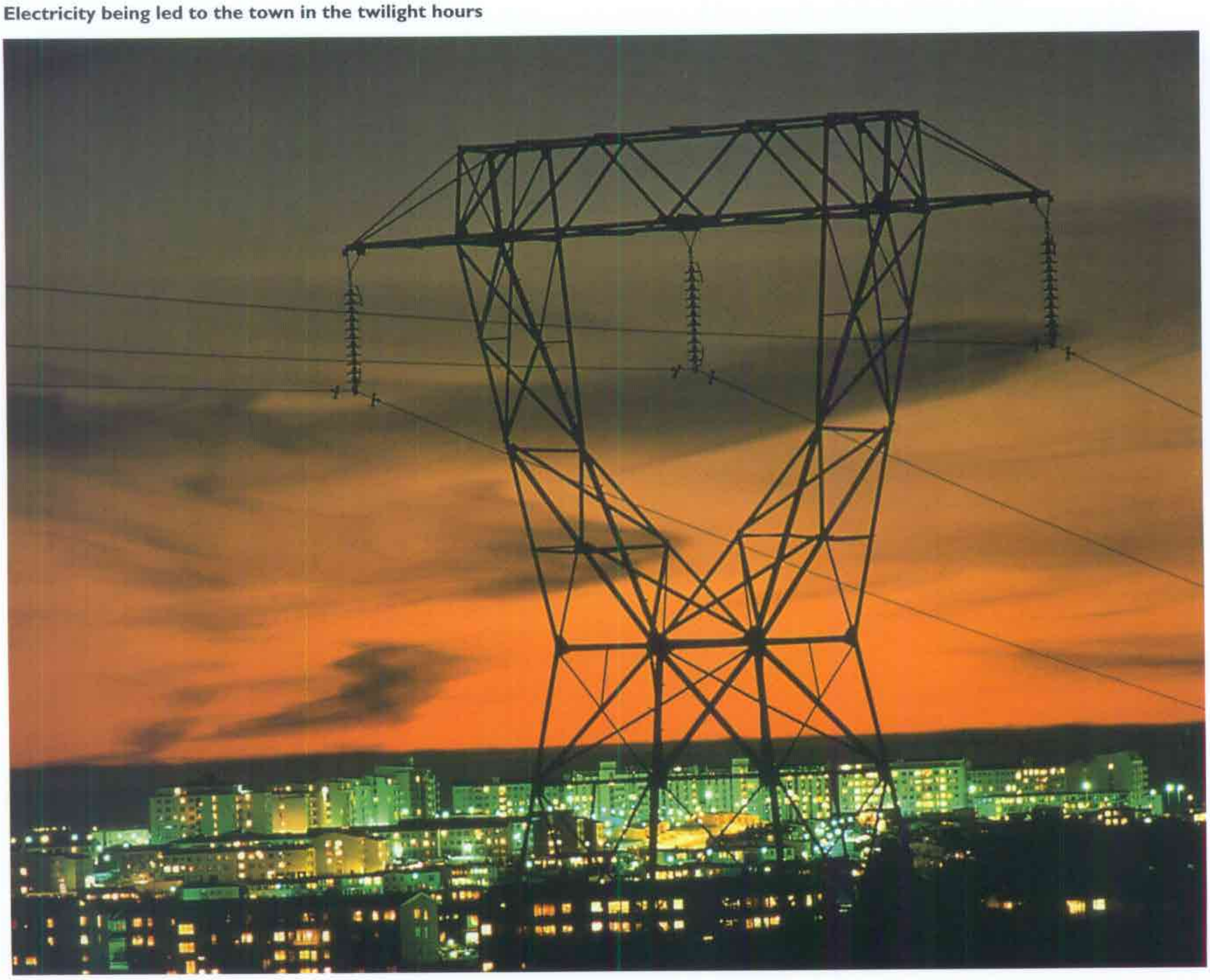
Entrance to the underground "Laxa III" hydroelectric power station in North Iceland

MISCELLANEOUS

The ICENET study group, which is composed of representatives of two Dutch electricity companies, a Dutch cable manufacturer and Reykjavik Municipality, is studying the possibilities for exporting electricity from Iceland to the Netherlands. The committee continued its work in 1995, with participation by representatives of the Landsvirkjun. A final report is expected in spring 1996. At the same time, the Landsvirkjun, in cooperation with Scottish Hydro-Electric, carried out a study on a submarine cable interconnection between Iceland and Scotland or England.

Electricity being led to the town in the twilight hours

PHOTO: S. JONSSON




Norway

PHOTO: FRED FRIBERG - NN/SAMFOTO

ENERGY POLICY

The Minister of Industry and Energy, Jens Stoltenberg, made a statement on energy policy in the Norwegian Parliament (the Storting) in March 1995. The statement and the ensuing debate in the Storting did not hold out the prospect of any change in energy policy. Government policy on the power market is expected to continue as at present. Key issues in the coming period will be the question of expanding gas-fired power generation and the continuation of work on a Nordic electricity market.

The government has presented its own report on the use of natural gas in Norway, including the construction of gas-fired power stations (White Paper No. 44 1994-95). The white paper discusses the conditions for gas-fired power generation from the Nordic point of view with an anticipated tighter power balance. Building gas-fired power stations in Norway will be an alternative way of meeting the increasing demand for power in the Nordic region. The government will only be able to support a gas-fired power station if it is cost-effective and contributes to improving the environment. The white paper is expected to come before the Storting in the spring of 1996.

The Storting has considered its own report on the organisation of power trading with Sweden (White Paper No. 11 1995-96). The report is based on the resolution passed by the Swedish Parliament (Riksdag) for new electricity legislation with effect from 1 January 1996. This white paper deals with the conditions for the transmission of power between Norway and Sweden, the establishment of a common electricity exchange between the countries and the basis for technical cooperation on systems between the national grid companies, Statnett and Svenska Kraftnät. The Government won approval by the Storting of its policy on a common Norwegian/Swedish power market, which will be expanded in the longer term to include Finland and Denmark. The resolution confirms the conclusions drawn at the meeting between the Nordic Ministers of Energy in June 1995 on the requirements to be met for continuing to develop the traditional Nordic cooperation on electricity.

The Ministry of Industry and Energy on 21 September 1995 granted a concession to EuroKraft Norge AS (EuroKraft) for an agreement on power interchange with EST EuroStrom Trading GmgH (EuroStrom). The agreement differs slightly from the long-term power interchange agreements for which concessions have previously been granted in that the parties are to undertake an almost energy-neutral interchange of up to 3 TWh annually (1.5 TWh in each direction). In addition, EuroKraft is to supply 0.5 TWh to Germany annually. The remaining capacity is to be used for short-term power interchange in accordance with prices on the Nordic electricity exchange and marginal costs in the EuroStrom system. The interchange is to take place via a 600 MW cable between Norway and Germany. The cable is to be operational no later than 1 January 2003 and the term of the agreement is 25 years.

EuroKraft is owned by 22 Norwegian power generators which together represent just under 30 per cent of Norwegian generating capacity. EuroStrom is owned on a 50/50 basis by Hamburgische Electricitäts-Werke AG (HEW) and RWE Energie AG (RWE). RWE is Germany's largest power generator, with an annual output of 125 TWh. HEW generates 12.5 TWh annually. The Norwegian Water Resources and Energy Administration (NVE) has refused an application from Akershus Energiverk for permission to take over the distribution board Oppegård Energiverk. NVE justified its refusal on the grounds that the purchase would signify increased vertical integration between power generation and distribution. According to NVE, this could mean increased opportunities for cross-subsidy and the use of market strength and could weaken the wholesale market. An appeal against the refusal has been lodged with the Ministry of Industry and Energy for a final ruling.

The government submitted proposals in December 1995 on wide-ranging changes in the taxation of power companies. The proposal replaces the present valuation-based tax (percentage of assessed value) with an ordinary tax on profits. The power companies have had strong objections to the proposed implementation of the proposal, and it is uncertain if the proposal in its present form will be adopted by the Storting.

ELECTRICITY CONSUMPTION

Total gross consumption in Norway amounted to 117.0 TWh in 1995, representing an increase of 3.5 TWh compared with 1994.

Gross consumption in general distribution amounted to 78.5 TWh in 1995, up 1.7% from 1994. Adjusted to normal temperature conditions, general consumption is calculated at 79.0 TWh, an increase of 1.7% compared with the same period in the previous year.

Consumption in energy-intensive industries amounted to 28.5 TWh, up 3.6% on the 1994 figure.

Total demand for power for electric boilers and pumped storage power amounted to 7.6 TWh, a rise of 10.4% compared with the previous year.

Consumption of light heating products (light fuel oils and paraffin) totalled 937 million litres. This represents a drop of 3.4% compared with 1994. Consumption of heavy fuel oils amounted to 344 million litres, representing a drop of 12.5%.

Electricity consumption accounted for 49.9% of the energy content in energy carriers supplied to end-users (net final consumption). This represents an increase of 0.3 percentage points from the 1994 figure. Petroleum products provided 36.8% and solid fuels 12.67%. District heating accounted for around 0.7%.

The peak load relating to domestic consump-

◄ **Ice-covered power lines**

tion, including electric boilers and pumped storage power, was recorded on 28 December, when it reached 19,491 MW. This represents a reduction of 295 MW compared with 1994. At the peak-load hour, exports amounted to 960 MW.

ELECTRICITY PRODUCTION

The recorded figure for hydro power generation was 122.9 TWh in 1995. With an addition of 0.6 TWh of thermal power, total generation thus amounted to 123.5 TWh. This is 10.0 TWh or 8.8% up on the 1994 output figure.

The interchange of power with other countries resulted in net exports of 6.5 TWh. This represents a change compared with the situation in 1994, when there were net imports of 0.1 TWh.

New generating capacity in 1995 totalled 113.9 MW, with average annual output of 490.0 GWh. The additional capacity was provided by a total of ten projects, mostly small-scale power stations. The largest single project was the Hekni power station, providing 56.0 MW and 240.0 GWh/year.

NVE has estimated the mean yearly output in the Norwegian hydro power system at 112.2 TWh based on data returned for the period from 1931 to 1990. In addition, Norway has thermal power stations with mean annual output of 0.6 TWh. Total Norwegian power output in 1994 was thus 9.4% higher than the calculated mean annual figure. The installed capacity at hydro power stations totalled 27,276 MW at 31 December 1995.

420 kV power line between Sima and Dagali, Finseskaret

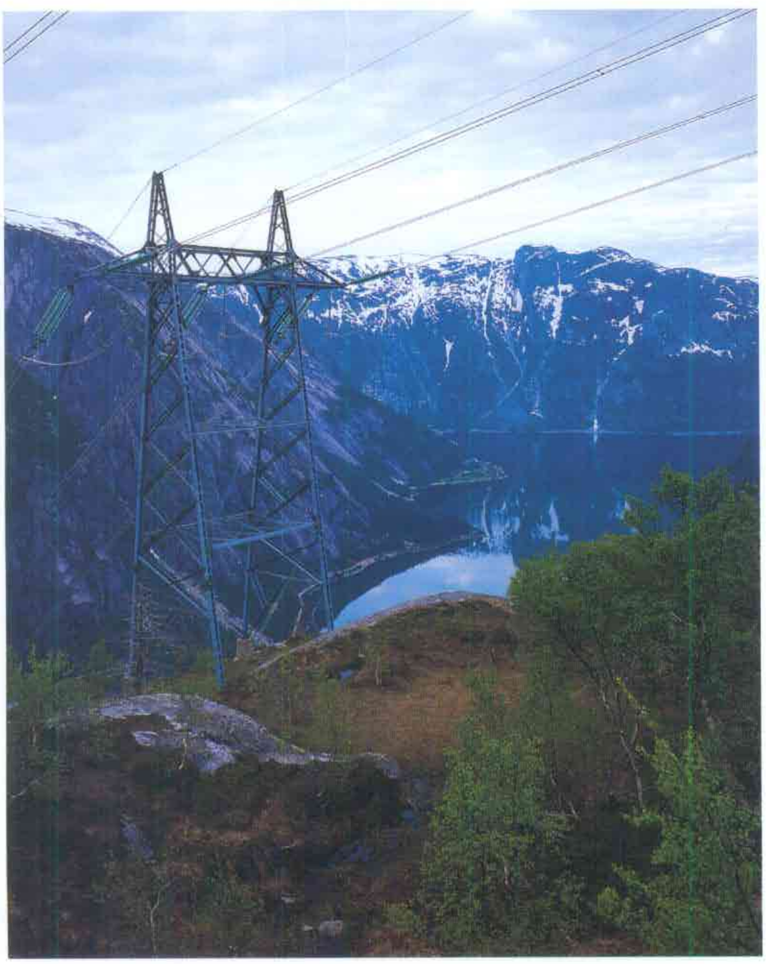


PHOTO: JØRN AREKLETT OMRE - NN/SAMFOTO

In 1995 the company Naturkraft AS, which is owned by Statoil, Statkraft and Norsk Hydro, has given the concession authorities advance notice of plans for gas-fired power stations. On that basis, the company has in February 1996 applied for licence to build and operate a gas-fired power station. The application includes the sites Kårstø in Rogaland county, and Kollsnes in Hordaland county. These are locations where North Sea gas is brought ashore. Installed power can amount to 350 MW for each site. A decision on the application will be made in 1996.

ELECTRICITY PRICES

The average price (quantity-weighted) for power sold through Statnett Marked AS was NOK 125/MWh for 1995. This represents a fall of as much as 29.4% compared with 1994. The average price of power distributed through the daily market was NOK 113/MWh. The highest price in this market was NOK 210/MWh (4 January) and the lowest was NOK 22/MWh (21 June). The average price of regulating power was NOK 112/MWh, whilst it was NOK 145/MWh for the weekly market. The total quantity sold through Statnett Marked was 40.9 TWh, made up of 20.0 TWh in the daily market, 5.5 TWh in the regulating power market and 15.4 TWh in the weekly market.

The average domestic price is calculated at NOK 0.497/kWh including taxes. This represents an increase of 4.6% compared with 1994. The average price for 1995 including taxes is made up of a power price of NOK 0.278/kWh and a transmission price of NOK 0.219/kWh.

An electricity tax is levied on the consumption of power. Manufacturing industry, mining, greenhouses and electric boilers have been exempted from this tax with effect from 1994. Consumers in the counties of Nord-Troms and Finnmark are also exempt from this electricity tax. The level of tax in 1995 was NOK 0.052/kWh, rising to NOK 0.053/kWh for 1996. A generating tax is levied on all electricity generated. The tax for 1995 stood at NOK 0.0152/kWh, whilst it has been increased to NOK 0.0155/kWh for 1996. The tax base is 1/15 of total output generated during the last 15 years. As with other goods and services liable to VAT, electricity was subject to 23 per cent VAT in 1995, and this rate remains unchanged for 1996. The three northernmost counties are exempt from VAT.

