The Electricity Market 2002

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The electricity markets in the Nordic countries have undergone major changes since the electricity market reform work was started in the early 1990s. We now have a common Nordic electricity market that includes all of the Nordic mainland countries i.e. the exception of Iceland.

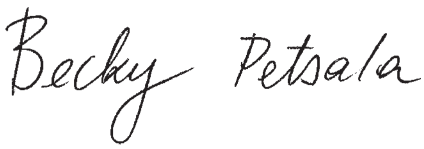
The objective of the electricity market reform is to introduce increased competition, to give the consumers greater freedom of choice and also, by open and expanded trade in electricity, create the conditions for efficient pricing.

The Swedish Energy Agency is the supervisory authority specified in the Electricity Act, and one of the tasks entrusted to it by the Government is to follow developments on the electricity market and to regularly compile and report current market information.

The purpose of "The Electricity Market 2002" publication is to meet the need for generalized and readily accessible information on the conditions on the Nordic market. The publication also includes summaries of information from recent years concerning electricity generation and utilization in the Nordic countries, the structure of the electricity market from the players' perspective, trade in electricity in the Nordic countries and in Northern Europe, electricity prices in the Nordic and other countries, and the impact of the electricity sector on the environment. ■

Eskilstuna, September 2002

Thomas Korsfeldt
Director-General



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Introduction

The electricity market in Sweden is open to competition, and users have the freedom to choose their electricity suppliers. The Swedish electricity market is part of a common Nordic electricity market that includes all mainland countries i.e. except Iceland. Developments on the Nordic electricity market are described in this publication. In this chapter, we begin with a brief introduction concerning the reform of the electricity market and the events since the reform was introduced.

The electricity market in Sweden was reformed on 1 January 1996 and new rules were then introduced. This meant that competition was introduced in trading and generation of electric power. Regulations that prevented trading in electricity were withdrawn, although grid operations remained a regulated monopoly. One of the objectives of the reform was to increase the freedom of choice for consumers and to create the conditions for keener competition in electricity supply.

In the past, customers who wanted to change their electricity supplier were obliged to install equipment for hourly metering of the electricity consumption. This requirement was abolished by the changes in law that came into force on 1 November 1999. These gave all electricity users the opportunity for free choice of electricity supplier. At the same time, electricity trading prices were freed and supervision of prices was discontinued.

The electricity markets in our neighbouring countries were also being reformed, and the electricity markets of the Nordic countries became increasingly integrated. There is now also a common marketplace known as Nord Pool, and tariffs for trading between the Nordic countries have been abolished. As a result, developments on the Swedish electricity market cannot be described in isolation without also considering developments in neighbouring countries. This publication therefore describes the electrical systems, taxes, price developments, etc. in the other Nordic countries too.

Nord Pool is open to a variety of players, and trade covers the entire Nordic region. Access to a common trading exchange has made the pricing more efficient. In addition, the exchange price can also be used as a reference for other trading outside Nord Pool.

Developments in the price of electricity

The market price of electricity is affected by a number of factors, including fuel prices, availability of water, and the power and energy balances of the various countries. The availability of water in Norway and Sweden has been very good in recent years, which has had a major influence on the price.

1996 was a dry year, which led to a high system price on Nord Pool. The price of electricity then dropped and has remained at a relatively low level up to the year 2001. The price of electricity rose during the spring of 2001 and remained at a higher level also during the summer months. The main reason was that the availability of water was lower than normal in Norway during the early part of the year. This created a higher demand for imported electricity in Norway and caused some apprehension that the year would be dry.

The total price of electricity to the end users has not followed the system price development. The total cost of electricity to the end consumers consists of three items, i.e. the price of electricity, the network charges and taxes. The price of electricity dropped between 1997 and 2000, but began rising again to all electricity customers during 2000 and 2001. During the same period, the network charges remained largely unchanged, while the tax on electricity increased substantially. This led to an increase in the total cost to domestic customers, whereas the cost to industrial customers, who are exempt from taxes, is lower.

Free choice of electricity supplier

The reform has enabled customers to choose freely the supplier from whom they want to buy their electricity. An opinion poll shows that most customers know that they can choose their supplier, and 37 % have acted on this by changing to a different supplier or negotiating their electricity price.

Competition on the electricity market

One objective of the electricity market reform was to increase competition at generator and supplier levels. Opinions differ about how well competition is performing.

The market concentration has increased in recent years since the dominating companies in Nordic countries have bought shares in competing companies on the Nordic market. The power companies and electricity trading companies are being developed towards bigger and more integrated energy companies, with operations in several countries.

According to ”Konkurrensen på elmarknaden” SOU 2002:7 (Competition on the electricity market), there are risks of inefficient competition, although there is no evidence that companies are using their market power towards their own ends. The study considers that competition is working relatively well.

Swedish generation capacity

In recent years, the former surplus generation capacity in Sweden has been reduced. The oil-fired condensing power stations that were previously used in Sweden as reserve capacity have been decommissioned, and the first reactor in Barsebäck was shut down.

Svenska Kraftnät, the Swedish grid utility, purchased a power reserve before the winter of 2000/2001 in order to strengthen the power balance during consumption peaks. During the autumn of 2001, the Government also entrusted Svenska Kraftnät with the task of safeguarding electricity generation capacity during very cold weather. This was to be done by purchasing reserve power capacity. The assignment resulted in additional power generation capacity consisting of previously decommissioned power generation plants and companies that were prepared to reduce their power consumption voluntarily. The procurement of reserve capacity is a temporary transitional measure. In the Government assignment, Svenska Kraftnät was also entrusted with the task of developing a system that would assure Sweden of power balance in the long term.

Risk of power shortage?

In recent years, Swedish generation capacity has been reduced, while peak consumption have increased somewhat. The total result is that the margins for achieving balance during consumption peaks have been lowered.

The power consumption is highest in southern and central Sweden, and these are also the areas in which generation capacity has been decommissioned. So the risk of power shortage is greatest in these areas. The power reserve purchased by Svenska Kraftnät has relieved the problem. But this is merely a transitional solution and a longer-term system is needed.

Towards a sustainable energy system

In March 2002, the Swedish Government tabled a new Energy Bill for "Samverkan för en trygg, effektiv och miljövänlig energiförsörjning" 2001/02:143 (A secure, efficient and environment-friendly energy supply).

The energy policy agreement has changed mainly the orientation of the regulatory measures aimed at influencing developments. A new system for promoting electricity generated from renewable energy sources is suggested, and notice is given of the possibility of introducing changes in taxation on combined heat and power generation. The new system will be based on trading with certificates. The changes in taxation on combined heat and power generation would put the tax rules on the same footing as that applicable to industry. The Government will revert to the matter in the Budget Bill for 2003.

The bill also includes measures for promoting more efficient energy utilization, such as by information and training, local and regional initiatives, and technology procurement.

In addition, the Government announced that it would study whether an agreement, similar to that concluded in Germany, for a controlled and responsible arrangement concerning nuclear power may be beneficial also in Sweden.

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FACTS – ELECTRICITY SYSTEM

Electricity is a commodity on which today's society is highly dependent. A vast electricity system is needed for supplying electricity to all households and industrial plants.

According to the international standard, the joule (J) is the unit used for measuring *electrical energy*. In Sweden, the watt hour (Wh) is often used for measuring energy. One joule is equivalent to one watt second and, since there are 3 600 seconds in one hour, one watt hour is 3 600 J. When large quantities of energy are measured, various multiples are used as outlined below:

k	(kilo)	10^3	thousand
M	(mega)	10^6	million
G	(giga)	10^9	billion
T	(tera)	10^{12}	trillion

The watt (W) is the unit used for measuring *power*, i.e. the energy per unit of time. One watt is equivalent to one joule per second. The instantaneous electricity consumption, i.e. the power consumption, is thus the electrical energy used during one second.

Electricity is a commodity that must be consumed at the same rate as it is generated. This means that electricity generation must constantly be controlled so that it will be in balance with the consumption. To maintain this balance, every country has a *system operator*.

In Sweden, Svenska Kraftnät is the system operator and has *system responsibility*. This means that it is responsible for the national grid and for maintaining the balance between consumption and generation throughout the country. To ensure balance, Svenska Kraftnät cooperates with more than 40 players who have balancing responsibility for one or several electricity users.

Electricity is generated in various types of plant. Plants that have high utilization and that are designed for generating continuously are known as base power, which includes nuclear power, for example.

The system operator has access to *disturbance reserve*, which consists mainly of gas turbines that can be started relatively quickly if problems should arise in the electricity system.

Controllable electricity generation is power generation whose output can be increased or reduced relatively simply and inexpensively to adjust the generation rate to variations in demand. The concept must not be confused with *control power*, i.e. the power that the system operator must have at his disposal for instantaneously balancing the generation rate to the consumption. The generation source that is economically most beneficial to use for control purposes is hydro power.

Uncontrollable power generation is generation capacity that either cannot be controlled or incurs high control costs. Power generation in unregulated watercourses and wind power are two examples. Combined heat and power generation also belongs to the group of uncontrollable power.

The availability of controllable power generation capacity is limited. The proportion of uncontrollable power generation is steadily increasing throughout northern Europe, since expansion is taking place principally in this category.