Statnett Marked AS, which organises the Norwegian marketplace for trading in physical power, reorganised the weekly market with effect from 29 September 1995 from being a market on which contracts for the delivery of physical power are sold to a purely financial market. The players will obtain daily calculations of gains and losses in rela-

PHOTO: SVENN ERIK HAGEN, STATNETT SF

420 kV line between Sima and Dagali, Finseskaret

tion to the daily market on the power contracts they have purchased up to the week in which the power is to be delivered. The contract is finally settled at the system price on the daily market.

MAIN GRID

The Skagerrak link, pole 1, failed on 21 June as a result of damage to a submarine cable. The fault occurred some 30 km from land at the point where the link comes ashore north of Tjele in Jutland. This is an area where damage had previously occurred to the cable, partly as a result of trawling activity by fishing vessels. The cable was repaired and ready for operation after 12 days. This is a major reduction in repair time compared with previous incidents. The previous incident of this kind occurred in 1988.

There was an outage on the 300 kV line between Fåberg and Øvre Vinstra on 16 August as a result of forest clearance work close to the line. Overhauls and disconnected lines due to previous faults led to sectioning of the Nordic grid with a separate area in Central Norway with a total surplus of 900 MW. The remaining Nordic grid consequently had a total deficit of 1,000 MW. This led to gas turbines being started up in Sweden and reduction of power transmission to Denmark via the KontiSkan link in Southern Sweden.

Plans for further expansion of the main grid are heavily dependent on cable links decided upon between Norway and the Continent and plans for gas-fired power stations. The first applications for concessions relating to specific transmission facilities are expected at the beginning of 1996.

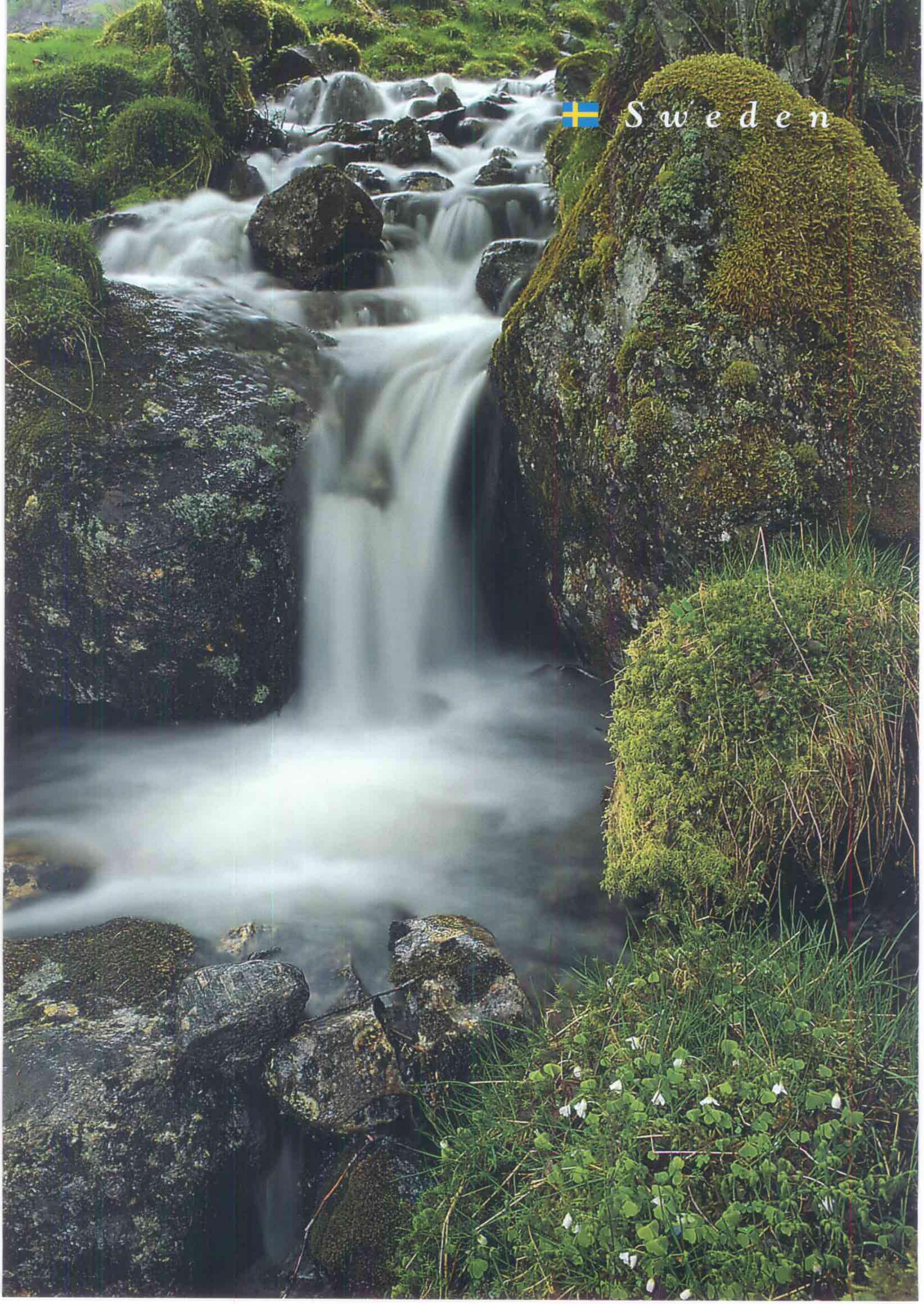

Sweden

PHOTO: TORBJÖRN ARVIDSSON

ENERGY POLICY

Energy policy throughout most of the year was dominated by two topics, reform of the electricity market and the future of nuclear power in the Swedish generating system. Both these issues were discussed during the year by a parliamentary commission, the Energy Commission.

The Commission delivered a preliminary report on electricity market issues on 22 February. The Commission's analyses showed that it was possible to change the regulations applicable to the electricity market without making it more difficult for an answer to be found to the issue of nuclear power. On 24 May, the government introduced Bill 1994/95:222, in which it was proposed that the dormant legislation on reorganisation of the electricity market should come into force on 1 January 1996 with minor adjustments. The Swedish Parliament (Riksdag) decided on 25 October to implement the reform.

The new legislation means that electricity will be generated and sold on a competitive basis, whilst grid activity will continue to be regulated and monitored in a special way. It is emphasised in the Parliamentary Industry Committee's report on this topic that the primary purpose of the reform is to strengthen the position of consumers.

The Energy Commission issued its report entitled "Reorganising the energy system" on 18 December. The report considers that conflicting aims continue to exist in energy policy. The Commission expresses this as follows: "*The Commission considers that conflicting aims remain. This is clearly apparent in relation to climate. Problems also arise for employment and welfare and because of the difficulty of maintaining competitiveness if all nuclear power is phased out by 2010. The results achieved in energy efficiency improvements, supplies of renewable energy and opportunities for maintaining internationally competitive prices will determine the pace at which nuclear power is phased out. In view of the forecasts and assessments made by the Energy Commission, no date for the decommissioning of the last reactor should be fixed.*" It is stated at the same time that "*it is the view of the Energy Commission that a nuclear power facility can be closed down during the period of the mandate without the power balance being noticeably affected.*" (The mandate expires in the autumn of 1998.)

The report has been sent out for comment to a large number of interested parties. The period for submission of comments expires during the spring of 1996 and it is therefore unlikely that a new statement of position on the nuclear power issue will be made in the Riksdag before the autumn of 1996.

ELECTRICITY CONSUMPTION

Electricity consumption in 1995, excluding electric boilers, amounted to 128.0 TWh, an increase of 2.4 TWh compared with the previous year. In addition to direct electricity consumption, transmission losses amount to 9.0 TWh, against 8.2 TWh in the previous year.

PHOTO: STEWEN QUIGLEY

Heating boiler fired by natural gas, Papyrus, Gothenburg

Weather conditions during the past year were broadly normal in terms of temperature, so that electricity consumption adjusted for weather rose by only 0.5 TWh, to 128.5 TWh.

Power supplied to disconnectable electric boilers in 1995 amounted to 4.7 TWh, representing an increase of 0.6 TWh compared with the previous year. Total electricity consumption in Sweden thus stood at 132.7 TWh, a rise of 3.0 TWh.

Industry including the energy sector used 56.0 TWh, a total of 1.6 TWh less than consumption in the previous year. Industrial consumption excluding the energy sector increased by 1.5 TWh. The food and timber processing industries used 2.4 and 2.0 TWh of electricity respectively.

The pulp and paper industry, which is the most intensive industrial user of electricity in Sweden, consumed 19.1 TWh, unchanged from the previous year.

Consumption by the rail and tramway sector was unchanged at 2.5 TWh.

Electricity consumption in the housing sector amounted to 36 TWh, a rise of 0.1 TWh from the previous year.

The interchange of power with neighbouring countries was less extensive than in the previous year. Sweden exported 9.4 TWh and imported 7.7 TWh, which gives a surplus of exports over imports of 1.7 TWh.

The year's single-hour peak figure for electricity consumption was 24.4 GWh/h, which was recorded on 21 December between 8 and 9 a.m. This can be compared with the all-time high of 26.2 GWh/h recorded on 12 January 1987.

ELECTRICITY SUPPLY

Total electricity output amounted to 143.3 TWh, an increase of almost 5.7 TWh compared with the previous year.

Hydro power stations generated 67.0 TWh, which is 3.4 TWh above the mean annual output level. Availability of water was very good during the year and for a period during the summer the inflow was extremely high. The inflow level during weeks 22 and 23 was 279 and 247%, respectively, of normal annual inflow. This was easily coped with on regulated rivers, but the high water levels caused flooding on unregulated rivers. Annual inflow was 121% of the average annual value. Reservoirs were 53 per cent full at the end of the year, equivalent to an energy value of approx. 18 TWh.

Output generated by the nuclear power stations during 1995 amounted to 66.7 TWh, representing a reduction of 3.5 TWh compared with the previous year.

The Oskarshamn I nuclear reactor was shut down for continued overhaul during the year. Apart from that there were few unplanned outages.

The energy availability rate was 76.9%, slightly down on the previous year. The availability rate in Swedish nuclear power can be compared with a world average of 69.8 - 74.5% over the last ten years for light-water reactors (reactors in the former Soviet Union are not included in the weighted world figure). Of the Swedish reactors, Forsmark 3 achieved the highest availability rate at 92.8%, closely followed by Forsmark 2 at 91.7% and Forsmark I at 91.5%.

Back-pressure generation amounted to 8.9 TWh, an increase of 0.3 TWh compared with 1994. Output from condensing plants, gas turbines etc. stood at 0.6 TWh, a decrease of 0.3 TWh.

As a result of the reconstruction of the Gideåbacka hydro power station, there was a net addition of installed power of 7 MW. Further hydro power capacity has also been added at Lofsån with 4 MW and Domnarvet with 2 MW. The capacity of the first reactor at the Oskarhamn nuclear power station was increased by 5 MW. There has been an addition of 35 MW based on wood chips at the combined heat and power station at Nyköping. A total of around 60 plants with a combined output of 29 MW have been added in the area of wind power.

Hydro power station - Norrbotten, Lule river

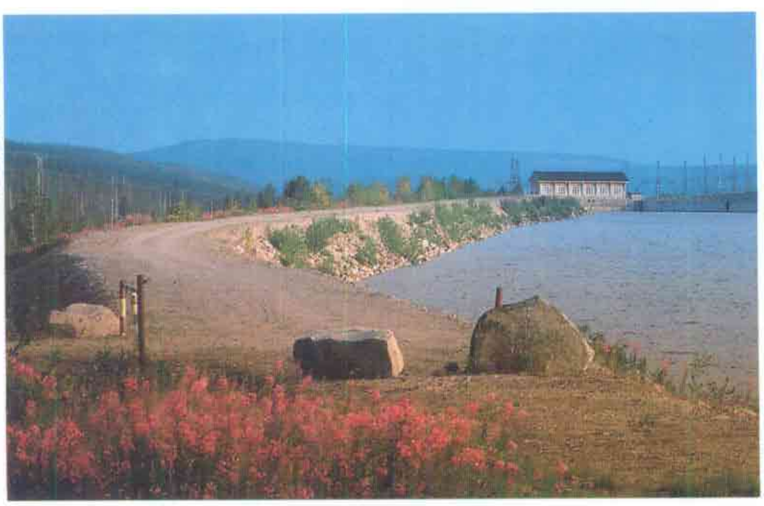


PHOTO: STEVEN QUIGLEY

PHOTO: TORBJÖRN ARVIDSON

Krakerud Power Station

The Kvarnsveden oil condensing plant has been closed down with a loss of 28 MW of output. A total of another 28 MW has disappeared as a result of small hydro power installations being closed down. Reconstruction of the pumped storage power plant at Juktan also started during the year. This has resulted in a loss of 335 MW. Following the closure of the gas turbine facility at Hallstavik and the relocation of parts of its capacity to Gotland, there has been a net decrease in capacity of 120 MW.

MAIN GRID AND INTERNATIONAL LINKS

Preparations have been made so that construction of the new 400 kV line between Breared and Söderåsen can be started. A concession has been obtained. Work has been carried out on a number of existing lines. On the line between Letsi and Betåsen and north of the Skellefteå river, a number of new pylons have been erected to reduce the risk of landslides due to ice loading. The line between Stadsforsen and Torpshammar has been upgraded.

The work on renovating the 400 kV switching station at Kolbotten is now nearing completion. The work has involved adding apparatus to supplement the switching station and installing a new monitoring facility.

At Avesta a new transformer has been installed to supply a new furnace at the steelworks. A reactor broke down at Hallsberg and was replaced with an old reactor which had been kept in reserve. A new 400 kV 150 Mvar reactor was installed at Söderåsen and commissioned on 1 March.

Optical-fibre links have been installed along existing lines in the Gothenburg and Stockholm areas and on the Malmö to Helsingborg and Stockholm to Väddö sections, a total of 290 km.


PHOTO: STEWEN QUIGLEY

Nuclear power station - reactor hall, Forsmark

ELECTRICITY PRICES

In view of developments in the Swedish electricity market in recent years, no uniform electricity price can be reported. The reason for this is that the players in the electricity market have started adjusting to the expected reorganisation even before reforms have been formally implemented. All contracts for the supply of electricity are therefore preceded by negotiations on prices and other terms of supply. The pricing picture is consequently highly fragmented.

As part of the financing of Sweden's membership of the EU, the Riksdag has decided to raise energy taxes from 1 January 1996. This means that hydro power taxation has been doubled and is levied at the rate of SEK 0.02 or 0.04/kWh except for more recent installations, which are exempt from this taxation. A premises tax has also been introduced from the same date which is levied on industrial premises (including power station premises) at the rate of 0.5 per cent of the assessed value. The tax on electricity generated at nuclear power plants was also increased from SEK 0.002/kWh to SEK 0.012/kWh.

In 1993 the Riksdag decided to raise energy taxes according to an index based on the general trend in prices over the twelve-month period from October to October. Taken together, these tax increases mean that the energy tax on electricity is rising to SEK 0.097 or SEK 0.043/kWh. The lower rate will be charged in Norrland, while the rest of the country will pay the higher rate.

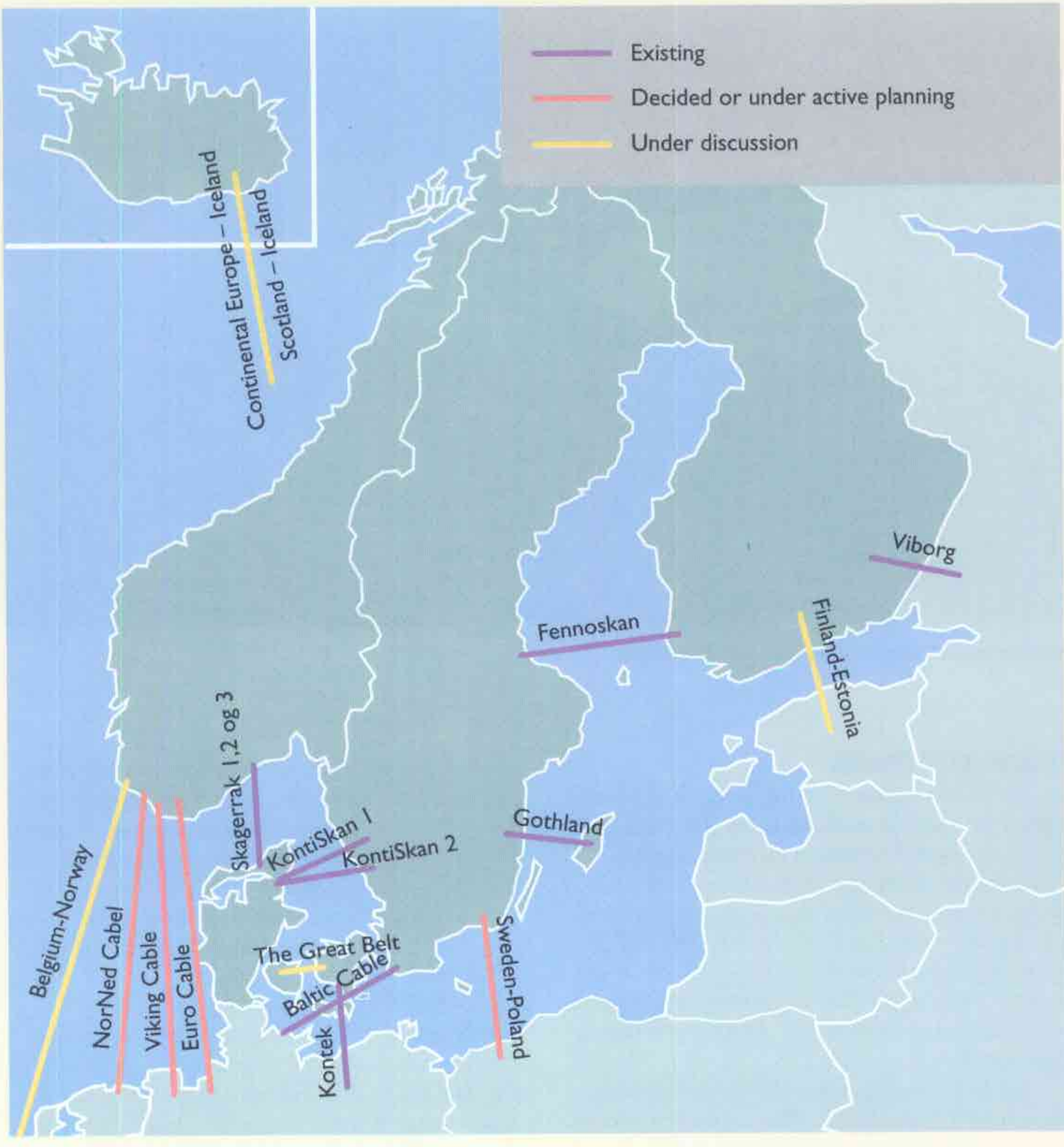
STRENGTHENED INTERCONNECTION BETWEEN NORDEL AND CONTINENTAL EUROPE

BACKGROUND

Nordel has been electrically linked with the world around it since the establishment of KontiSkan 1 in the middle of the 1960s. The electrical interconnections between the synchronous Nordel system have been strengthened and expanded in step with an increasing electrical load and general expansion of the power transmission systems. Today, the total transmission capacity is about 3,700 MW distributed over 8 HVDC interconnections. The 8 interconnections are: KontiSkan 1 and 2, Skagerrak 1, 2 and 3, Viborg, Baltic Cable and Kontek. In addition, there are internal HVDC interconnections in the synchronous Nordel - for example, the Fennoskan and Gotland interconnections.

Further interconnections with a total capacity of more than 6,000 MW have already been decided or are under consideration. Already decided or planned interconnections include: a link between Norway and the Netherlands (NorNed Cable), two links between Norway and Germany (Viking Cable and Euro Cable), and an interconnection between Sweden and Poland. Interconnections under discussion include Storebælt (the Great Belt), Nor-

Figure 1. *HVDC interconnections in the Nordel system*



way - Belgium, Iceland - Scotland, Iceland - Continental Europe and Finland - Estonia.

The total transmission capacity of HVDC interconnections from the Nordel system may thus amount to almost 10% of the installed capacity within 10 years. A transmission capacity of this magnitude is not large compared with the transmission capacity between areas within Nordel. The increase in transmission capacity can therefore be seen as a natural consequence of the blurring of frontiers and national territories and their replacement by regional or global considerations. With a stagnating electricity load and a consequently limited expansion of production capacity, the strengthened interconnection can also be seen as a natural internationalisation of the power utilities in a stagnating market.

Regardless of the cause of the development, the strengthened interconnection offers new opportunities for trade in electricity and requires technical cooperation with new business partners. The interconnections also bring hitherto unknown technical challenges with consequences for both the planning and operation of the Nordel system. These include coordination of the HVDC interconnections' technical characteristics and coordination with neighbouring regions, e.g. UCPTE, among others.

THE DRIVING FORCES BEHIND INCREASED INTERCONNECTION BETWEEN NORDEL AND CONTINENTAL EUROPE

The rapid expansion of HVDC interconnections between Nordel and Continental Europe will help to optimise economic utilisation of hydro-power-dominated production in Nordel and the thermal-power-dominated production in Continental Europe. Figure 2 shows the percentage distribution of the different forms of electricity generation in the Nordel and UCPTE systems.

Another vital factor is the growing focus on eco-friendly electricity production and optimum utilisation of the hydro-power system, with consequent requirements concerning reduction of emissions. In some cases a more competitive electricity market has led to power interchange agreements and cable interconnections with a view to making use of the differences between the production systems in different regions. This may also help to improve the utilisation and profitability of the production apparatus. Other contributing factors are differences in the production price for electricity, natural variations in precipitation and the Nordic countries' need for dry-year safeguards.

Load stagnation and increased internationalisation of the sector are also driving the development forward. Similar conditions apply in other sectors experiencing stagnation in the primary market.

The technical feasibility of closer interconnection has improved considerably since the mid-1960s. For technical reasons, interconnections between the Nordel system and the neighbouring systems can only be established as HVDC interconnections and will in many cases involve long submarine cables. The technological development within HVDC converter stations and cables is going to make it possible in just a few years to establish submarine cable links with capacities of up to 800-1,000 MW. The technology development has also led to a reduction in the specific price for transmission capacity for HVDC interconnections.

The new HVDC interconnections between Nordel and Continental Europe can be used for several different forms of power and energy interchanges:

Energy exports

Energy interchange between Nordel and the outside world is based on the fact that hydro production in Nordel is cheaper than conventional thermal production in Continental Europe. Generally speaking, few agreements of this kind are being entered into at present because surplus electricity in Nordel in years with normal precipitation is falling. Export of electricity will therefore primarily take place in wet years and in spring flood situations. An exception to this are the outlined interconnections from Iceland.

Peak-load power/pumped-storage power

Pumped-storage power agreement, under which hydro power produced in Nordel replaces thermal production in Continental Europe in high-load periods and the transmitted energy is returned to Nordel during low-load periods. The return supply is produced at thermal base-load and medium-load units in Continental Europe.

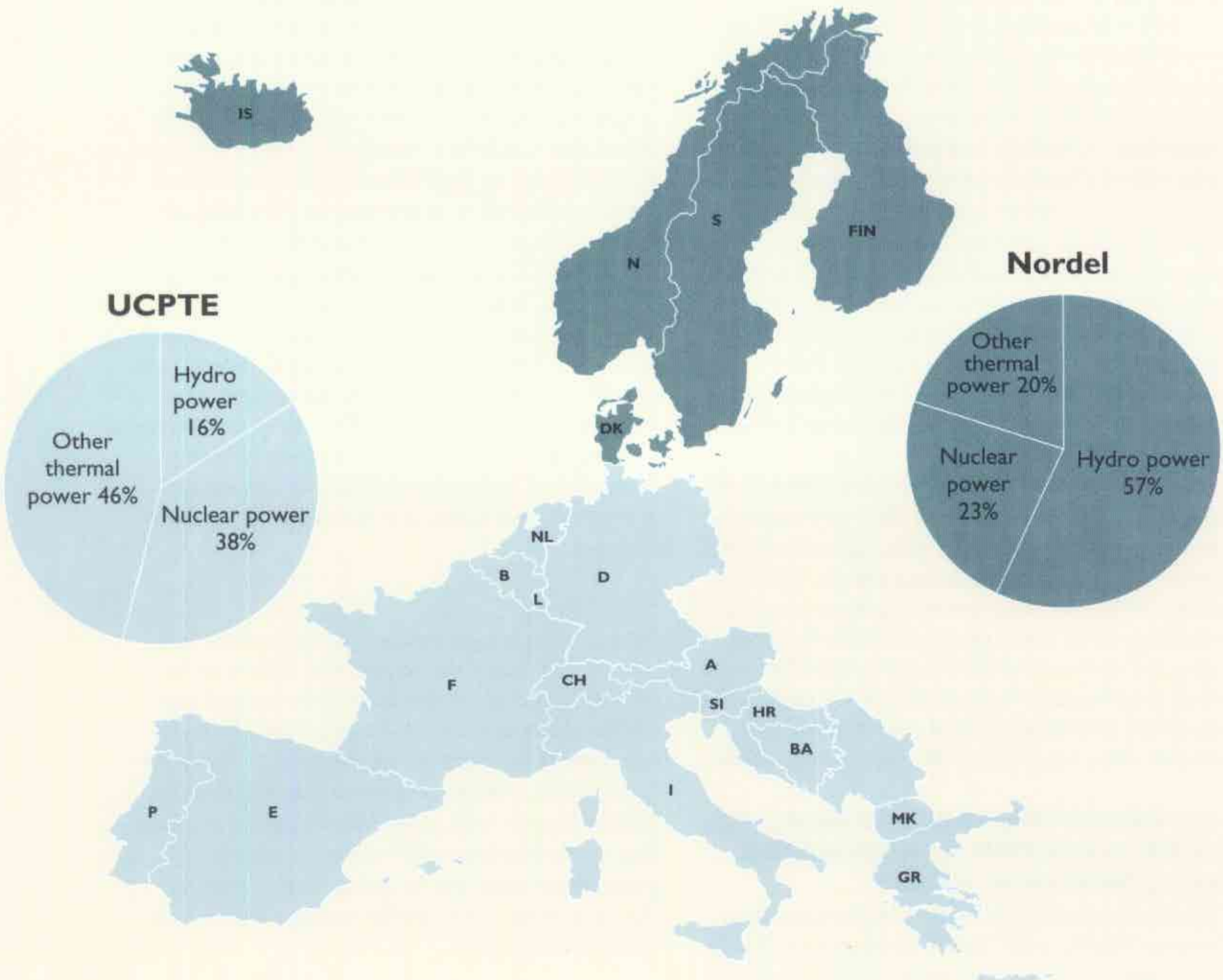
Dry-year safeguards

A hydro-power-dominated system is often vulnerable to dry years. A possible form of interchange via the interconnections will therefore be electricity exports from Continental Europe to Nordel in dry years.

Occasional power

Electricity may also be interchanged because of differences in marginal production prices and/or interchange prices between the two linked regions.

Figure 2. *Electricity generation in 1995, breakdown by form of generation*



Other services

The HVDC interconnections can also be used for interchange of other services - for example, regulating power and reserves.

Agreements on interchange will often cover a combination of two or more of the above-mentioned elements.

DIRECT CURRENT (HVDC) OR ALTERNATING CURRENT (HVAC)

The closer interconnection between the Nordel systems and Continental Europe is exclusively in the form of HVDC interconnections. There are both technical and financial reasons for this.

There is an upper limit on the length of an HVAC-cable. An AC-cable or overhead line receives a constant charging current from the AC-system, irrespective of the load. The size of the charging current is proportional to the length of the line. This puts a certain upper technical limit on the length. For overhead lines, this is normally not a problem, partly because it is possible to compensate for the charging current on the way and partly because the charging current in overhead lines is relatively small. In the case of cables, on the other hand, the charging current is large, and the maximum distance therefore small. This problem does not arise in the case of HVDC interconnections, regardless of whether an overhead line or a cable is used. Therefore, there is actually no upper technical limit on the length of an HVDC interconnection.

For long interconnections, HVDC is cheaper than HVAC. An HVDC interconnection requires two conductors in order to transmit power. Of these, one can be earth/water. An HVAC interconnection, on the other hand, requires three conductors to transmit power. However, the terminal equipment for HVDC interconnections is considerably more costly than for HVAC interconnections. Consequently, HVDC is cheaper than HVAC in the case of big distances. The break-even distance - at which HVAC and HVDC cost the same - depends on the voltage level, the use of cable or overhead line and the need for transmitted power.

Technically, interconnection of two non-synchronous systems can be effected with both AC and DC. However, AC requires far greater transmission capacities than the expected interchange. This is because AC forces the systems to be synchronous and means that it must be possible to interchange large quantities of electricity in order to keep the systems synchronous during or immediately after a grid fault. In addition, different operating philosophies concerning, for example, frequency regulation make it difficult to link two large systems with HVAC interconnections. Lastly, an HVAC interconnection, unlike an HVDC interconnection, increases the fault current level, which can cause problems in some situations.