For the second reactor in Barsebäck, the earlier Government opinion that decommissioning could take place in 2003 at the earliest still applies. After renewed appraisal, the Government will submit its opinion to the the Parliament in the spring of 2003.

In conjunction with the proposed changes, notice is given that the Swedish Energy Agency will be given a number of new tasks, including the one within the framework of the new system for trading with certificates. It is also suggested that the Swedish Energy Agency should be given the role of expert authority for improving the performance of the electricity market. ■

FACTS – THE MARKET

As a result of the electricity market reform, all consumers have the freedom to choose their electricity supplier, and trading in electricity takes place in competition. However, the grid operations remained a regulated monopoly. On today's electricity market, there must be a clear demarcation between generation and trading in electricity and network operations. This means that a corporate body that runs network operations must not generate or trade in electricity.

The price on the consumer's electricity bill consists of three parts. One of these is the *price of electricity*, the second is the *network charge*, and the third consists of the *taxes*. The only part that the customer himself can influence is the price of electricity. The network charge is payable to the network owner in the region.

The *network owner* provides the physical transmission of electricity and is responsible for the electrical energy being conveyed from the generation plants to the users. A network owner must have a *network concession* from the Swedish Energy Agency. The network concession means that the network owner has a permit to build and operate power lines.

Electricity generators generate electricity and deliver it to the electricity network. The generator owns the generation plants and sells electrical energy to electricity trading companies, on the electricity exchange or directly to end customers. *Electricity trading companies* buy electricity from a generator or on the exchange and sell it to the consumer. Electricity trading companies can also sell electricity that they have generated themselves.

An electricity trading company can also serve as balance provider by concluding an agreement to this effect with Svenska Kraftnät. This involves economic responsibility for ensuring that generation and consumption are always in balance within the undertaking of the company. An electricity trading company can either have balancing responsibility itself or can purchase the service from another company.

The *electricity supplier* sells electricity on the electricity market in competition with other suppliers. Electricity supplier is the collective name for anyone who sells electricity on the market, and the term covers both electricity generators and electricity trading companies.

There is no price regulation in electricity trading, and it is assumed that the electricity user can switch to a different electricity supplier if he is offered better terms. The price of electricity is set according to agreements between buyers and sellers, and is not revealed if the parties decide not to publish the information.

The Nordic countries have a common electricity exchange known as Nord Pool on which players from Norway, Finland, Sweden and Denmark can trade in electricity. Nord Pool is owned in equal parts by the system operators in Norway (Statnett) and Sweden (Svenska Kraftnät). Nord Pool organizes trade in electricity on a physical market and a financial market, and offers clearing services.

The *physical market* comprises the *electricity spot* and *electricity base* products. Electricity spot is a 24-hour market for short-term trading in physical electricity contracts. On the electricity spot, the system price (spot price) is determined 24 hours in advance for every hour of the day. The system price is set as an equilibrium price based on the collective buy and sell bids in the area. Due to the physical transmission limitations between the Nordic countries, different *price areas* are formed periodically on the spot market. The electricity base is a physical adjustment market for trading in hourly contracts in Sweden and Finland. Trading can take place up to one hour before delivery during all hours of the day.

On the *financial market*, the players can hedge the price of electricity against changes in the spot price. This takes place through the *electricity forward* and *electricity option* products. On Nord Pool forward market, the players can hedge the price of electricity by means of futures and forwards for a period of up to four years. Trading can be done on 24-hour, week, block, seasonal and year contracts. *Electricity option* is a financial instrument for risk management and hedging of future revenues and costs linked to trading in electricity contracts.

In its *clearing operations*, Nord Pool acts as contractual opposite party in power contracts. The financial risk of those who have traded in contracts is thereby reduced.

A relatively large proportion of the trade in electricity in the Nordic countries takes place via Nord Pool. Trading by means of bilateral contract also takes place here. A bilateral contract is trade in which an agreement is concluded between two players.

Energy and environmental policies

If an integrated electricity market is to perform well, common rules and conditions on the markets of the individual countries are vitally important. The energy policies in other countries, above all in the Nordic countries, have therefore become of increasing significance to Sweden.
In recent years, environmental problems have become of growing decisiveness to the energy policy. Measures against acidification and over-fertilization have been adopted long ago and the work is continuing. Extensive international work is now also in progress in the field of climate, one of the results of which is the Kyoto Protocol. This chapter describes the current situation in the area of energy and environmental policies in the Nordic countries and the EU.

Sweden

The electricity market in Sweden was opened to competition in 1996, when wide-ranging amendments were made to the Swedish electricity legislation. In 1999, all electricity customers were given the opportunity to change to a different electricity supplier at no extra cost, since the demand for hourly metering was abolished.

Study of the competition on the electricity market

During the autumn of 2001, the Government entrusted a special investigator with the task of analyzing the competition on the electricity market. The main reason was that both the spot price on the electricity exchange and the prices on the end customer market (particularly prices to domestic customers) had increased substantially during 2001 compared to 2000, even though hydro power generation in Sweden during the same period was high. In January 2002, the study submitted its final report on ”Konkurrensen på elmarknaden” SOU 2002:7 (Competition on the electricity market). The study considered that the pricing and competition on the electricity market performed relatively well, but that there were worrying signs, such as the reduction in the number of players in both generation and trading. The study therefore suggested that developments in pricing and competition on the electricity market should be continually monitored. The study considered that pricing on the raw power market is mainly controlled by a couple of fundamental factors. As an example, the water inflow and the hydro power generation in Norway in 2001 was lower than in the year 2000. The energy balance has deteriorated, since the electricity consumption had increased at the same time as electricity generation plants with high costs were shut down. The costs of generating thermal power have also increased in recent years for reasons such as the increased prices of fossil fuels and developments on the Swedish currency exchange rates.

Power balance

In December 2001, the Government entrusted Svenska Kraftnät with the task of strengthening the power balance in Sweden. In the short term, the power balance was to be strengthened by 400–600 MW in addition to the 1000 MW of power reserves that were purchased at the end of 2000. The Government also instructed Svenska Kraftnät to develop a system for assuring Sweden of long-term power balance. Svenska Kraftnät is to report on this part of the assignment no later than 1 October 2002.

Towards a sustainable energy system

In March 2002, the Swedish Government tabled a new Energy Bill on “Samverkan för en trygg, effektiv och miljövänlig energiförsörjning” 2001/02:143 (A secure, efficient and environment-friendly energy supply). The guidelines given in the 1997 energy policy decision remain. The objective of the energy policy is to secure, both in the short term and the long term, the availability of electricity and to increase the use of energy from renewable energy sources. The energy policy is aimed at creating the conditions for efficient energy utilization and cost-effective Swedish energy supply. At the same time, the impact on health, the environment and the climate must be low and the change-over to an ecologically appropriate society should be facilitated. The 2002 energy policy agreement changes, above all, the orientation of the regulatory means that will influence the development in the short term.

A new system is suggested for promoting environment-friendly and renewable electricity generation. The objective is to increase the use of electricity from renewable sources by 10 TWh from the 2002 level up to the year 2010. This will be achieved by a system based on electricity certificates, as described in specific in the chapter The Market. In addition, the bill includes measures for promoting more efficient use of electricity by means such as information and training, local and regional initiatives and procurement of technology.

In conjunction with the proposed changes, an announcement was made that the Swedish Energy Agency will be given a number of new tasks, including those within the framework of the new system for trading in electricity certificates. It is also proposed that the Swedish Energy →

Agency should be given a role of expert authority for improving the performance of the electricity market.

The bill also includes advance notice of the possibility of introducing amendments to the taxation for combined heat and power generation. According to the amendments, the taxation rules would be made equivalent to those applicable to industry. The Government will revert to this matter in the Budget Bill for the year 2003. In the bill, the Government also announces that a study will be made to determine whether an agreement, similar to that concluded in Germany, for a controlled and responsible arrangement concerning nuclear power could be beneficial also in Sweden. The Government will invite the power industry to negotiations. For the second reactor at Barsebäck, the Government's earlier opinion that decommissioning cannot take place until some time during 2003 at the earliest still applies. The Government will submit its appraisal to the Parliament in the spring of 2003 after a renewed appraisal.

Swedish climate strategy

In November 2001, the Government submitted a Climate Bill to the Parliament. The Government proposed that the Swedish emissions of greenhouse gases should be at least 4 percent lower than the emissions in 1990 as a mean value for the period 2008–2012. The objective is a Swedish undertaking that goes beyond what Sweden needs to do according to the Kyoto Protocol of the Climate Convention. The Kyoto Protocol is an agreement between industrialized countries, whereby the carbon dioxide emissions would be reduced by about 5 % from the 1990 emission level up to the period 2008 – 2012. According to the distribution, so called burden sharing, made within the European Union, the emissions by Sweden would be allowed to increase by up to 4 percent. According to the Government, the Swedish objective will be reached without compensation for absorption in carbon sinks or by employing flexible mechanisms.

Flexible mechanisms means:

- joint implementation, i.e. that one industrialized country implements measures in another industrialized country and is credited with the emission reductions from the latter.
- mechanism for clean development, i.e. that an industrialized country implements projects that yield emission reductions in a developing country.
- emissions trading, i.e. that a country which reduces its emissions by more than its undertaking can sell emission rights to a country that cannot meet its target.

The climate work and the national objective will be continually monitored. If the emission drop is not on target, the Government can suggest further measures or, if necessary, reappraise the target. Consideration will have to be given to the competitiveness of Swedish industry. Check points are suggested in 2004 and 2008. At the 2004 check point, the Government intends to consider, as a supplement, a target that includes the flexible mechanisms. In its report, The Committee on Environment and Agriculture of the Parliament supports the Government´s proposal for Swedish climate policy targets.

Other work now in progress

The energy taxation system is now being reviewed. The aim is to make the system clearer and raise its environmental relationship. As an element aimed at raising the environmental relationship, the Government decided in the spring of 2000 to launch a green fiscal reform in 2001. The reform means that the tax on environmentally harmful activities is raised, while taxes on work are lowered. The reform will comprise a total of SEK 30 billion and will be in progress for a period of 10 years. A parliamentary committee has been appointed for the work of implementing the strategy for a continued green fiscal reform. The task of the committee is to study the make-up of rules for lowering tax on energy in sectors that are open to competition. The study must be completed by 31 December 2002 at the latest.

In addition, a delegation with a parliamentary composition has been appointed with the aim of preparing a proposal for a Swedish system and a set of regulations for the flexible mechanisms of the Kyoto Protocol. The proposal must be submitted to the Government by 31 December 2002 at the latest. In addition, a special negotiator has been entrusted with the task of obtaining the source information and submitting a proposal for a general agreement between Sweden and the countries involved concerning joint implementation. The final report on the assignment must be submitted no later than 1 December 2002.

Norway

Norway opened its electricity market to competition back in 1991. Standardized settlement was introduced in 1995, which enabled all electricity users to change their electricity suppliers without incurring costs.

The 1999 energy strategy of the Norwegian Government states that the energy policy will be drawn up so that it supports an ambitious environmental policy. The generation and use of energy must conform to the environmental demands, and the energy prices should reflect, as far as possible, the environmental costs.

Generation will be based to a greater extent on renewable energy sources. The aim is to use a further 4 TWh of waterborne heat generated from renewable energy sources, and to expand wind power so that the annual energy generated will increase to 3 TWh before the year 2010. Another objective is to restrict the energy consumption and reduce dependence on electric heating. A new institution known as Enova, which is a wholly-owned State company, has been formed in conjunction with the Government's energy strategy, and its task is to enable the energy strategy to be implemented. The operations of Enova will largely be financed by a State energy fund.

Construction of gas power stations in the country has been discussed for a number of years. Two plant concessions for gas power stations were granted in 1997. A plant concession was granted in 2001 for a natural gas-fired combined heat and power station. In addition to the plant concession, an emission concession is also required. The content of the emission concessions for the two gas power stations was the subject of discussions in the Parliament, which led to a delay in the permission process. The Parliament decided that the emission requirements would not be more stringent than those applicable in EU countries, and new emission concessions were granted in 2001. The investment decisions for the two gas power stations were scheduled for April 2002. However, the decision was delayed. The investment decision for the combined heat and power station is scheduled for December 2002.

Circumstances have changed as a result of the change of government in the autumn of 2001. The new coalition government has set up a target according to which the conditions for building "carbon dioxide-free" gas power stations would be improved. One element in this context is that a cooperation programme will be established with industry and support for such generation will be introduced. The Government will revert in the matter before the summer of 2002. It is therefore still unclear whether investments in gas power will be based on conventional technology or a technology that includes carbon dioxide sequestration. Moreover, the Government considers it important to obtain permission for upgrading and expanding smaller hydro power plants.

A Norwegian climate strategy was presented in June 2001. A supplement to this strategy was presented in March 2002. The reason was that the Government realized the need for pursuing a more aggressive climate policy. An important difference is that, in the supplement, the Government suggests that the national system for emissions trading should be established by 2005 for the emission sources that are not covered by any carbon dioxide charge. The main orientation in the earlier proposal was that the State would launch a negotiation process for concluding agreements with these activities.

Finland

The Finnish Electricity Market Act came into force in 1995, and the electricity market was opened to all Finnish electricity users in November 1998 when standardized settlement was introduced for electricity customers whose consumption was low.

The Finnish energy strategy was approved by the Parliament in 1997. One of the main objectives was to use economic regulatory instruments and market economy mechanisms for creating the conditions for secure energy supply and competitive prices. In addition, the emissions to the environment were to be such that Finland would meet its international obligations. Another objective is to accelerate the development and commercialization of energy-efficient technology, and also technology that employs renewable energy. A special plan of action for renewable energy sources was adopted in 1999, and a new energy saving programme was presented in 2000.

The national Finnish climate strategy was presented to the Parliament in March 2001. This states that the use of coal must be reduced either by expanding nuclear power or by increasing the use of natural gas, or by a combination of the two. In addition, it was decided that Finland's need to import electricity must be reduced. The Finnish climate strategy is based on national action.

A commission was appointed in September 1999 and was entrusted with the task of preparing a proposal for how the flexible mechanisms could be used in the national climate strategy. The commission submitted its report in January 2001. The commission considers that the uncertainty factors related to the flexible mechanisms lead to the climate policy having to be based principally on domestic reduction measures. As an example, if a system for emissions trading is introduced in the EU, it may be appropriate to reassess this.

A Finnish consortium applied in 2000 for permission to build a new nuclear power station. In January 2002, the Finnish Government decided in principle that a fifth nuclear reactor could be built. This decision was then to be examined by the Parliament. The Parliament voted on the matter on 24 May and approved the Government's decision.

Denmark

The electricity market in Denmark is not yet as competitive as it is in the other Nordic countries. The first step was taken in 1999 when the market was opened to electricity customers with a consumption that exceeded 100 GWh annually. As from 1 January 2001, all electricity users with a consumption in excess of 1 GWh were given freedom of choice of electricity supplier, and the Danish electricity market will be completely open to competition by 2003.

The energy policy is focused on reducing the environmental impact of electricity generation. The "Energi 21" plan of action of the Danish Government states that the most important means for reducing the environmental impact is to develop renewable energy utilization, improve energy efficiency and adapt the energy sector to a reformed energy market. Coal will be phased out of Danish electricity generation by year 2028 by means such as support for changing over from coal to biofuel.

Another important measure is the Danish system of trading in emission rights for electricity generation. The system will be introduced during the period 2001–2003. A ceiling of 22 million tonnes of carbon dioxide emissions has been set for 2001. The ceiling will subsequently be lowered by 1 million tonnes a year. By way of comparison, emissions from electricity generation in 1999 amounted to 23 million tonnes. Emissions in excess of the quota will be subject to a carbon dioxide charge of DKK 40 per tonne of carbon dioxide. No political decision has yet been taken as to whether the system will continue after the year 2003.

After the change of government in Denmark in November 2001, the energy issues were moved from The Ministry of the Environment to The Ministry of Economic and Business Affairs. At the same time, a review of the support system in the field of energy was begun, with greater focus on cost-effectiveness. Payments of further support were stopped until further notice. During 2002, the new Danish Government will obtain additional source information in order to decide on the need for continued support and the associated costs.

In conjunction with the reform of the Danish electricity sector, it was decided that a system of trading in electricity certificates would be established. The system was scheduled to gradually replace the present support system from 1 January 2003 onwards. However, political discussions are currently being held to decide whether or not the system is to be introduced.

A new climate policy strategy that gives a collective picture of the Danish

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climate policy was presented in March 2000. In the source information for the strategy, calculations were done with the aim of assessing whether the Danish obligations in accordance with the Kyoto Protocol would be achieved with the present measures. According to the calculations, a large proportion of the emission reduction of 21 % undertaken by Denmark could be achieved. However, it is assumed in the forecast that quotas have been decided for net exports of electricity, so that any Danish electricity export will be matched by purchases of international emission rights. The new measures suggested are voluntary agreements with industry for reducing the emissions of fluorinated gases, additional measures for improving the efficiency of energy consumption, and new initiatives in the field of transport.

EU

Work is in progress in the EU on creating an internal energy market with increased competition. The Electricity Market Directive was adopted in December 1996. The aim of the Directive is to create common rules for the generation, transmission and distribution of electricity. According to the Directive, the market for electricity will gradually be opened to competition. The Directive envisages that 28 % of the electricity market will be open to competition by the year 2000, and 33 % by 2003. Several countries, including Sweden, Finland, Great Britain, Austria and Germany, have opened their markets to all customers. The countries in which the electricity markets were least open to competition were France, Greece, Ireland and Portugal.

The EU adopted the Natural Gas Directive in June 1998, and this will gradually open the natural gas market to competition, analogously with the Electricity Market Directive. By the year 2000, at least 20 % of the natural gas market was to be open to competition. This was then to increase to 28 % five years after the Directive came into force and to 33 % after ten years. The European Commission presented a proposal for amending the Natural Gas Directive. One of the proposals of the Commission is that the market should be opened fully to all customers except households by the year 2004 and that the market should be opened completely by 2005. No decision concerning the new time schedule has yet been taken.