Because of the precise and rapid control of HVDC interconnections, it is possible to control precisely the power that is interchanged. It is also possible, through suitable choice of additional regulation on HVDC interconnections to interchange fully controlled supplementary services, such as oscillation damping, regulating power, frequency regulation reserve and instantaneous disturbance reserve. Similar control cannot be achieved directly for HVAC interconnections without special, costly components.

A summary of the principal characteristics of HVDC and HVAC interconnections are given in figure 3.

TECHNICAL POSSIBILITIES WITH HVDC

HVDC interconnections are normally established for interchange of power and energy. Thanks to fast and extremely flexible control systems, HVDC interconnections can also help to strengthen the AC grids in the connected AC systems. Establishment of additional regulation in connection with HVDC interconnections is often cheap, seen in relation to the total cost. Widely used additional regulation includes:

Interchange of regulating power and instantaneous disturbance reserve

The cost of establishing these services varies, depending on the production plant and the strength of the grid. Technically, there is nothing to prevent interchange of such services via HVDC interconnections. With HVDC interconnections, the characteristics and quantity of the services can be adjusted to some extent to the needs of the recipient, the capacities of the dispatcher and the agreements between the parties.

Figure 3. *Characteristics of HVAC and HVDC interconnections*

Characteristics	HVAC interconnection	HVDC interconnection
Length of interconnection	There is an upper limit	Any length
Connection of asynchronous systems	Yes, but requires high transmission capacity	Yes
Interchange of reserves	Yes	Yes, precisely controlled
Availability factor	Very high	High
Inspection time	Very short	Short
Control of interchange	Difficult	Yes, very precise
Transmission capacity	High (factor 2 or more)	Limited. Can be increased to 50% at small extra cost

Emergency power regulation
Frequency- or voltage-controlled emergency power intervention can be used to mitigate the consequences of grid faults or production outages. This type of intervention can also take place as (part of) a grid protection system, the purpose of which is to increase transmission capacity or operating reliability in the existing AC grid by relieving critical parts of the grid.

Damping of oscillations
The Nordel system normally has sufficient damping to ensure that faults in the grid do not cause undamped or poorly damped oscillations. However, in some parts of the system improved damping would be advantageous and could help to increase the system's transmission capacity. HVDC interconnections can be equipped with damper regulation so that they help to damp oscillations in the system. This would allow heavier loading of the grid and/or afford greater reliability. However, this use of HVDC interconnections creates a risk of oscillations spreading from one region to another.

Reactive power regulation
Especially in the case of partial loads, an HVDC interconnection can afford some degree of voltage control. This would not normally be financially attractive as a general operating condition, but can be extremely effective, both technically and financially, in abnormal operating situations. Thus, after a grid fault or outage of generating plant, an HVDC interconnection could participate in the reactive power regulation.

TECHNICAL PROBLEMS WITH HVDC - NEED FOR COORDINATION

Use of HVDC interconnections has been described in many contexts, and the particular technical problems relating to them have been discussed. However, there are a number of factors that are of special relevance to the Nordel system and the closer interconnection with the Continent.

When two or more HVDC interconnections are established at a short distance from each other there is a risk of a fault in the AC system resulting in simultaneous, short-term stopping of power transmission on all the HVDC interconnections. There is also a risk of electrically closely connected HVDC interconnections affecting each other after a grid fault, resulting in uncertain and slow restart. As a consequence, in connection with a big expansion of HVDC interconnections, these factors may mean that traditionally relatively harmless AC grid faults end up becoming the dimensioning faults for the Nordel system. To avoid this it is necessary to analyse the expansion with HVDC interconnections in a total Nordel perspective, independent of agreements and ownership.

The aforementioned must also be seen in relation to the fact that the longer the cables used in an HVDC interconnection, the longer it will take to re-establish power transmission after an AC grid fault. Normally harmless and relatively frequent grid faults could stop transmission on the HVDC interconnections for 1 second or more, which could cause regulating problems at the power stations. Operating experience has also shown that having many HVDC interconnections increases the risk of cascade-like events with commutation failure, causing faults to spread within regions separated by HVDC interconnections.

Uncoordinated use of emergency power intervention on the HVDC interconnections - for example, in the form of instantaneous reserve or frequency regulating reserve - also leads to a risk of a fault in one region spreading to another. A fault in Continental Europe that causes a fall in frequency and consequent emergency power intervention could result in a major frequency disturbance in the Nordel system if the intervention is not coordinated. It is also important for the settings of the HVDC interconnections to be coordinated so that they do not counteract each other.

HVDC interconnections are extremely reliable grid components, but because of their greater complexity, they have a slightly higher probability of faults and a greater need for inspection than a normal AC interconnection. An HVDC interconnection typically requires one week's inspection a year and will typically have a shorter (or longer) forced outage five to ten times a year due to a fault or event in the installations. Consequently, the availability factor for an HVDC interconnection is typically lower than for an AC-line. This factor must be taken into account in both the planning and the operation of the system.

An HVDC overhead line takes up less space than an HVAC-line with the same transmission capacity, but even so, several technical factors concerning HVDC interconnections have aroused the attention of environmental and nature preservation organisations and similar. The factors concerned include compass misreading around submarine HVDC-cables, environmental impacts from marine electrodes and potential fields from electrode stations with consequences for metallic gas pipes and other installations.

ADMINISTRATION

The restructuring of the organisation at the power utilities (including division into production, transmission and distribution), the establishment of exchanges, and the development from cooperation to increased competition, mean that clear agreements are needed to settle the question of administration. The HVDC interconnections' control options open the way for direct and controlled interchange between regions.

Power flow restrictions in the transmission grid can consist of both AC and DC components. It is therefore necessary to define the transmission capacity in a sufficiently uniform way for them to be added sensibly, thereby enabling optimum utilisation of the transmission grid.

Big, simultaneous power changes in the HVDC interconnections can cause major frequency deviations in the system. As mentioned earlier, this can occur, for example, in the case of emergency power intervention. Coordination of the control system settings between the HVDC interconnections is necessary in order to maintain good quality frequency.

In a period with major structural changes within the sector, different models have been chosen for incorporating the new interconnections, both organisationally and contractually, and with respect to the way in which they are financed and used.

As will be seen from the foregoing, there are considerable technical challenges that can only be met through cooperation between the parties. This applies both in the planning phase and the later operating phase. In some cases, special technical designs are needed, while in others it will suffice to coordinate the settings of the HVDC interconnections. In the former case it is best for the situation to be clarified before contracts are signed with the suppliers - and in both cases, all questions must be settled before the installations go into operation.

In the planning phase cooperation can take place in connection with the entry into agreement on the design and use of the individual interconnections, and through joint reports and joint technical recommendations. The choice of form of cooperation depends on several factors:

- The ownership situation and commercial use of HVDC interconnections (which are complicated and commercially confidential)
- Highly specialised technical details
- Interaction between grid and power stations in both synchronous systems
- The system characteristics (secondary services) (which depend on the grid and generating plant that are in operation)
- Linkage of the planning phase and the later operating phase - this calls for simple operational cooperation models
- In the operating phase, the coordination takes place within the framework of the operation agreements.

For system safety it is of vital importance to maintain full control of the HVDC interconnections' fast power regulation and full control of their operational "behaviour" during grid faults.

An overall evaluation of these factors indicates that this can best be done through technical coordination and cooperation between the two synchronous systems independently of the ownership and use of the commercially competing HVDC interconnections.

This can, for example, be described in joint technical recommendations, which should be as simple and operational as possible so that they can be adjusted easily when new HVDC interconnections go into operation. Operation of an HVDC interconnection between two systems with different operating practices and different languages makes big demands concerning these recommendations, since they are required to ensure stable operation and must not make effective use of the interconnections difficult.

Supplementary to this, internal agreements must be entered into within the two synchronous systems on how the system characteristics are to be maintained, including the internal distribution of obligations. The latter is already a prime task for both Nordel and UCPTE, irrespective of how the HVDC interconnections are regulated. Within market-oriented systems, responsibility for the system characteristics (system responsibility) is regulated by the national authorities.

The article has been prepared by Søren Støvring-Hallsson in collaboration with Nordel's Operations Committee, The Grid Group and the NOKSY Group

Statistics

CONTENTS

PHOTO: JUNEBAVARIA

DEFINITIONS

Installed capacity (net capacity): Is given in MW and constitutes the arithmetic sum of the rated capacity of the unit installed, but excluding own consumption.

Transmission capacity: Is the rated capacity in MW of a line with due regard taken to the limits imposed by the transformers connected to it.

Electricity generation (net generation): Is usually given in GWh and represents the output ex works, i.e. excluding own production at power station.

Condense: Is defined as the output from a turbo-generator set operated by steam that is expanded in a cooling water condenser to enable the steam to be utilised exclusively for electric power generation.

Combined heat and power (CHP): Is the generation of electric energy by a generator set driven by steam which, when discharged from the turbine, is applied for a purpose irrelevant to power generation such as district heating (CHP District heating) or process steam for industry (CHP Industry). Previously designated back-pressure generation.

Imports/Exports: Is given in GWh and represents the settled values which (inclusive of compensation of loss) are registered as purchases and sales of electricity between the individual countries. *Net imports*: Is the difference between imports and exports.

Notes:
The Norwegian share of Linnvasselv is considered as exports from Sweden to Norway.
The German share of Enstedværket is considered as exports from Denmark to Germany.

Total consumption: Is given in GWh and is the sum of electricity generation and net imports.

Occasional power to electric boilers: Is given in GWh and is the supply of electricity to electric boilers on special conditions for the generation of steam or hot water, which is alternatively generated by firing with oil or other fuels.

Gross consumption (electricity available): Is usually given in GWh and is the calculated electricity consumption: the sum of domestic electricity generation and imports deducting exports and occasional power to electric boilers.

Losses: Are usually given in GWh and is the calculated expression of the difference between gross consumption and net consumption.

Pumped storage power: Is given in GWh and is the electrical energy consumed by the pumps in raising the water into the upper reservoir.

Net consumption: Is usually given in GWh and is the sum of power consumed by the consumers.

UNITS AND SYMBOLS

kW	kilowatt
MW	megawatt = 1,000 kW
J	joule
kJ	kilojoule
PJ	petajoule = 10^{15} J
kWh	kilowatt-hour = 3,600 kJ
MWh	megawatt-hour = 1,000 kWh
GWh	gigawatt-hour = 1,000,000 kWh
TWh	terawatt-hour = 1,000 GWh
~	Alternating current (AC)
=	Direct current (DC)
.	Data are nonexistent
..	Data are too uncertain
0	Less than 0.5 of the given unit
–	No value

EXAMPLE OF CALCULATION:

Electricity generation
\+ Imports
\- Exports

Total consumption
\- Occasional power to electric boilers

Gross consumption (electricity available)
\- Losses, pumped storage power etc.

Net consumption

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Ólafur Pálsson - The Iceland Energy Agency, Iceland
Arne Hjelle - Statnett Market, Norway
Gunilla Kierkegaard and Yngve Wending - Vattenfall AB, Sweden

The present statistics were prepared before the 1995 official statistics for the individual countries have become available. Certain figures in the Annual Report may thus differ from the official statistics.

S1 *Installed capacity 31.12.1995, MW*

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total installed capacity 1995	10 220	14 746	1 049	27 545	34 608	88 168
Commissioned in 1995	382	220	5	158	90	855
Decommissioned in 1995	544	–	–	44	519	1 107
Hydro power	10	2 842	880	27 276	16 152 [1]	47 160
Nuclear power	.	2 310	.	.	10 045	12 355
Other thermal power	9 609	9 588	119	265	8 344	27 925
Of which:						
Condense	5 906 [2]	3 673	.	73	2 712	12 364
CHP District heating	3 349	3 007	.	.	3 178	9 534
CHP Industry	65	2 030	.	157	636	2 888
Gasturbine etc.	289	878	119	35	1 818	3 139
Other renewable power	601	6	50	4	67	728
Of which:						
Wind power	601	6	.	4	67	678
Geothermal power	.	.	50	.	.	50

[1] Incl Norwegian share of Linnvasselv (25 MW)
[2] Incl. German share of Enstedværket (300 MW)

S2 *Average-year generation of hydro power 1995, GWh*

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Average-year generation 1995	–	12 600	4 950	112 187	63 645	193 382
Average-year generation 1994	–	12 530	4 950	111 697	63 600	192 777
Change	–	70	–	490	45	605