The EU has set up a target whereby the proportion of renewable energy sources in the total energy consumption would increase from 6 % to 12 %. A separate Directive (Directive on the promotion of electricity from renewable energy sources in the internal electricity market) states that the proportion of electricity generation from renewable energy sources should increase to 22 % by the year 2010. Both targets are indicative, i.e. they are not binding on the countries. According to the Directive, the member countries should adopt the necessary measures to enable the target to be reached and should submit periodic situation reports.

In November 2000, the European Commission presented the Green Paper “Towards a European strategy for the security of energy supply”. This states that the Union is consuming increasing amounts of energy and is importing growing numbers of energy products. If nothing is done in the next 20–30 years, 70 % of the energy demand in the European Union will be met by imported products, compared to 50 % today. In the Green Book, the Commission outlines the grounds for a long-term strategy in the field of energy. Important elements in this strategy are:

- a sweeping change in the consumption behaviour for which taxes are indicated as an instrument for controlling the demand
- increasing the use of renewable energy
- analyzing the use of nuclear power in the medium-range perspective
- for oil and coal, imports of which are increasing, consider strengthening the system of strategic laws and plan for new import routes.

In addition, the European Commission has launched the European Climate Change Programme (ECCP). The programme consists of two parts, one of which is a list of prioritized measures, and the other is a plan of action for an emissions trading system that will become operative in 2005. In October 2001, the Commission presented a proposal for a Directive for an emissions trading system. According to the proposal, the trading system will cover 46 % of the estimated EU emissions. One of the areas covered is that of power stations and combined heat and power (CHP) stations with power inputs of more than 20 MW. In addition, it is suggested that all member countries should issue, free of charge, emission rights during the period 2005 to 2007 to the participating plants. In June 2006 at the latest, the Commission will examine the experience gained, in order to decide which type of harmonized allocation method is most appropriate for the future. The proposal is now being discussed. ■

The Electricity system

Today's society is highly dependent on electricity. An extensive electrical system is necessary for our day-to-day use of electricity. Electricity must be continuously generated and transmitted to the consumers. The generation and consumption of electricity must be in balance at all times, for which far-reaching balance control is necessary. At the same time, electricity should be generated at reasonable cost and should not make an excessive impact on the environment. This chapter describes electricity consumption, electricity generation, the environmental impact of the electricity system, electricity generation costs, and the transmission of electricity in the Nordic perspective.

Electricity consumption

The development of electricity consumption is dependent on growth of the national economy. Since 1990, the total electricity consumption in the Nordic countries has increased by an average of 1.4 % annually. The greatest increase has taken place in the residential, commercial and services sectors, which can be explained in part by the growing services sector that uses more electrical equipment, and the increased use of electric space heating in Finland and Norway.

Electricity consumption in Sweden

Since the early 1970s, the consumption of electricity in Sweden has increased at the rate of almost 3 % annually. The increase was steep during the 1970s and then tapered off. During the period between 1990 and 2000, the actual electricity consumption increased by a total of 4.8 %, but after temperature correction, the figure is 4.5 %. In 2001, the residential, commercial, services, etc. sector accounted for half the total electricity consumption, while industry accounted for just over one third. A forecast for the Swedish electricity consumption for the year 2010 is shown in Table 1.

Industry

The use of electricity in industry is linked to the economic activities in the various fields of industry. During the 1980s, industrial production grew at the rate of about 2 % annually, and the annual increase in electricity consumption was just over 3 %. During the recession in the early 1990s, industrial production fell substan- →

Table 1 • Electrical energy consumption in Sweden in 1990, 1995–2001 and forecast for 2010, TWh

	1990	1995	1996	1997	1998	1999	2000	2001	*2010*
Industry	53.0	51.3	51.5	52.7	53.9	54.5	55.9	55.1	*58.6*
Pulp and paper industry	20.0	19.1	19.3	20.5	21.1	21.6	22.8	21.6	*23.2*
Iron- and steelworks	4.8	5.0	4.9	4.9	4.9	5.0	5.4	5.3	*5.8*
Chemical industry	6.2	5.7	5.5	5.8	5.8	5.9	5.8	6.1	*7.0*
Engineering industry	7.2	7.1	7.0	6.9	7.1	7.0	7.0	6.8	*7.5*
Residential, commercial, services etc.	65.0	70.4	71.6	69.6	69.9	69.1	70.4	75.3	*74.2*
Electric heating	25.8	25.3	27.3	26.1	23.9	21.5	21.4		*27.6*
Domestic electricity	17.9	19.7	19.3	18.6	19.4	16.9	17.7		*21.1*
Electricity for appliances	21.3	25.4	25.0	24.9	26.6	30.7	31.3		*25.5*
Transport	2.5	2.7	3.1	3.0	2.8	3.0	2.6	2.8	*3.2*
District heating, refineries	10.3	7.8	6.3	6.8	6.6	6.3	5.8	5.2	*4.6*
Distribution losses	9.1	10.1	10.2	10.7	10.9	10.6	11.9	12.1	*11.4*
Total net consumption[1]	139.9	142.4	142.7	142.6	144.0	143.5	146.6	150.5	*152.0*
Total net temperature-corrected consumption	143.1	142.7	141.7	143.3	145.0	144.8	149.5		*152.0*

The figures are a revision of those in last year´s issue. [1] I.e. excl. in-house consumption of electricity and heat generation plants.
Source: For the years 1990–2000 Energy in Sweden 2000, Swedish Energy Agency. For the year 2001 Statistics Sweden. For year 2010 Swedish Energy Agency climate report, ER 13:2001, Swedish Energy Agency 2001.

tially, which lead to electricity consumption dropping by 3.2 % annually between 1990 and 1992. During the period between 1997 and 2001, electricity consumption increased at the rate of more than 1 % annually. The upturn was due mainly to the higher rate of growth in the pulp and paper industry.

Electricity consumption varies between the different industries. In 2001, electricity-intensive industries such as the mining industry, pulp and paper industry, basic chemicals industry, ironworks, steelworks and non-ferrous metal works accounted for almost 70 % of the total industrial electricity consumption. The share of the engineering industry was 12 %. Almost 90 % of the electricity in industry is used for processes and motor drives.

Residential, commercial and services sector

In the residential, commercial and services sector, electricity is used for heating single-family and multi-family dwellings and commercial and public premises, for domestic electricity in dwellings, and for appliances in commercial and public premises. The electricity used for street and road lighting and for water and sewage treatment is also included.

Electric space heating currently accounts for just over 30 % of the total electricity consumption in the residential, commercial and services sector. The actual consumption of electricity for heating varies from year to year, and depends on factors such as the temperature conditions. Electricity consumption for space heating was lower during the last years of the 1990s than earlier in the decade. During 1998, a grant was introduced for the conversion of electrically heated houses to district heating or to individual fuel firing, with the aim of lowering the amount of electric heating. No grants were paid during 1999 and 2000 due to a ban ordinance, but the grants were reintroduced on 1 June 2001. Domestic electricity accounts for about 25 % of the total electricity consumption in the sector. This consumption has not followed any trend during the 1990s, but is expected to increase in the coming few years. Electricity for appliances, which currently accounts for just over 40 % of the electricity consumption in this sector, has increased most in the 1990s. This increase is due mainly to the increasing numbers of electrical apparatus in the services sector.

Figure 1 • Electrical energy generated in the Nordic countries, TWh, and electrical energy consumption in 2001, kWh per inhabitant

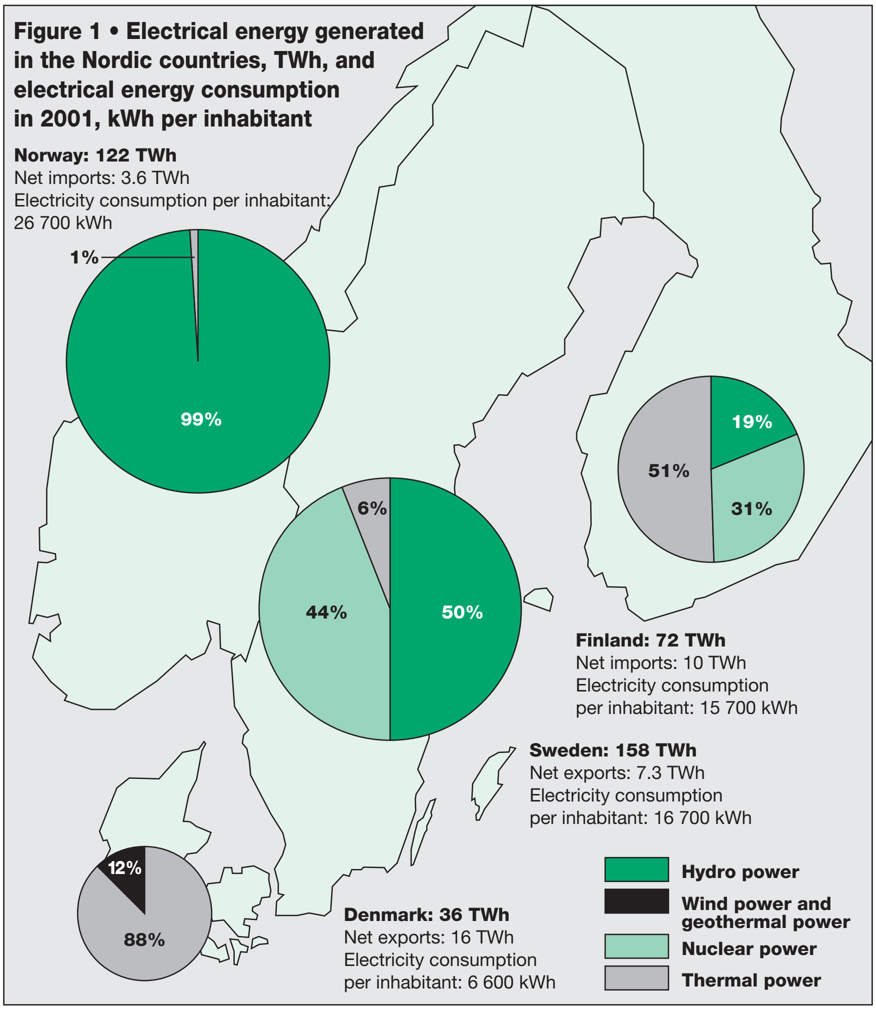


Table 2 • Electrical energy consumption in Finland, Denmark and Norway, TWh

	Finland				Denmark				Norway			
	1990	1996	2000	2001	1990	1996	2000	2001	1990	1996	2000	2001
Industry (incl. the energy sector)	33	37	45	45	9	10	11	10	47	45	53	52
Residential, commercial and services, etc.	26	29	31	34	20	22	22	23	51	59	61	64
Transport	0,4	0,5	[1]	[1]	0,2	0,3	[1]	[1]	0,6	0,6	[1]	[1]
Losses	2,9	2,9	2,9	3	2,3	2,9	2,1	2,3	6,9	8,5	10	10
Total consumption	62	69	79	82	31	35	35	35	105	113	124	125

[1] For the years 2000 and 2001 transport is included in the residential, commercial and services sector.

Source: Processed information from the Finnish Energywindows, Adato Energia Oy, the Danish Energy Administration, the Norwegian SSB and Nordel.

Transport

In the transport sector, electricity is used mainly for powering trains, underground trains and trams. At less than 2 %, this sector accounts for a very small proportion of the total national electricity consumption. The consumption between 1990 and 2001 has been relatively stable at around 2.7 TWh annually.

District heating and refineries

The consumption of electricity in the district heating sector consists mainly of supplies to electric boilers and heat pumps. Supplies to electric boilers dropped from 6.3 TWh in 1990 to 1.6 TWh in 2001. The electrical energy input for heat pumps during 2001 amounted to 1.9 TWh. The electricity consumption in refineries is relatively constant and amounts to 0.8 TWh annually.

Forecast for 2010

Table 1 shows a forecast for the consumption of electricity in 2010. It should be noted that the forecast is based on different assumptions concerning economic development and developments in oil prices.

Electricity consumption is expected to increase by 0.1 % annually between 2001 and 2010.

FACTS

Thermal power – power stations in which heat is converted into electrical energy. This includes condensing power, nuclear power and combined heat and power generation. Conventional thermal power does not include nuclear power.

Combined heat and power (CHP) generation – power stations that generate both electricity and heat for supplying neighbouring district heating networks or industrial processes.

A gas turbine plant is basically a "jet engine" that drives a generator. The fuel used in Sweden is mainly light fuel oil.

Condensing power station – power station with a condensing steam turbine. Such plants generate only electricity. The plants in Sweden are fired mainly with fuel oil. Condensing power is also generated in combined heat and power stations with recoolers.

Hydro power stations – power stations that convert the kinetic energy of water into electrical energy.

Nuclear power station – condensing power station that uses nuclear energy for generating electricity.

Wind power station – power station that converts the kinetic energy of wind into electrical energy.

Natural gas combined cycle – a combined gas turbine and steam turbine plant fuelled with natural gas.

Electricity consumption in Denmark, Norway and Finland

Electricity consumption between 1990 and 2001 has increased in all Nordic countries as shown in Table 2. The highest rate of increase was recorded in Finland at an annual average rate of 2.5 % since 1990.

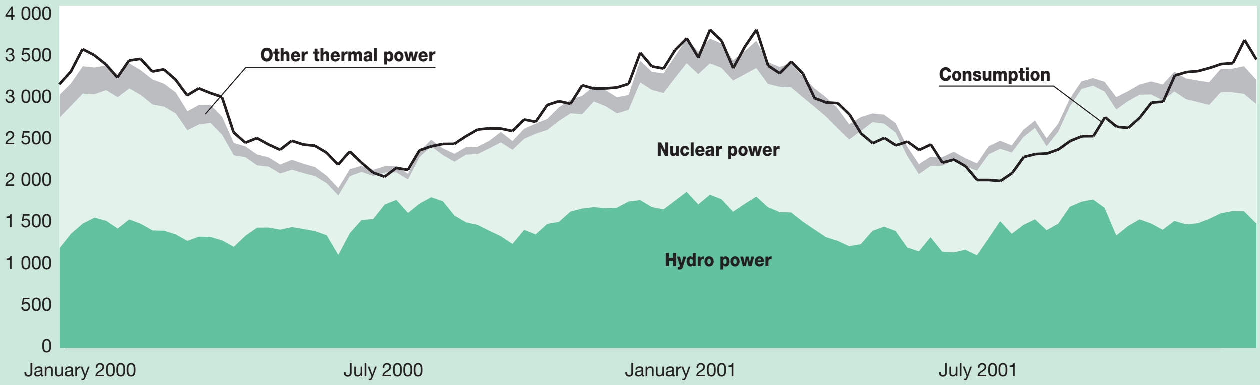
In Norway and Finland, the industrial sector accounts for a large proportion of the total electricity consumption at just over 40 % and 55 % respectively. This is because, just like Sweden, Norway and Finland have a large proportion of electricity-intensive industry. In Denmark, which has a different industrial structure, industry accounts for almost 30 % of the electricity consumption, but a larger proportion is used in the residential, commercial and services sector (66 %). This is explained by the fact that the agricultural sector is relatively large in Denmark.

Viewed in an international perspective, all Nordic countries with the exception of Denmark have a relatively high average per capita electricity consumption. Important reasons for this are the high proportion of electricity-intensive industry and the cold climate. See also the section entitled "An international perspective".

Power generation

Power generation in the Nordic countries is based on hydro power, nuclear power and conventional thermal power. In addition, there are a few oil-fired condensing power stations, gas turbines and wind turbines. In Norway, power is generated principally by hydro power and in Den- →

Figure 2 • Electrical energy generated and consumption in Sweden during 2000 and 2001, GWh per week



Source: Compiled information from Swedenergy.

Table 3 • Electrical energy generated in Sweden in 1990, 1995–2001 and forecast for 2010

	1990	1995	1996	1997	1998	1999	2000[5]	2001[5]	*2010*
Production[1]	141.7	144.1	136.6	145.3	154.7	151.0	141.9	157.8	*147.8*
Hydro power	71.4	67.3	51.2	68.2	73.8	70.9	77.8	78.5	*68.6*
Wind power	0.0	0.0	0.0	0.2	0.3	0.4	0.4	0.5	*3.9*
Nuclear power	65.2	67.0	71.4	66.9	70.5	70.2	54.8	69.2	*63.6*
Conventional thermal power	5.1	9.8	14.0	10.0	10.1	9.5	8.8	9.7	*11.8*
of which:									
CHP in industry	2.6	3.9	4.0	4.2	4.0	3.9	4.3	4.4	*4.9*
CHP in district heating networks	2.4	5.8	7.1	5.6	6.0	5.6	4.5	5.2	*6.8*
Condensing power	0.0	0.1	2.8	0.2	0.1	0.0	0.1	0.1	*0.1*
Gas turbines[2]	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*
Consumption[3]	139.9	142.4	142.7	142.6	144.0	143.5	146.6	150.5	*152.0*
of which distribution losses	9.1	10.1	10.2	10.7	10.9	10.6	11.9	12.1	*11.4*
Imports-exports[4]	-1.8	-1.7	6.1	-2.7	-10.7	-7.5	4.7	-7.3	*4.2*

The figures are a revision of those in last year´s issue.
[1] Net generation, i.e. excluding in-house energy use in power generation
[2] The item has been redefined compared to 1996 and covers only gas turbines that serve as stand-by in the power system.
[3] Due to rounding-off, the total sums do not always agree with the sums of the individual items.
[4] For year 1990, imports–exports also include a statistical carry-over.
[5] The figures for the year 2001 are based on preliminary statistics.
Source: For years 1990–2000 Energy in Sweden 2001, Swedish Energy Agency. For years 2001 Statistics Sweden, for 2010 ER 13:2001, Swedish Energy Agency climate report, Swedish Energy Agency 2001.