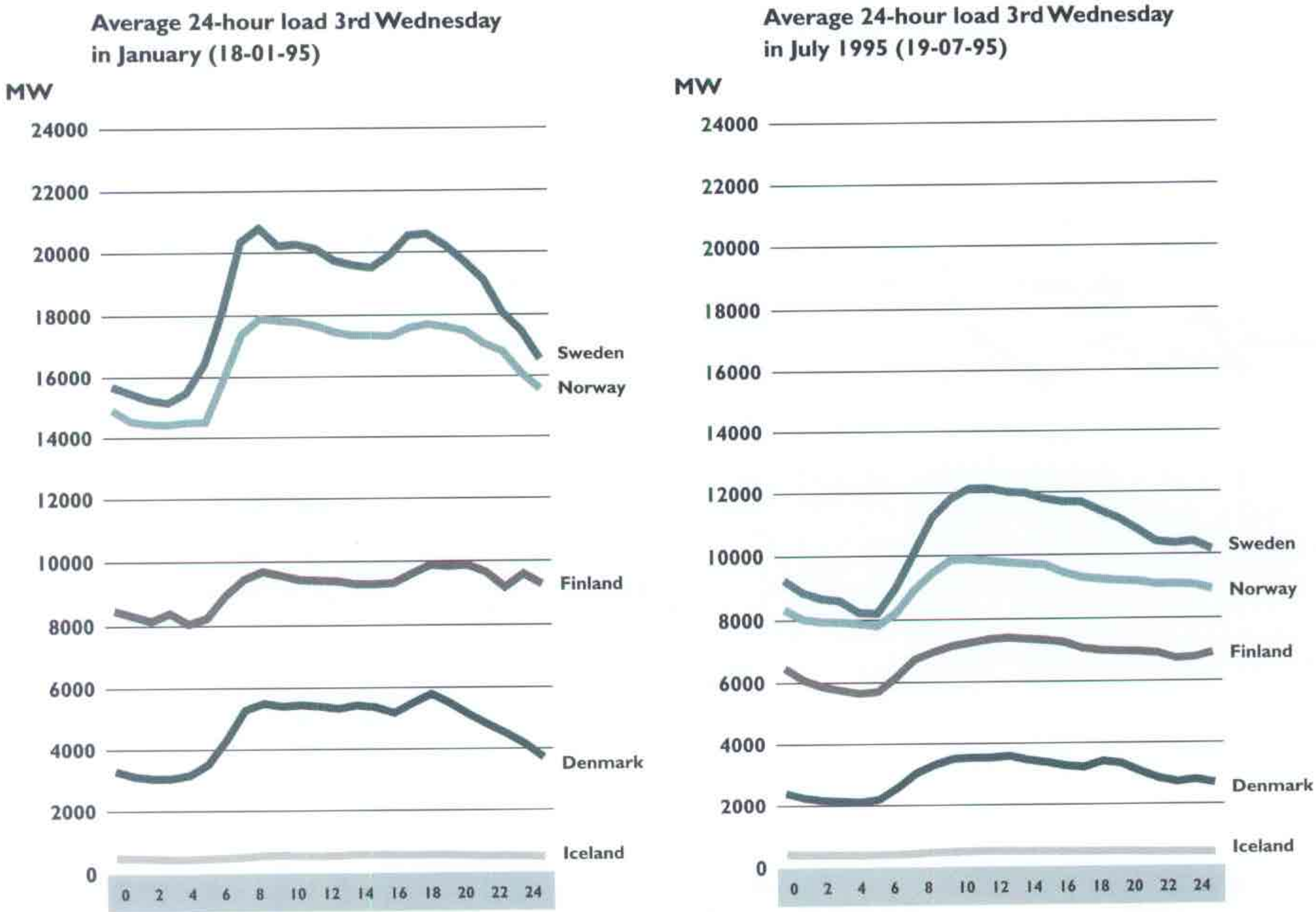
S3 *Changes in installed capacity 1995*

Power category	Power plant	Commissioned	Decommissioned	Change in average-year generation (Hydro power)	Type of fuel
		MW	*MW*	*GWh*	
Denmark					
CHP District heating	Fynsværket		195		Coal/Oil
	Midtkraft		70		Coal/Oil
	Silkeborg	98			Natural gas
	Enstedværket		144		Coal/Oil
	Vestkraft		125		Coal/Oil
	Svanemølleværket	80			Natural gas
	Østkraft	37	10		Coal
	Masnedø	8			Straw
	Næstved	38			Natural gas/ Waste, refuse
	Jyderup	5			Natural gas
	Smørum	6			Natural gas
	Sorø	6			Natural gas
	Jægerspris	6			Natural gas
	Præstø	4			Straw
	Others	19			Natural gas
Wind power	Various	75			
Finland					
Hydro power	Koivukoski	25		20	
	Matarakoski	11		32	
	Others	4		18	
CHP District heating	Toppila 2	105			Peat
	Rovaniemi	30			Peat
	Others	5			
CHP Industry	Kyro	40			Natural gas
Iceland					
Hydro power	Laxá	5		0	
Norway					
Hydro power	Frøystul	43	23	70	
	Skree	7	0	36	
	Hekni	56	0	240	
	Trelandsfoss	8	8	-2	
	Åsebotn	16	0	85	
	Herlandsfoss	14	12	6	
	Kinso	2	0	12	
	Fossheim	9	0	29	
	Valsøyfjord	4	2	2	
	OVF. Vikvatn	0	0	11	
Sweden					
Hydro power	Juktan		335	0	
	Gideåbacka	15	8	10	
	Lofsån	4		18	
	Domnarret	2		20	
	Various changes		28	0	
Nuclear power	Oskarshamn I	5			
Condense	Kvarnsveden		28		Oil
CHP District heating	Nyköping	35			Wood waste
Gasturbine	Hallstavik		120		
Wind power	Abt. 60 new plants	29			

S4 *Decided power plants (larger than 10 MW)*

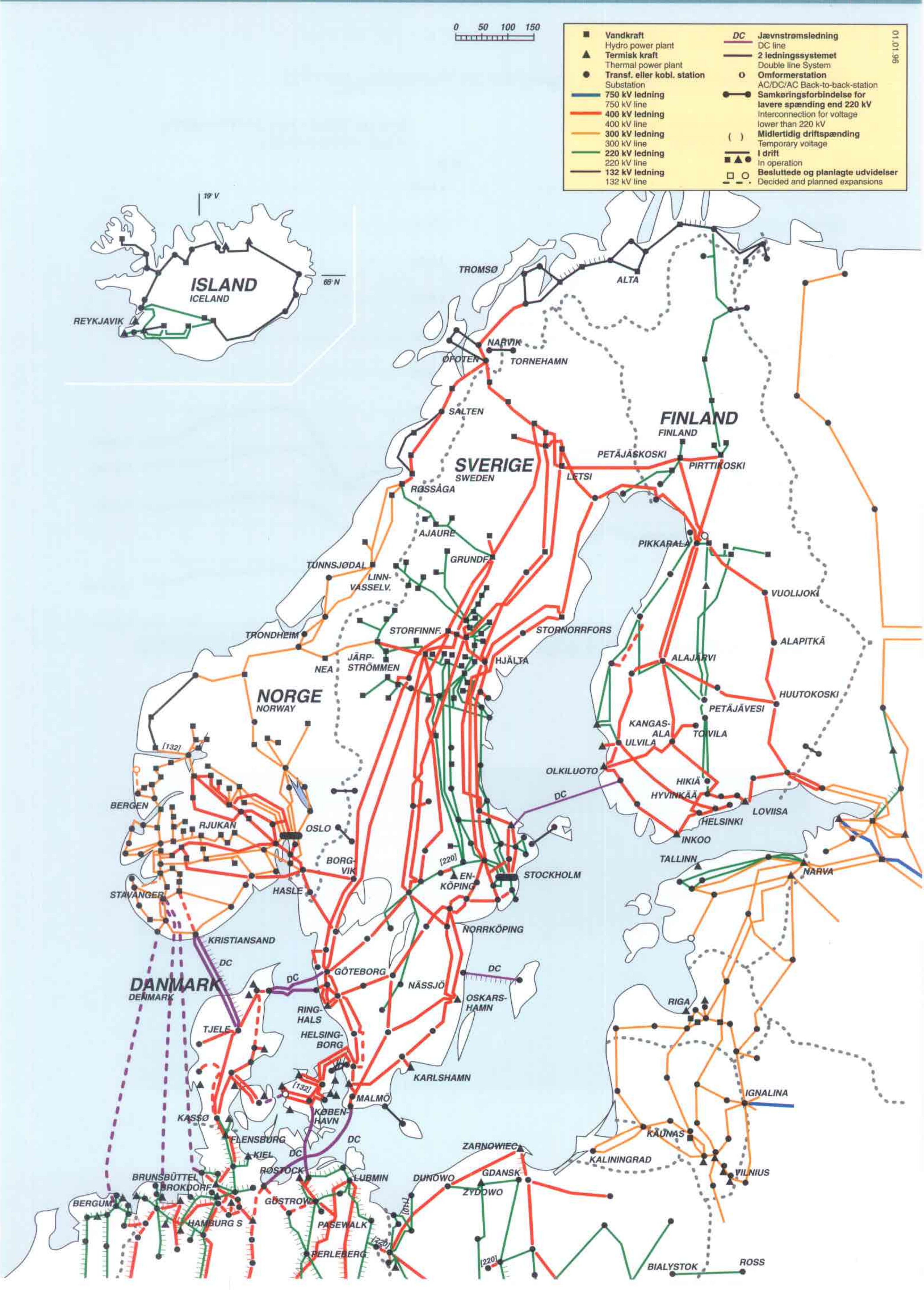
Power category	Power Plant	Capacity	Estimated commission	Average-year generation	Type of fuel
		MW	Year	GWh	
Denmark					
CHP District heating	Skærbækværket 3	394	1997		Natural gas
	Nordjyllandsværket 3	385	1998		Coal/Oil
	Sønderborg	56	1996		Natural gas/Waste, refuse
	Avedøreværket 2	386	2000		Coal/Natural gas/ Straw/Wood waste/(Oil)
	Århusværket	88	1999		Coal/Oil/Biomass
	Ringsted	12	1996		Natural gas
Finland					
Hydro power	Pamilo	26	1997	0	
	Vuotos	37	2001	430	
CHP Industry	MB/Rauma	85	1996		Waste, refuse
	MB/Kemi	30	1996		Waste, refuse
	VTS/Kemi	60	1996		Waste, refuse/Peat
	PVO Nokia	45	1997		Natural gas
	Kirkniemi	70	1997		Natural gas
	Neste POVO	70	1997		Natural gas
	VTS/Oulu	50	1997		Waste, refuse
CHP District heating	Forssa	15	1996		Wood waste/Bark
	Vuosaari B	450	1997		Natural gas
Norway					
Hydro power	Skjerka	95	1997	80	
	Gravfoss	34	1996	78	
	Svartisen II	40	1998	251	
Sweden					
CHP District heating	Brista	39	1996		Wood waste
	Skellefteå	39	1996		Wood waste
	Växjö	37	1996		Wood waste

S5 *System load on 3rd Wednesday in January and 3rd Wednesday in July 1995*



	Installed net capacity	Maximum system load	Minimum system load
GW	*31.12.95*	*3rd Wednesday in January 1995 6:00 p.m.*	*3rd Wednesday in July 1995 5:00 a.m.*
Denmark	10.2	5.8	2.1
Finland	14.7	9.9	5.7
Iceland	1.0	0.6	0.4
Norway	27.5	17.7	7.9
Sweden	34.6	20.6	8.2
Nordel	**88.0**	**54.6**	**24.3**

All hours are local time



0 50 100 150
01.01.96
Vandkraft
Hydro power plant
Termisk kraft
Thermal power plant
Transf. eller kobl. station
Substation
750 kV ledning
750 kV line
400 kV ledning
400 kV line
300 kV ledning
300 kV line
220 kV ledning
220 kV line
132 kV ledning
132 kV line
DC Jævnstrømsledning
DC line
2 ledningssystemet
Double line System
Omformerstation
AC/DC/AC Back-to-back-station
Samkøringsforbindelse for lavere spænding end 220 kV
Interconnection for voltage lower than 220 kV
Midlertidig driftspænding
Temporary voltage
I drift
In operation
Besluttede og planlagte udvidelser
Decided and planned expansions
ISLAND
ICELAND
REYKJAVIK
19° V
65° N
TROMSØ
ALTA
NARVIK
OFOTEN
TORNEHAMN
SALTEN
FINLAND
FINLAND
SVERIGE
SWEDEN
PETÄJÄSKOSKI
PIRTTIKOSKI
LETSI
RØSSÅGA
AJAURE
PIKKARALA
GRUNDF
TUNNSJØDAL
LINN-
VASSELV.
VUOLIJOKI
STORFINNF.
STORNORRFORS
TRONDHEIM
ALAPITKÄ
ALAJÄRVI
JÄRP-
STRÖMMEN
NEA
HJÄLTA
NORGE
NORWAY
HUUTOKOSKI
PETÄJÄVESI
KANGAS-
ALA
ULVILA
TOIVILA
OLKILUOTO
HIKIÄ
HYVINKÄÄ
LOVIISA
HELSINKI
INKOO
BERGEN
RJUKAN
OSLO
DC
TALLINN
NARVA
BORG-
VIK
EN-
KÖPING
STOCKHOLM
STAVANGER
HASLE
NORRKÖPING
KRISTIANSAND
DC
GÖTEBORG
DC
DANMARK
DENMARK
NÄSSJÖ
OSKARS-
HAMN
RIGA
RING-
HALS
TJELE
HELSING-
BORG
KARLSHAMN
MALMÖ
IGNALINA
KØBEN-
HAVN
KASSØ
FLENSBURG
KAUNAS
KIEL
DC
ZARNOWIEC
KALININGRAD
BRUNSBÜTTEL
BROKDORF
ROSTOCK
LUBMIN
DUNOWO
GDANSK
VILNIUS
BERGUM
GÜSTROW
ZYDOWO
HAMBURG S
PASEWALK
PERLEBERG
BIALYSTOK
ROSS

S6 *Existing interconnections between the Nordel countries*

Countries Stations	Rated voltage	Transmission capacity as per design rules[1]		Total lines	Of which cable
	kV	MW		km	km
Denmark-Norway		**From Denmark**	**To Denmark**		
Tjele-Kristiansand	250/350	1 040	1 040	240/pol	127/pol
Finland-Norway		**From Finland**	**To Finland**		
Ivalo-Varangerbotn	220~	100	70	228	.
Denmark-Sweden		**From Sweden**	**To Sweden**		
Teglstrupgård-Mörarp 1 and 2	132~	350 [2]	350 [2]	23	10
Hovegård-Söderåsen 1	400~	800 [2]	800 [2]	91	8
Hovegård-Söderåsen 2	400~	800 [2]	800 [2]	91	8
Vester Hassing-Göteborg	250=	290	270	176	88
Vester Hassing-Lindome	285=	380	360	149	87
Hasle (Bornholm)-Borrby	60~	60	60	48	43
Finland-Sweden		**From Sweden**	**To Sweden**		
Ossauskoski-Kalix	220~	] 900 [3]	] 700	93	.
Petäjäskoski-Letsi	400~			230	.
Keminmaa-Svartbyn	400~			134	.
Hellesby (Åland)-Skattbol	70~	35	35	77	56
Raumo-Forsmark	400=	500	500	235	198
Norway-Sweden		**From Sweden**	**To Sweden**		
Sildvik-Tornehamn	132~	125	125	39	.
Ofoten-Ritsem	400~	750	750	58	.
Røssåga-Ajaure	220~	250 [4]	250 [4]	117	.
Linnvasselv, transformer	220/66~	50	50	.	.
Nea-Järpströmmem	275~	450 [4]	450 [4]	100	.
Lutufallet-Höljes	132~	40	20	18	.
Eidskog-Charlottenberg	132~	100	100	13	.
Hasle-Borgvik	400~	] 1800 [4]	] 1800 [4]	106	.
Halden-Skogssäter	400~			135	.