Table 4 • Electrical energy generated in Finland, Denmark and Norway, TWh

	Finland				Denmark				Norway			
	1990	1996	2000	2001	1990	1996	2000	2001	1990	1996	2000	2001
Production	52	66	67	72	24	50	34	36	120	104	143	122
Hydro power	11	13	14	13	...	...	...	…	120	103	142	121
Wind power	0	...	...	…	1	1	4	4	0	...	...	…
Nuclear power	18	19	22	22	0	0	0	0	0	0	0	0
Conventional thermal power of which:	23	36	31	36	24	49	30	32	1	1	1	1
CHP in district heating networks	9	12	13	14	8	15						
CHP in industry	8	10	12	11	0	2	2	2				
Condensing power	7	14	7	11	15	32	28[1]	30[1]				
Gas turbines, diesels etc.	...	...	...	0								
Imports–exports	11	4	12	10	7	-15	1	-1	-16	9	-19	4
Consumption	62	69	79	82	31	35	35	35	105	113	124	125

… less than 0.1 TWh. [1] Including generation in CHP stations in district heating networks.
Note: Due to rounding-off, the total sums do not always agree with the sums of the individual items.
Source: Processed information from the Finnish Energia, Norwegian SSB, Danish Energy Administration and Nordel.

mark, by conventional thermal power. The Finnish power generation system is based on conventional thermal power, nuclear power and hydro power. In Sweden, hydro power and nuclear power normally account for 95 % of the total electricity generated.

Power generation in Sweden

Figure 2 shows the Swedish electricity balance week by week during 2000 and 2001. The electricity generation rate varies with the consumption, and generation is therefore high in the winter and low in the summer. The annual overhauls of the nuclear power units are scheduled for the summer when the electricity demand is at a minimum. The hydro power water reservoirs are filled during the spring and summer, and the water stored is then used during the winter and up to the spring floods.

During 2001, hydro power accounted for 50 % of the Swedish electricity generation, nuclear power accounted for 44 %, and fossil-fired and biofuel-fired generation for just over 6 %. The total electrical energy generated increased by just over 11 % from the year 2000 and amounted to 158 TWh. The reason for the increase is that the generation rate in the Swedish nuclear power stations increased by more than 14 TWh compared to the year 2000. At the same time, the energy generated by hydro power was the highest ever in Sweden at just over 78 TWh, according to preliminary statistics.

During 2001, Sweden was a net exporter of electricity. Table 3 shows the Swedish electricity balance and the Swedish Energy Agency forecast for developments in the somewhat longer perspective. The estimates are based on the energy policy decisions made by the Swedish Parliament and are based on the assumption that the system of taxes and charges applicable today will remain throughout the forecast period. The forecast for 2010 assumes “normal year generation”. The appraisal is otherwise based on different assumptions concerning economic development.

Table 5 • Installed capacity in the Nordic countries on 31 December 2001, MW

	Denmark	Finland	Norway	Sweden	Nordic countries[1]
Total installed capacity[2]	12 480	16 827	27 893	31 721	88 921
Hydro power	11	2 948	27 571	16 239 [3]	46 769
Nuclear power		2 640		9 436	12 076
Conventional thermal power	9 983	11 200	305	5 753	27 241
Condensing power[4]	0	3 912	73	1 023 [8]	5 008
CHP, district heating	9 275 [5,6]	3 712	12	2 340	15 339
CHP, industry	438 [7]	2 698	185	929	4 250
Gas turbines, etc.	270	878	35	1 461 [8]	2 644
Wind power	2 486	39	17	293	2 835

[1] Excluding Iceland.
[2] The power is the sum of the net outputs of the individual units in the power system, and thus cannot be regarded as the total available power at any particular point in time.
[3] Including the Norwegian share of Linnvass River (25 MW).
[4] Including long-term mothballed power in Finland (around 700 MW).
[5] Including condensing power.
[6] Including German share of Ensted Power Station (313 MW) and long-term reserve at Vendsyssel Power Station (295 MW).
[7] Including industrial in-house generators (about 37 MW).
[8] Including out-put of stations included in the power reserve agreements in Sweden.
Source: Processed statistics from Nordel.

Table 6 • Electrical energy generated by hydro power in Norway, Finland and Denmark, TWh, and installed capacity, MW in 2001

	Energy generated, TWh	Installed capacity, MW
Norway	121	27 571
Finland	13	2 948
Denmark	0.03	11

Source: Nordel.

Power generation in Denmark

Danish power generation is based principally on coal-fired and natural gas-fired combined heat and power (CHP) stations and condensing power stations. A minor proportion of power generation is based on biofuels. In 2001, power generation in conventional thermal power stations accounted for more than 88 % of the total electrical energy generated in Denmark. Of these 54 % were based on coal and 28 % on natural gas. “Energi 21”, which is the long-term plan drawn up by the Danish Government for sustainable energy development in Denmark, is aimed at increasing the use of biofuels for electric power generation. This will take place by increased use of straw and wood chips, and by biofuel-fired thermal power stations being converted to combined heat and power stations.

Among the Nordic countries, Denmark has the highest proportion of electricity generated by wind power. In 2001, the Danish wind power plants accounted for 12 % of the total power generation. Denmark also has a small proportion of hydro power, although this is not discernible in the statistics.

Power generation in Finland

Power generation in Finland is based on conventional thermal power, nuclear power and hydro power. In 2001, conventional thermal power accounted for 51 % of the total energy generated, nuclear power accounted for 31 % and hydro power for 19 %. The fuels mainly used in Finnish thermal power stations are biofuels, coal, natural gas and peat. A small proportion of the electricity generated is based on fuel oil. Finland has relatively high imports from neighbouring countries, and net imports in 2001 amounted to around 10 TWh. To be able to meet the growing electricity consumption and reduce the dependence on imports, the Finnish power generation system must be expanded. This has led to a discussion on expanding nuclear power. Another alternative discussed was the construction of natural gas-fired power stations. These two alternatives are given in the Finnish national climate strategy from March 2001, and they are aimed at reducing coal consumption and thus the emissions of carbon dioxide.

In January 2002, the Finnish Government decided in principle to build a fifth nuclear power reactor. This decision was approved by the Finnish Parliament on 24 May.

Power generation in Norway

Norwegian power generation is based principally on hydro power. In 2001, hydro power accounted for 99.3 % of the total electricity generated in Norway. The remainder of the electricity originated mainly from natural gas-fired generation plants. Expansion of natural gas-fired power generation is also the subject of discussion in Norway. The 1999 energy

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Figure 3 • Water inflow in Sweden during a normal year and during 1999–2001, GWh per week

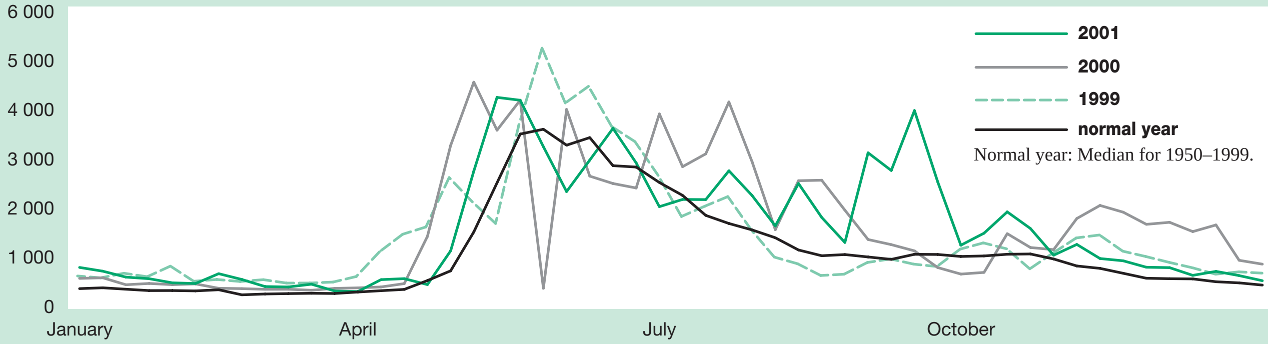


Figure 4 • Reservoir contents in Sweden during an average year and during 1999–2001, percent

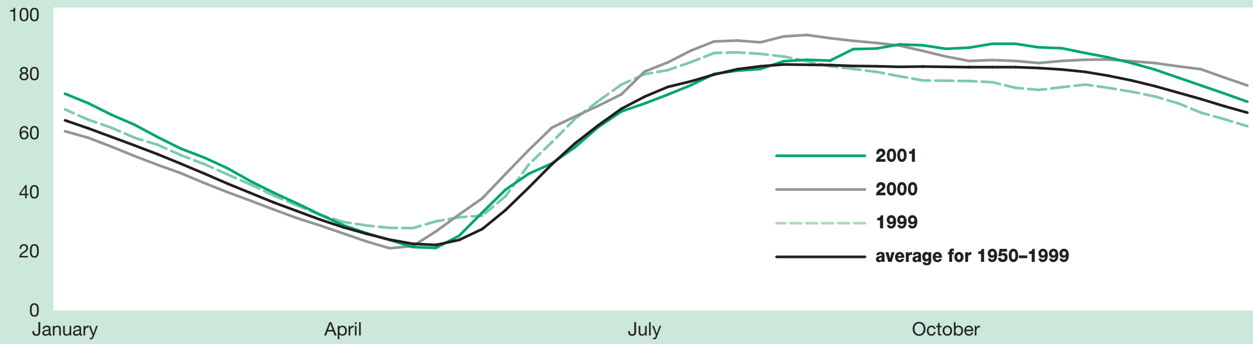
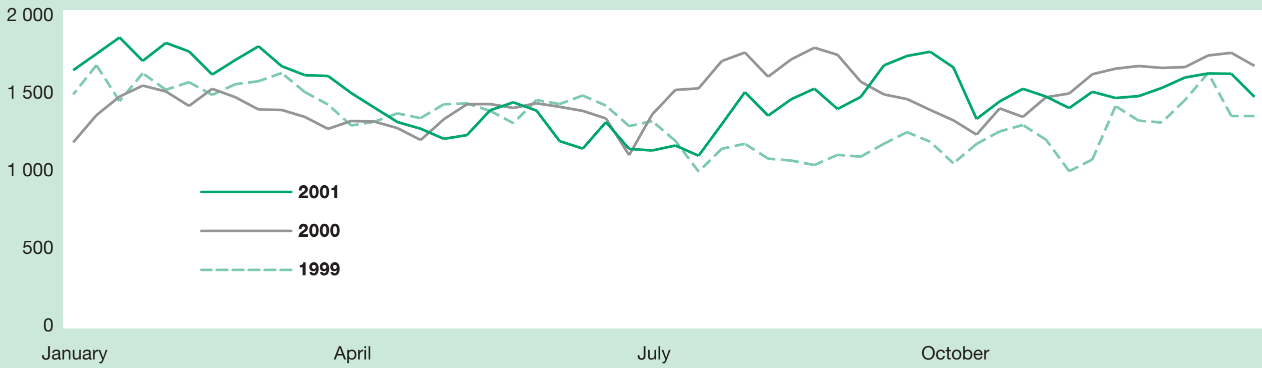


Figure 5 • Hydro power generation in Sweden in 1999–2001, GWh per week



Source: Compiled information from Swedenergy.

strategy of the Norwegian Government states that the energy policy will be drawn up so that it supports an ambitious environmental policy. Generation will be based to a higher degree on renewable energy sources. The aim is to use a further 4 TWh of water-borne heat generated by renewable energy sources and to expand wind power so that the annual generation rate will increase to 3 TWh before the year 2010.

Installed power in the Nordic countries

Table 5 shows the total installed net power in the Nordic countries at the end of 2001. Wind power has increased in all countries, but most of all in Denmark and Sweden. In Sweden, the installed wind power has increased by 52 MW during 2001, while in Denmark, it has increased by 105 MW. In Sweden, the available installed power in condensing power stations and gas turbines has increased due to the power reserve purchased by Svenska Kraftnät. For further particulars, see section Power balance issues.

Hydro power

In 2001, hydro power accounted for more than 55 % of the electricity generated in the Nordic countries. The total installed power at the end of the year was 46 769 MW. Just below 60 % of the installed power is in Norway, 35 % in Sweden and 6 % in Finland. Hydro power generation in Denmark is marginal. The total normal year generation in the Nordic countries is between 180 and 190 TWh. The year 2001 was a wet year, above all in Sweden, and the total energy generated amounted to 213 TWh.

Water inflow

2001 began as a normal year, but the water inflow in Sweden was much higher than normal during the autumn and winter. However, the water inflow in Norway was lower than normal in the beginning of the year, which led to increasing prices on the electricity exchange. The inflow

Tabell 7 • Energy generated by hydro power on various Swedish rivers in 1990 and 1995–2001, TWh, and installed capacity on 31/12 2000, MW

	1990	1995	1996	1997	1998	1999	2000	2001	Inst. capacity
Luleälven	15.8	14.0	14.1	16.0	12.4	15.8	15.9	15.3	4 355
Skellefteälven	4.8	4.5	3.4	4.4	4.7	5.2	5.2	5.5	1 023
Ume älv	9.3	8.0	5.4	8.3	9.1	8.2	9.3	10.0	1 736
Ångermanälven incl. Faxälven	9.4	7.8	5.5	8.0	9.5	7.7	13.6 -	14.4	2 574
Indalsälven	9.7	9.8	7.5	10.2	10.4	10.0	11.7	10.9	2 103
Ljungan	1.9	2.0	1.6	2.1	3.4	2.4	3.1	2.5	606
Ljusnan	3.5	3.8	3.2	3.7	4.1	3.8	4.3	4.5	802
Dalälven	4.7	4.6	3.1	4.4	5.5	4.7	5.6	5.8	1 107
Klarälven	2.3	2.4	1.9	1.6	1.7	1.7	2.0	2.0	380
Götaälv	1.4	2.0	0.9	1.4	1.6	2.2	2.0	2.1	301
Other Rivers	3.9	3.8	1.6	4.0	7.1	4.9	5.1	5.5	1 242
Total	71.4	67.0	51.0	68.1	73.6	70.4	77.8	78.5	16 229

Note. The totals for energy generated differ somewhat from the official statistics.
Source: Swedenergy Annual Report 2001, and Statistical Yearbook 2002, Statistics Sweden.

during the summer increased also in Norway, and was above normal level during the autumn. The total water inflow in Sweden amounted to 84.1 TWh during the year (inflow uncorrected for spillage). In a normal year, defined as the median for the water inflow during the period between 1950 and 1996, the inflow is 64.5 TWh. The inflow during the past three years is shown in Figure 3.

Reservoir contents

During the first quarter of 2001, the reservoir contents in Sweden were just above normal level, but over a few weeks during the spring and summer, dropped to a level below normal. However, the high inflow rate during the autumn led to the reservoir contents being higher than normal during the autumn and winter. Early in 2002, the reservoir contents were also above normal level. The reservoir contents in recent years and in a normal year are shown in Figure 4.

Hydro power in Sweden

Sweden has more than 700 large hydro power stations, each with an installed capacity of more than 1.5 MW. In addition to these, there are also around 1200 small hydro power stations that together generate around 1.5 TWh. The four biggest rivers account for around 65 % of the total hydro power generated in Sweden (see Table 7).

During a year with normal water inflow, hydro power has the capacity to produce 64.2 TWh of electrical energy, excluding losses, which corresponds to roughly 45 % of the total electricity generated in the country. The electricity generated by hydro power can vary widely, depending on the inflow and the reservoir contents. During extremely dry years, such as 1996, production may amount to no more than 51 TWh, whereas in wet years, it could total just over 78 TWh. The highest annual electrical energy generated so far was recorded in 2001 at 78.4 TWh. The maximum water volume in the long-term reservoirs corresponds to an energy of 33.6 TWh. Figure 5 shows the electrical energy generated by hydro power during the past three years.

Hydro power in Norway, Finland and Denmark

Virtually all of the electricity generated in Norway is based on hydro power, with only about 0.5 TWh coming from other sources. The energy generated during 2001 amounted to 121 TWh. During the same year, Finland generated 13 TWh of electricity in hydro power stations. The hydro power generated in Denmark is marginal. In 2001, the energy generated was 0.03 TWh.

Nuclear power

Six nuclear power stations with a total of 15 reactors are now in operation in the Nordic countries. Out of this total, eleven reactors are in Sweden and four in Finland.

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FACTS

The annual *generation potential* of a reactor is calculated as the number of hours of operation per year, multiplied by the maximum output of the plant. Since the power station itself needs electricity for its operation, a distinction is made between gross and net power output. In Swedish reactor plants, the average net output is around 95 % of the gross output.

There are two ways of measuring the efficiency of a nuclear power station, i.e. utilization and availability. Energy utilization specifies the relationship between actual electrical energy generated and the theoretically possible energy generation over a certain period of time. This is important for the valuation of the economy of the plant and thus the production costs.

Energy availability specifies the period of time during which the generator has been synchronized at the grid, regardless of its output.

Tabell 8 • Generation data for Swedish nuclear power reactors in 2001

Reactor	Net out-put, MW	Energy generated, TWh: Max. available[1]	Energy generated, TWh: Actual[2,3]	Losses[4], TWh: Coast-down	Losses[4], TWh: Load-reduction	Losses[4], TWh: Annual overhaul	Losses[4], TWh: Other losses[5]
Barsebäck 1	(600)	-	-	-	-	-	-
Barsebäck 2	600	4.6	4.4	0	0	0.4	0.2
Forsmark 1	968	8.0	5.7	0.5	0.1	0.4	0.1
Forsmark 2	964	7.8	5.4	0.3	0	0.3	0.4
Forsmark 3	1 155	8.7	7.9	0.5	0	1.4	0.1
Oskarshamn 1	445	3.3	3.1	0.1	0.1	0.3	0.4
Oskarshamn 2	602	4.9	3.9	0	0	0.4	0.1
Oskarshamn 3	1 160	9.4	7.3	0	0.2	0.5	0.4
Ringhals 1	835	6.3	3.3	0.4	0	0.5	0.3
Ringhals 2	870	6.6	5.2	0.2	0	0.6	0.4
Ringhals 3	920	7.1	6.2	0.8	0	0.6	0.3
Ringhals 4	915	7.1	4.1	0.4	0	0.7	0.2
Totalt	9 456[6]	73.9	69.7	3.2	0.5	6.2	2.9

[1] Net output x availability of the reactor x 8 760 hours.
[2] Net output x utilization of the reactor x 8 760 hours.
[3] Due to rounding-off in the source information, the figures do not agree with the statistics given in other tables. In addition, the statistical information has been obtained at different times.
[4] Generation losses are defined as losses that are not availability-dependent (coast-down, load reduction, influence of cooling water temperature and external faults) and those that are availability-dependent (periodic tests, faults and overhauls). Other losses included both types of loss, in which the cooling water influence, external faults, periodic tests and faults are added together.
[5] For Barsebäck 2, other losses also include the extended overhaul shut-down.
[6] Excl. Barsebäck 1. The reactor was shut down on 3 November 1999.