[1] Maximum permissible exchange
[2] Thermal limit. The total transmission capacity is +/- 1300 MW. It can be higher, however, if the practical possibilities of supply are limited, it is most often due to the import/export capacity of the Swedish or the Danish system. On the basis of Baltic Cable, Kontek and others, an analysis of an increase of the transmission capacity of the interconnections is proceeding.
[3] Further 100 MW for power balance deviation
[4] The transmission capacity can in certain operating situations be lower due to bottlenecks in the Norwegian network. 1800 MW implies a network protection system during operation (PDC = Production disconnection)

S7 *Existing interconnections between the Nordel countries and other countries*

Countries Stations	Rated voltage	Transmission capacity		Total lines	Of which cable
	kV	MW		km	km
Denmark-Germany		**From Nordel**	**To Nordel**		
Kassø-Audorf	2 × 400~	] 1 400 [1]	] 1 400 [1]	107	.
Kassø-Flensburg	220~			40	.
Ensted-Flensburg	220~			34	.
Bjæverskov-Rostock	400=	600	600	166	166
Finland-Russia		**From Nordel**	**To Nordel**		
Imatra-GES 10	110~	.	100	20	.
Yllikkälä-Viborg	±85=	.	900	.	.
Nellimö-Kaitakoski	110~	60	60	20	.
Norway-Russia		**From Nordel**	**To Nordel**		
Kirkenes-Boris Gleb	154~	50	50	10	.
Sweden-Germany		**From Nordel**	**To Nordel**		
Västra Kärrstorp - Herrenwyk	450=	600 [2]	600 [2]	250	220

[1] Transmission capacity alters between 1200 and 1500 MW due to operating conditions
[2] Due to limitations in the German network, the transmission capacity is limited to 250 MW from Nordel and 200 MW to Nordel for the present

S8 *Decided interconnections*

Countries Stations	Rated voltage	Transmission capacity as per design rules	Total lines	Of which cable	Brought into service
	kV	MW	km	km	Year
Denmark -Denmark (Storebælt/The Great Belt) Elsam - Elkraft	400 =	500-600	approx 70	approx 70	1)
Norway-The Netherlands (NorNed Kabel) Lista - Eemshaven	400 - 500 =	min 600	approx 550	approx 550	2001
Norway-Germany (Euro Cable) Feda [2] - Brunsbüttel	400 - 500 =	min 600	approx 550	approx 550	2002
Norway-Germany (Viking Cable) Feda [2] - Wilhelmshaven	400 - 500 =	min 600	approx 550	approx 550	2003

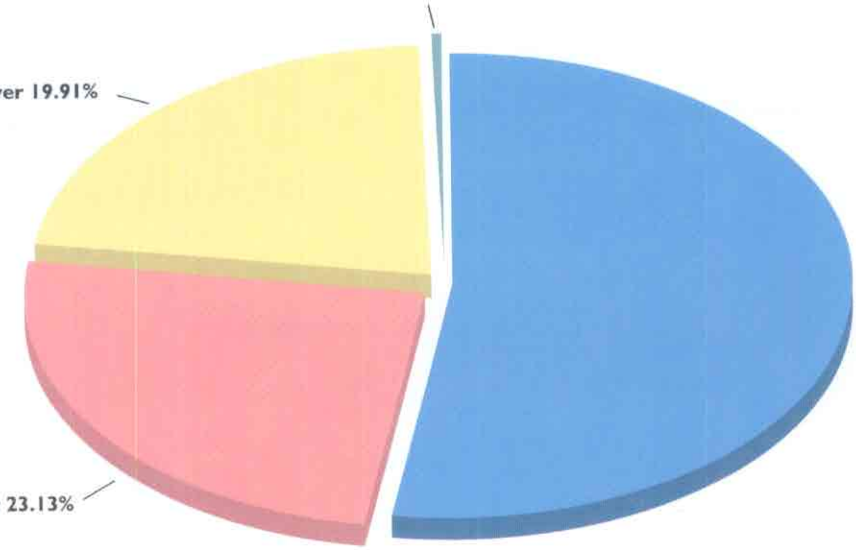
1) Uncompleted decision procedure
2) Overhead line to Tonstad

S9 *Transmission lines 110 - 400 kV in service 31.12.1995*

	400 kV, AC and DC	220-300 kV, AC and DC	110, 132, 150 kV
	km	km	km
Denmark	1 285 [1]	540 [2]	3 952 [3]
Finland	3 821 [4]	2 660	14 750
Iceland	.	492	1 315
Norway	2 110	5 782 [2]	10 300
Sweden	10 657 [4]	4 621 [2]	15 000

1) Of which 2 km in service with 150 kV and 46 km with 132 kV
2) Of which 80 km in Denmark and 96 km in Sweden (KontiSkan), 89 km in Denmark and 382 km in Norway (Skagerrak) in service with 250 kV DC and 75 km in Denmark and 74 km in Sweden (KontiSkan 2) in service with 285 kV DC
3) Of which 13 km in service with 60 kV and 105 km in service with 50 kV
4) Of which 99 km in Finland and 99 km in Sweden DC submarine cable and 34 km in Finland and 2 km in Sweden DC land cable (Fenno-Skan)

S10 *Total electricity generation within Nordel 1995*



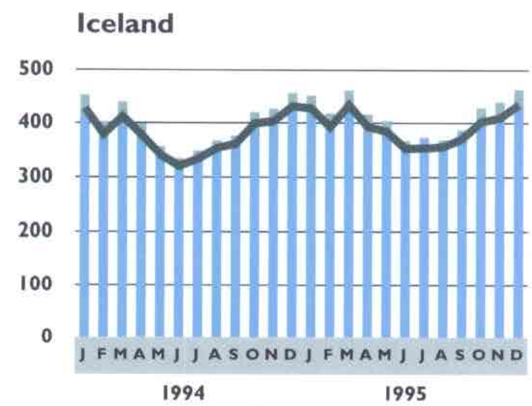
S11 *Electricity generation 1995, GWh*

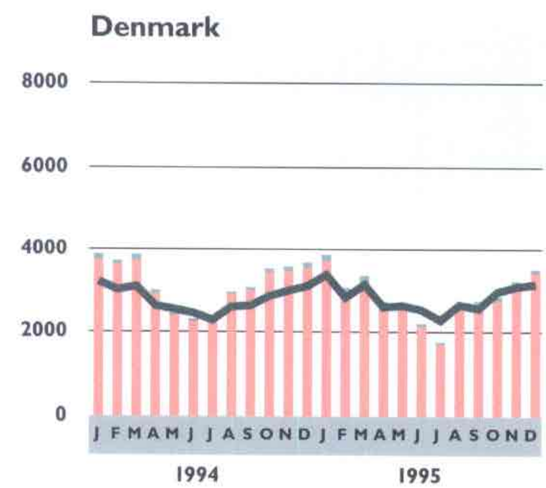
	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total generation 1995	34 339	60 610	4 975	123 481	143 311	**366 716**
• **Hydro power**	33	12 785	4 680	122 826	67 017	**207 341**
• **Nuclear power**	.	18 125	.	.	66 697	**84 822**
• **Other thermal power**	33 163	29 692	6	646	9 498	**73 005**
Of which:						
Condense	32 638 [1]	8 783	.	90	409	**41 920**
CHP District heating	..	11 389	.	.	4 674	**16 063**
CHP Industry	525	9 513	.	368	4 214	**14 620**
Gasturbine etc.	–	7	6	188	201	**402**
• **Other renewable power** [2]	1 143	8	289	9	99	**1 548**
Total generation 1994	38 044	62 180	4 774	113 530	137 653	**356 181**
Change as against 1994	-9.7%	-2.5%	4.2%	8.8%	4.1%	**3.0%**

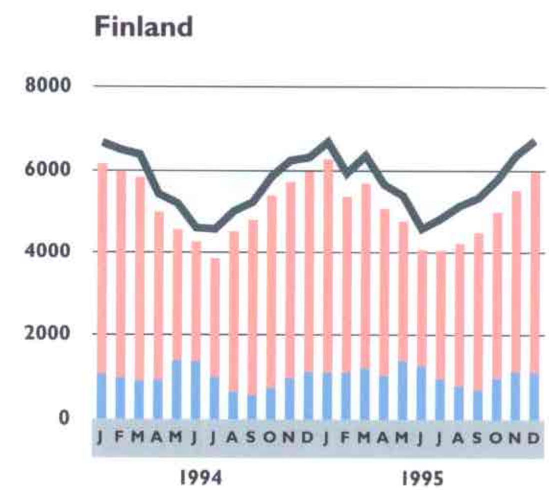
[1] Incl. generation in combined heat and power stations
[2] Wind power. Iceland: Geothermal power

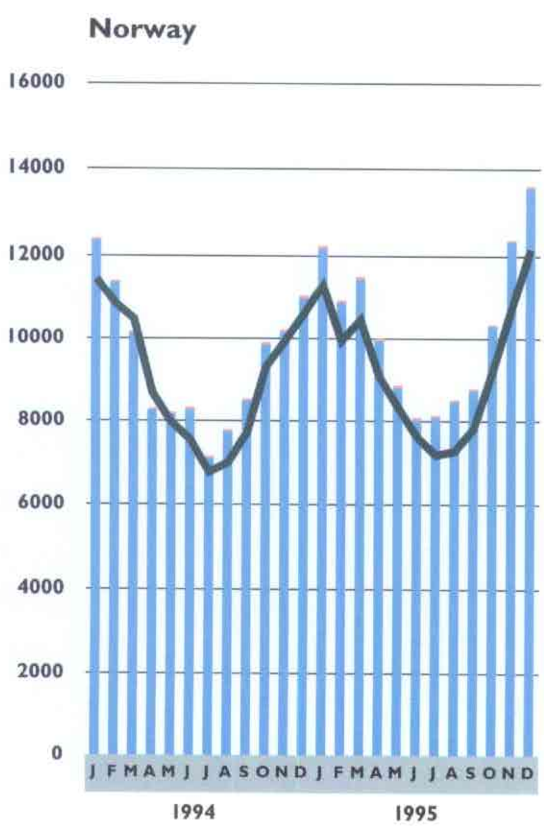
S12 *Monthly electricity generation and gross consumption 1994 -1995, GWh*

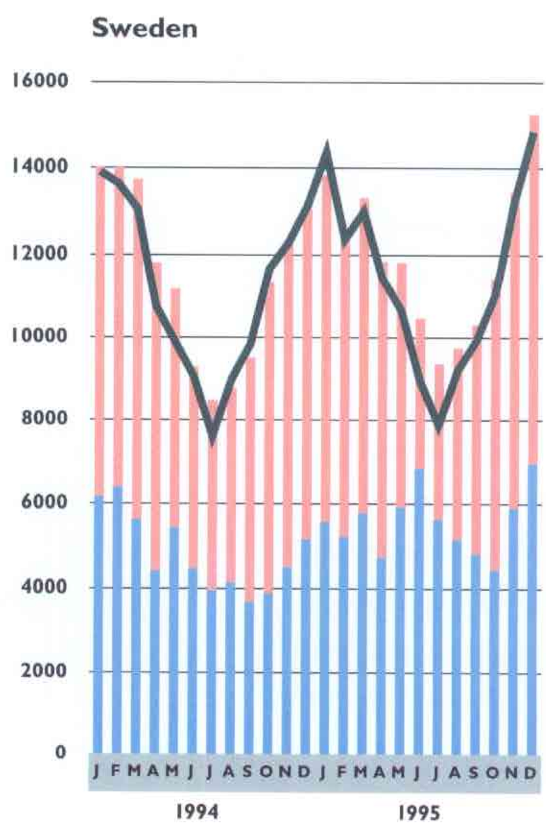
- Gross consumption
- Generation by hydro power
- Generation by nuclear and other thermal power
- Generation by wind power or by geothermal power (Iceland)











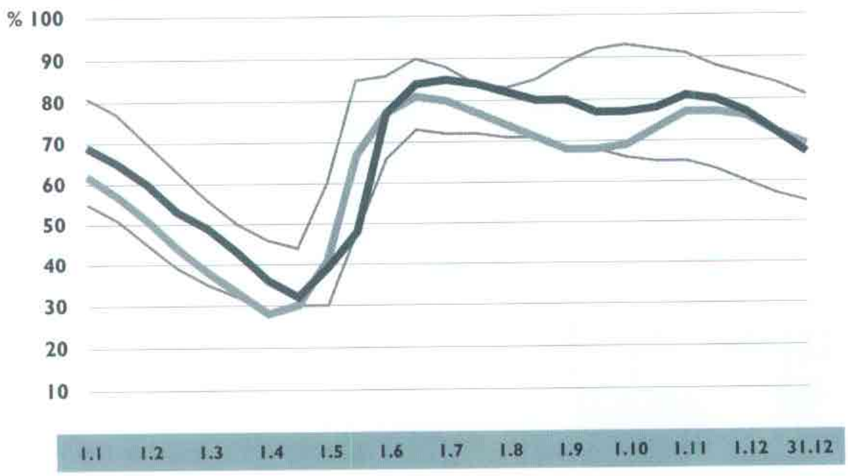
S13 *Water reservoirs 1995*

■ **Water reservoirs 1995 shown in %**

■ **Water reservoirs 1994 shown in %**
Norway: Average 1982-1991

■ **Minimum- and maximum in %**

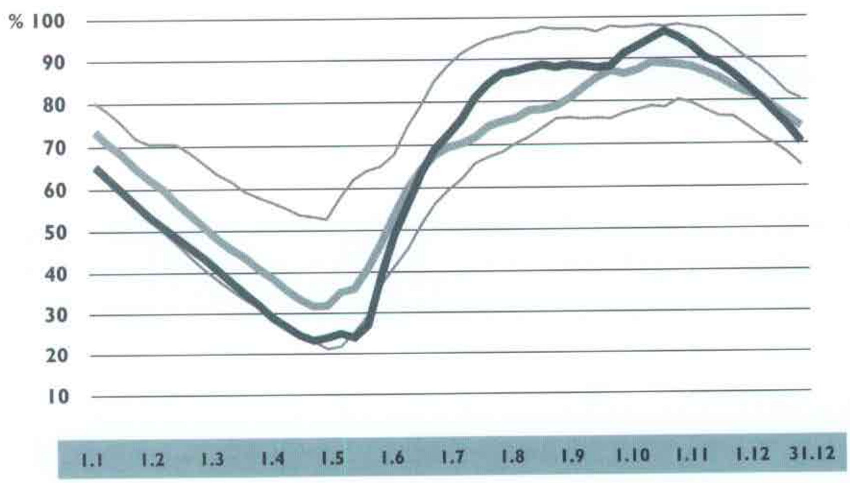
Finland



Reservoir capacity
1.1.1995: 4 900 GWh
31.12.1995: 4 900 GWh

Minimum and maximum values from data which have been recorded 1985-1994

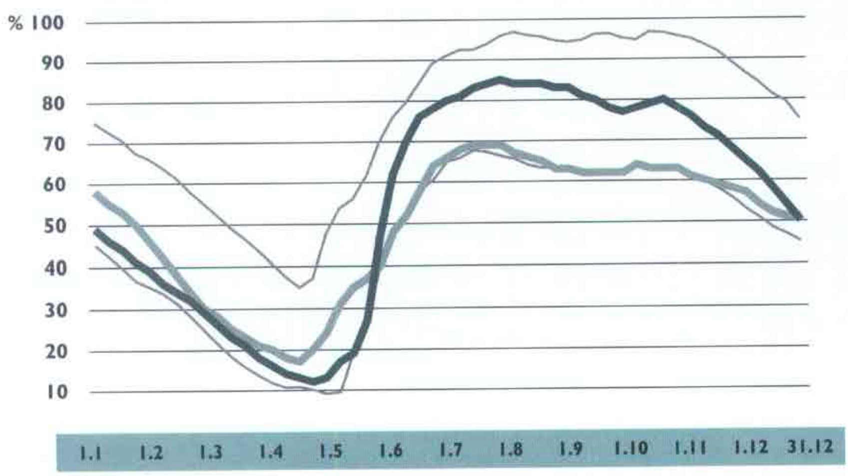
Norway



Reservoir capacity
1.1.1995: 77 073 GWh
31.12.1995: 77 888 GWh

Minimum and maximum values from data which have been recorded 1982-1991

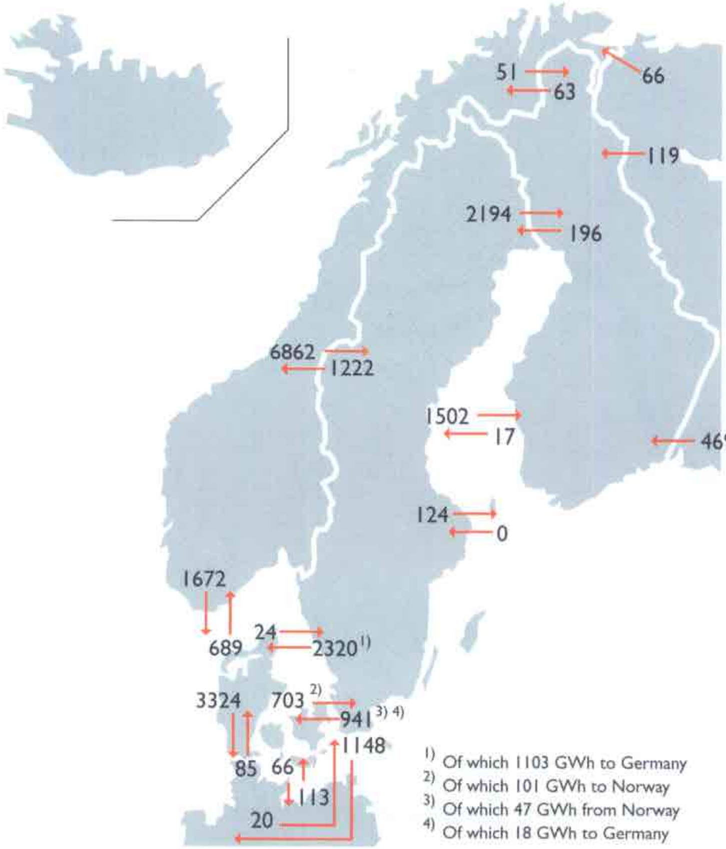
Sweden



Reservoir capacity
1.1.1995: 33 550 GWh
31.12.1995: 33 550 GWh

Minimum and maximum values from data which have been recorded 1980-1994

S14 *Exchange of electricity 1995, GWh*



1) Of which 1103 GWh to Germany
2) Of which 101 GWh to Norway
3) Of which 47 GWh from Norway
4) Of which 18 GWh to Germany

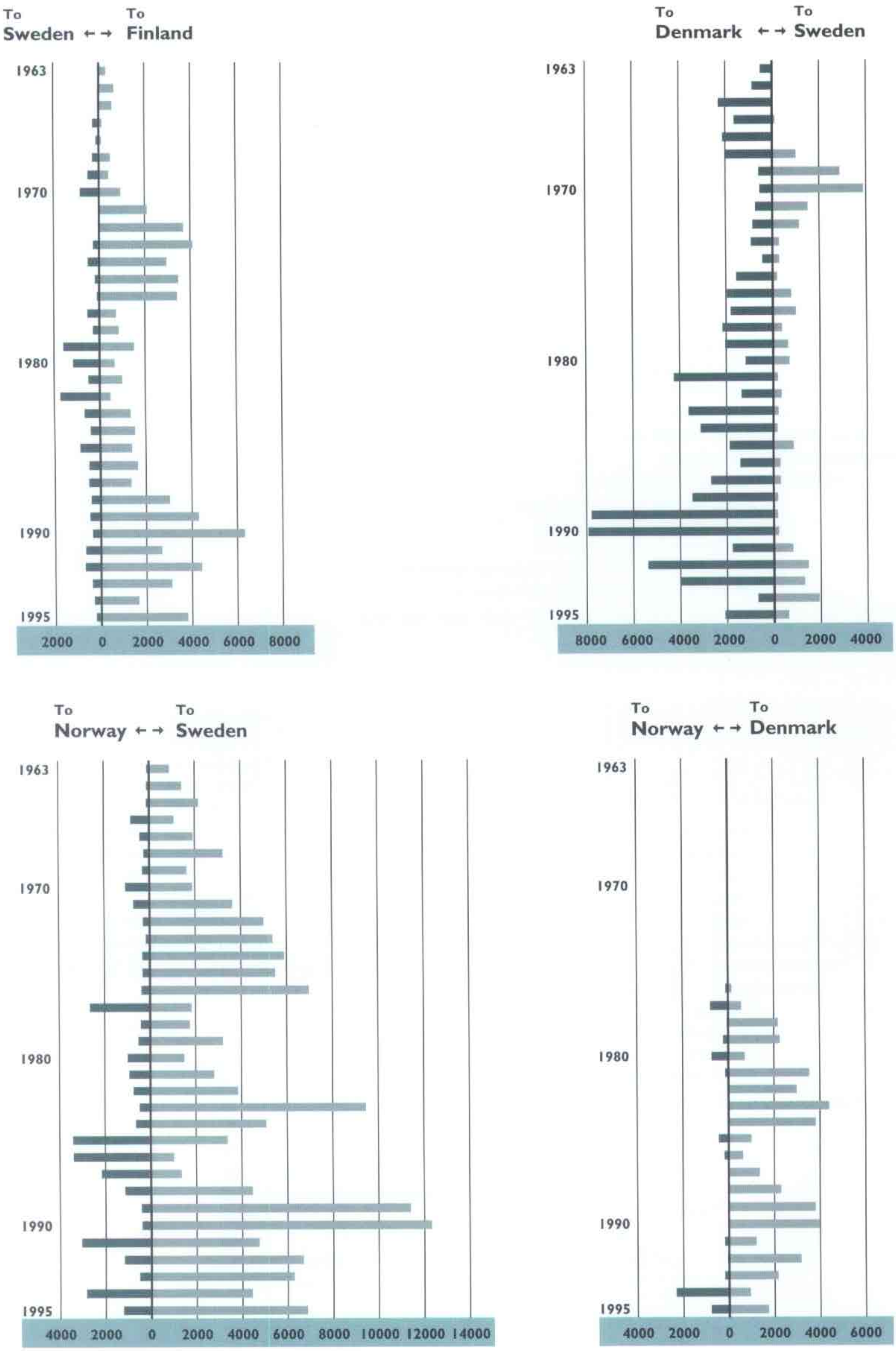
S15 *Imports/Exports 1995, GWh*

	Imports to:					
	Denmark	Finland	Norway	Sweden	Other countries [1)]	Σ Exports
Exports from:						
Denmark	.	.	790	625	3 390	4 805
Finland	.	.	63	213	.	276
Norway	1 719	51	.	6 862	.	8 632
Sweden	2 093	3 821	1 222	.	2 270	9 406
Other countries [1)]	198	4 815	66	20	.	5 099
Σ Imports	4 010	8 687	2 141	7 720	5 660	28 218

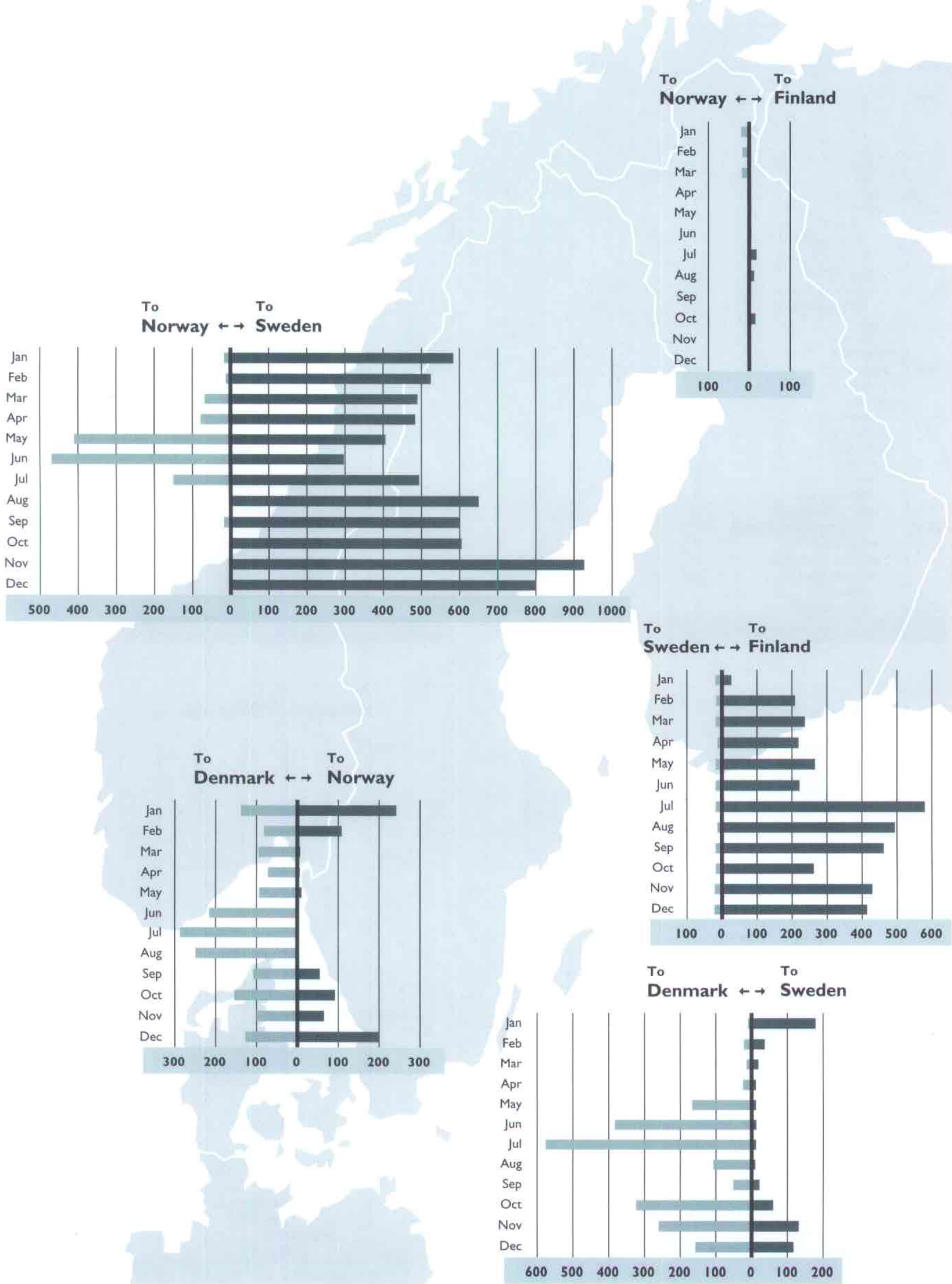
	Denmark	Finland	Norway	Sweden	Nordel
Total imports 1995	4 010	8 687	2 141	7 720	22 558
Total exports 1995	4 805	276	8 632	9 406	23 119
Net imports	**- 795**	**8 411**	**-6 491**	**-1 686**	**- 561**
Net imports/ Gross consumption	-2.4%	12.2%	-5.8%	-1.2%	-0.2%

1) Germany and Russia

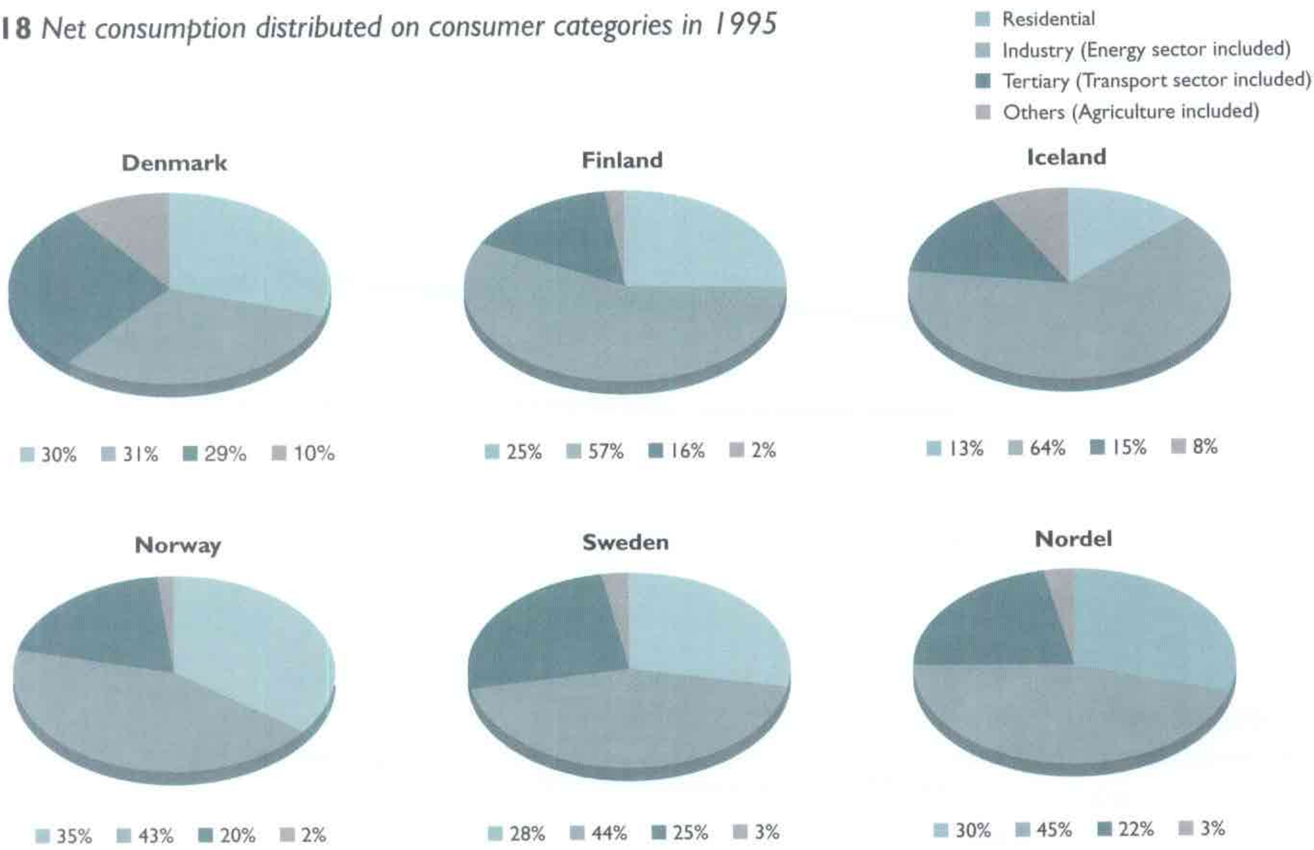
S16 *Exchange of electricity 1963 - 1995, GWh*



S17 *Monthly exchange of electricity between the Nordel countries 1995, GWh*



S18 *Net consumption distributed on consumer categories in 1995*

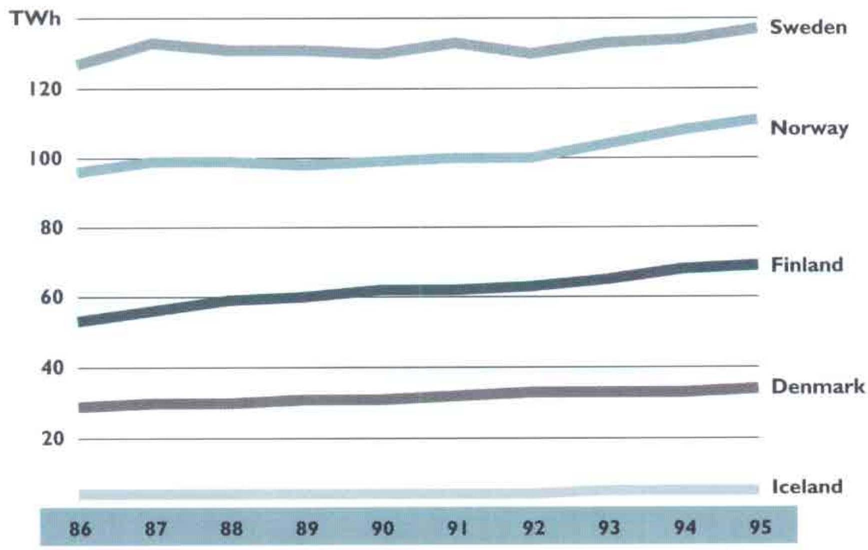


S19 *Electricity consumption 1995, GWh*

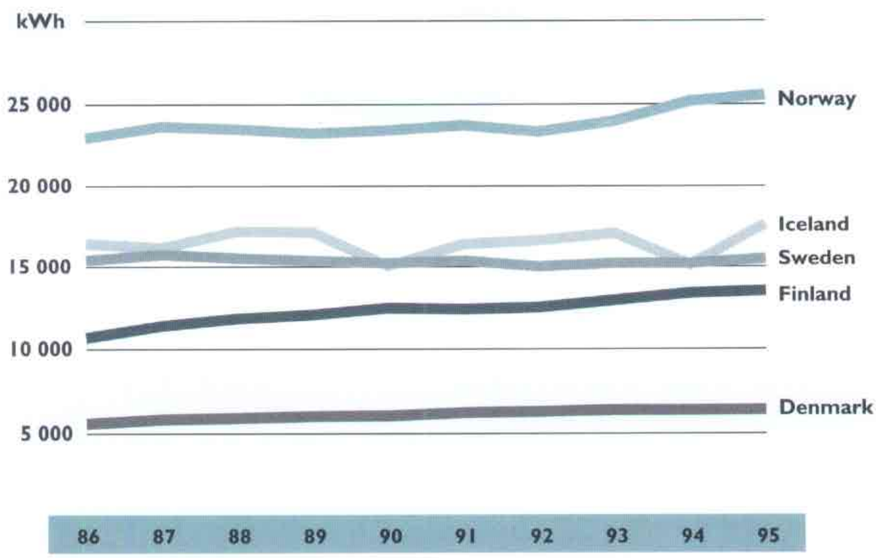
	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Total consumption 1995	33 544	69 021	4 975	116 990	141 625	**366 155**
Occasional power to electric boilers	.	82	271	5 869	4 672	**10 894**
Gross consumption 1995	33 544	68 939	4 704	111 121	136 953	**355 261**
Losses, pumped storage power etc.	2 194	2 719	284	11 391[1]	8 953	**25 541**
Net consumption	31 350	66 220	4 420	99 730	128 000	**329 720**
Of which:						
Residential	9 400	16 760	580	35 200	36 000	**97 940**
Industry (Energy sector included)	9 700	37 820	2 830	43 480	56 000	**149 830**
Tertiary (Transport sector included)	9 050	10 300	660	19 450	32 500	**71 960**
Others (Agriculture included)	3 200	1 340	350	1 600	3 500	**9 990**
Average population 1995, mill. inh.	5.241	5.109	0.267	4.348	8.837	**23.802**
Gross consumption per inh., kWh	6 400	13 494	17 618	25 557	15 498	**14 926**
Gross consumption 1994	33 198	68 153	4 537	108 305	133 836	**348 029**
Change in gross consumption as against 1994	1.0%	1.2%	3.7%	2.6%	2.3%	**2.1%**

[1] Of which pumped storage power 1 705 GWh

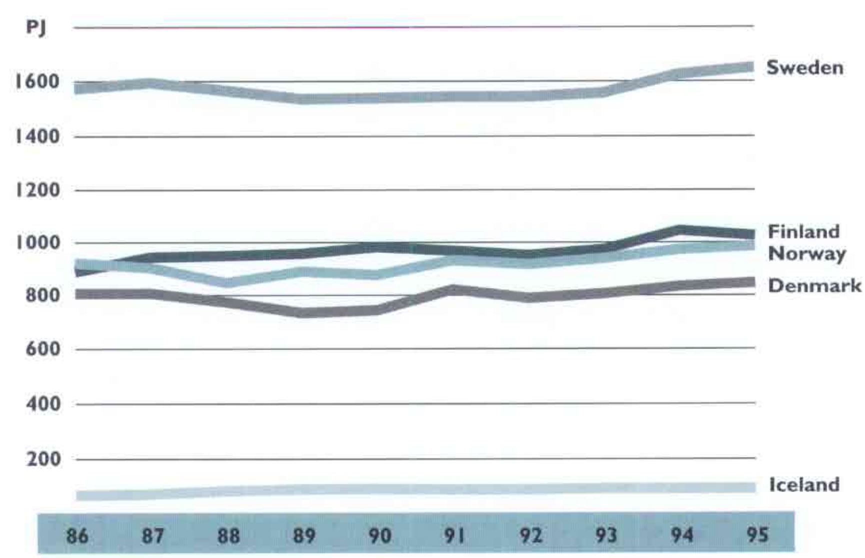
S20
Gross consumption 1986-1995, TWh



S21
Gross consumption per inhabitant 1986-1995, kWh



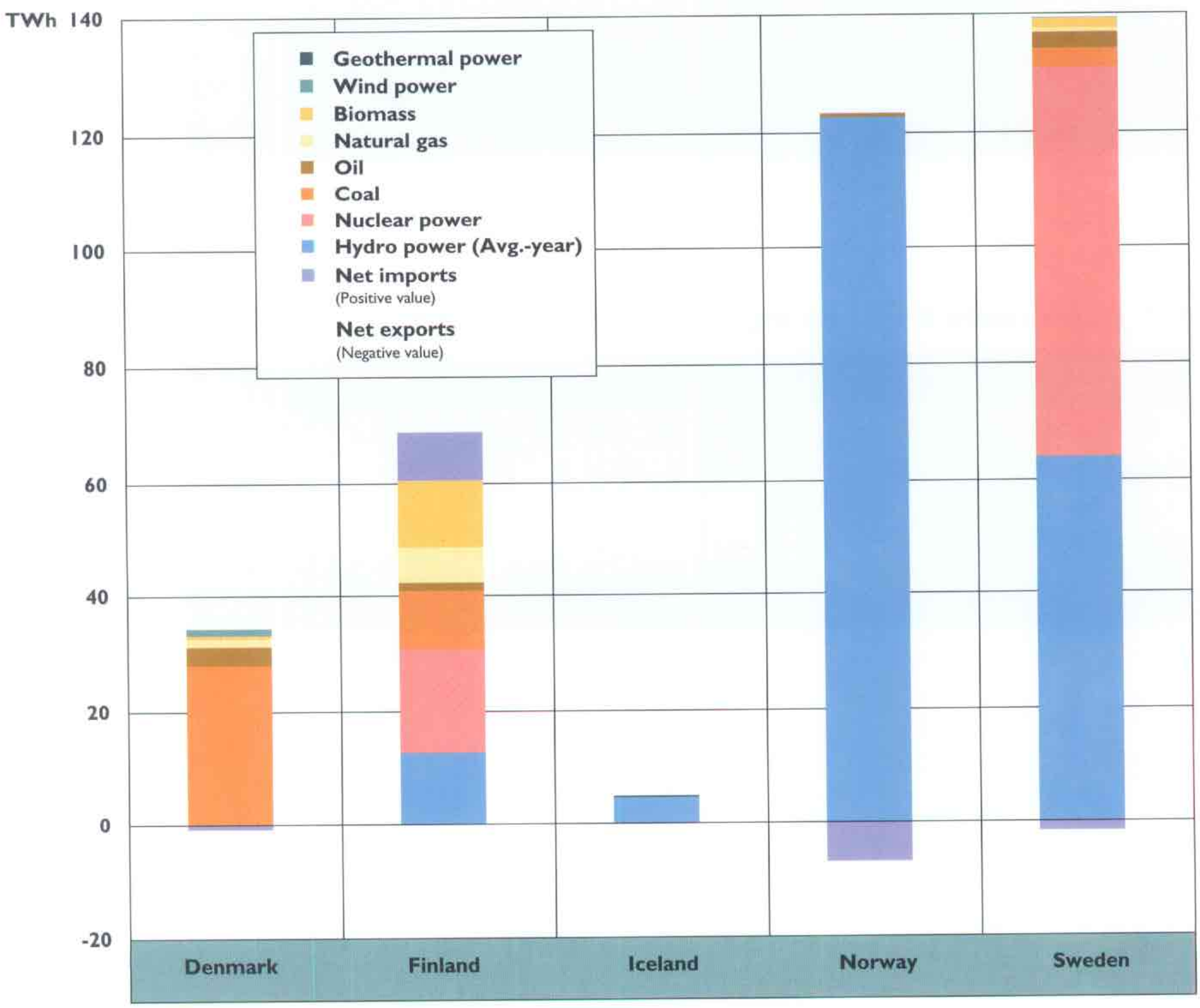
S22
Total energy supply 1986-1995, PJ



S23 *Total consumption 1995, GWh*

	Denmark	Finland	Iceland	Norway	Sweden	Nordel
Generation 1995	34 339	60 610	4 975	123 481	143 311	**366 716**
Net imports 1995	- 795	8 411	.	-6 491	-1 686	**- 561**
Total consumption 1995	33 544	69 021	4 975	116 990	141 625	**366 155**
Generation 1994	38 044	62 180	4 774	113 530	137 653	**356 181**
Net imports 1994	-4 846	6 077	.	90	256	**1 577**
Total consumption 1994	33 198	68 257	4 774	113 620	137 909	**357 758**
Change in total consumption	1.0%	1.1%	4.2%	3.0%	2.7%	**2.3%**

S24 *Distribution of total consumption on energy sources 1995, TWh*



S25 *Gross consumption in 1995 and prognoses for 2000 and 2005, TWh*

Year	Denmark	Finland	Iceland	Norway	Sweden
1995	34	69	4.7	111	137
2000	38	81	6.2	[1]	142
2005	39	89	6.4	[1]	151

[1] No official prognoses are available

S26 *Peak load demand in 1995 and prognoses for 2000 and 2005, MW*

Year	Denmark	Finland	Iceland	Norway	Sweden
1995	6 910	10 730	742	20 302 [1]	24 435
2000	8 198 [2]	14 200	887	[3]	28 400
2005	9 002 [2]	15 600	933	[3]	30 200

[1] Excl. reserve requirements
[2] Of which 350 MW at VEAG's disposal
[3] No official prognoses are available

S27 *Installed capacity in 1995 and prognoses for 2000 and 2005, MW*

Year	Denmark	Finland	Iceland	Norway	Sweden
1995	10 220	14 746	1 049	27 545	34 608
2000	9 835 [1]	16 000	1 084	[2]	34 700
2005	8 778 [1]	[2]	1 134	[2]	35 000

[1] Excl. capacity of autoproducers
[2] No official prognoses are available

CURRENT NORDEL RECOMMENDATIONS

- ***Availability concepts for thermal power***
  September 1977
- ***Automatic operational measures and applicable rules relating to operating reserves***
  September 1982
- ***Reserve power in the Nordel system (supplement to above report)***
  May 1988
- ***Coordinated frequency-controlled grid protection in the synchronous Nordel area***
  August 1983
- ***Requirements for time response for the instantaneous disturbance reserve***
  August 1992
- ***Localisation of system oscillations equipment***
  August 1992
- ***Network dimensioning criteria***
  August 1992
- ***Common disturbance reserve***
  August 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

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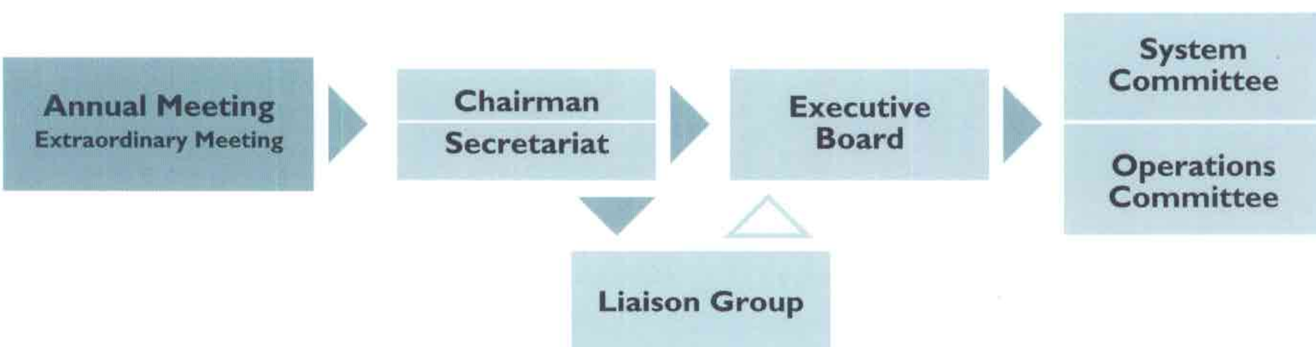

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