Note. Due to rounding-off, the actual energy generated does not agree with the maximum available generation – coast-down – load reduction.
Source: Compilation of information from the nuclear power safety company, Kärnkraftssäkerhet och Utbildning AB.

Table 9 • Net electrical energy generated in the Swedish reactors in 1990 and 1995–2001, TWh

	Commissioning year	1990	1995	1996	1997	1998	1999	2000	2001	Total energy generated from commissioning, TWh	Availability in 2001 percent
Barsebäck 1	1975	4.3	3.9	4.1	3.7	4.3	2.6	-		92.7	-
Barsebäck 2	1977	4.2	3.4	3.8	3.9	4.0	3.5	2.9	4.4	94.9	88.4
Forsmark 1	1980	6.2	7.3	7.3	5.4	7.3	7.6	5.7	7.3	139.7	94.8
Forsmark 2	1981	6.4	7.1	7.3	7.3	7.2	7.3	5.4	7.4	135.4	92.3
Forsmark 3	1985	7.9	8.9	8.8	9.0	9.0	8.8	7.9	8.2	137.1	86.2
Oskarshamn 1	1972	2.5	0.0	2.4	2.9	1.3	3.3	3.1	3.1	72.1	83.7
Oskarshamn 2	1974	4.0	4.2	3.8	4.4	4.4	3.2	3.9	4.7	105.6	92.3
Oskarshamn 3	1985	7.6	8.9	8.5	9.0	8.0	8.5	7.2	9.1	135.3	92.6
Ringhals 1	1976	4.5	5.7	6.5	2.2	5.6	4.9	3.2	5.8	117.2	86.1
Ringhals 2	1975	5.2	6.1	5.7	6.2	6.1	6.4	5.1	6.3	127.9	86.9
Ringhals 3	1981	5.9	4.9	6.8	6.6	6.4	7.0	6.2	6.3	118.4	88.5
Ringhals 4	1983	6.5	6.3	6.3	6.4	6.8	7.0	4.1	6.6	114.1	88.2
Total		65.2	66.7	71.3	67.0	70.4	70.1	54.8	69.2	1 390.4	89.1

Source: Compilation of information from the nuclear safety company, Kärnkraftssäkerhet och Utbildning AB.

The electricity generated in a nuclear power station is determined by the availability of the plant and by its maximum output. The maximum electrical output is restricted by the thermal loading and by the capacity of the generators. The electricity generated can be increased by raising the outputs on the nuclear power stations, but this often involves modifications or extensions to the plant.

Availability and energy utilization

Availability is determined by the unscheduled outages and by the annual overhaul shut-downs. During the overhaul shut-downs, which take place in the summer when the electricity demand is a minimum, maintenance and inspection work are done on the reactors, and the reactors are also refuelled. The overhaul normally takes around four weeks and reduces the maximum full-year energy availability to 85–90 %.

The degree of energy utilization in nuclear power reactors is restricted by load reductions and by coast-down. Load reduction involves running the plant at reduced power for economic reasons. The amount by which the load is reduced is dependent on factors such as the demand for electricity and the availability of hydro power.

Coast-down, or burnup-dictated power reduction, involves adjusting the degree of enrichment of the fuel, with the aim of minimizing the fuel costs. Variations in the electricity demand make it uneconomical to charge the reactors so that maximum output will be achieved. Fuel charging is therefore adjusted so that the generation capacity gradually declines over a period of a few weeks prior to every overhaul shut-down.

Nuclear power in Sweden

In 2001, the electrical energy generated by nuclear power in Sweden was 69.2 TWh, which is 26 % higher than in 2000. The generation results for the Oskarshamn station were the highest ever. One reason for the high generation rate was that the prices of electricity were relatively high, which made it profitable to maintain a high generation rate in the nuclear power stations.

The availability of Swedish reactors in 2001 varied between 83 % and 95 %, the average being 89 %. The corresponding international mean value for these reactor types was just over 80 %. In four of the reactors, the energy availability was in excess of 90 % (see Table 9).

The availabilities of the various reactors are affected by the durations of the annual overhaul shut-downs. During 2001, the overhaul shut-downs on most of the reactors were on schedule. Extensive modernization of the Oskarshamn 1 reactor was begun in December 2001 and the work will continue up to October 2002. The project will include the introduction of a new safety concept aimed at raising safety, the introduction of a computerized control system, modernization of a control room and installation of a more efficient turbine.

Swedish operating permits

The original permits for the Swedish nuclear power reactors are not restricted in time. However, special conditions can be introduced in order to maintain safety in accordance with Section 8 of the Act on Nuclear Activities. As long as the concessionaire conforms to the legal requirements on safety, the permits cannot be withdrawn. To shut down a reactor, the provisions of the the Nuclear Power Phase-out Act must be applied. This was adopted in December 1997 by the Swedish Parliament. According to Section 2 of this Act, the Government may decide, for every nuclear power reactor, that the right to operate it shall cease on a certain date.

Barsebäck 1 was shut down on 30 November 1999. In the opinion of the Government, Barsebäck 2 will be shut down at the end of 2003 at the latest, provided that the loss of generation capacity can be compensated by reduced electricity consumption and new generation capacity. The Government has considered the matter on two occasions, but then concludes that the conditions were not met. A further appraisal will be made during 2003.

→

Table 10 • Gross power, MW and energy generated, TWh, in the Finnish reactors in 2001

Reactor	Commissioning year	Gross output, MW	Energy generated in 2001, TWh	Availability in 2001, percent
Loviisa 1	1977	488	7.7	90.6
Loviisa 2	1981	488		
Olkiluoto 1	1979	840	14.1	96.3
Olkiluoto 2	1982	840		
Totalt		2 656	21.8	93.4

Source: www.energia.fi

Table 11 • Electrical energy generated in conventional thermal power stations in the Nordic countries in 2001, TWh

	Denmark	Finland	Norway	Sweden
Conventional thermal power	31.7	36.4	0.9	9.7
CHP in district heating networks	0.0	14.4	0.0	5.2
CHP in industry	2.2	11.5	0.0	4.4
Condensing power	29.5[1]	10.5	0.0	0.1
Gas turbines, diesels, etc.	0.0	0.0	0.0	0.0

[1] Including energy generated in CHP stations in district heating networks.

Source: For Denmark, Finland and Norway: Nordel. For Sweden: Own processing of information from Statistics Sweden.

Table 12 • Electrical energy generated in thermal power stations, classified by fuel, in the Nordic countries in 2001, TWh

Fuel	Denmark	Finland	Norway	Sweden
Biofuel, peat, etc.	1.9	14.4	0.0	3.7
Coal	17.1	10.7	0.0	2.1
Natural gas	9.0	9.0	0.3	1.0
Oil	0.5	1.5	0.0	2.5
Others	3.2	0.7	0.6	0.3
Total	**31.7**	**36.3**	**0.9**	**9.6**

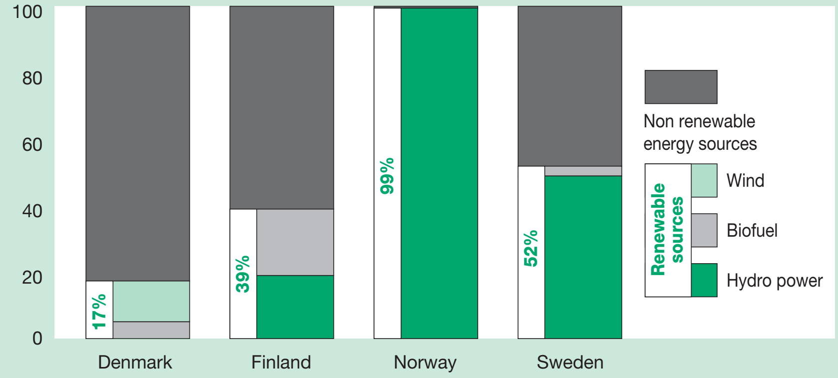
Note: Due to rounding-off, the total sums do not always agree with the sums of the individual items.

Source: Nordel.

Nuclear power in Finland
Finland has two nuclear power stations in operation, with a total of four reactors. These power stations account for around 30 % of the total electricity production in Finland. Table 10 shows the gross output, which includes the power demand of the plant itself. During 2001, the energy generated by Finnish nuclear power stations was 21.8 TWh.

In January 2002, the Finnish Government decided in principle that a fifth nuclear power reactor would be built either at the Loviisa or the Olkiluoto nuclear power station, in accordance with the application submitted by Teollisuuden Voima Oy (TVO). The decision then had to be examined by the Parliament, which voted on the bill on the 24 May 2002 and approved the Government's decision.

Figure 6 • Proportions of electricity generated from renewable sources out of a total electricity generated in the Nordic countries in 2002, percent



Source: Nordel.

Conventional thermal power

Conventional thermal power stations generate electricity by burning various fuels. The fuels used in the Nordic countries are coal, oil, natural gas, peat and biofuels. Power is generated in combined heat and power stations, condensing power stations, and gas turbine power stations.

Both electricity and heat are generated in combined heat and power (CHP) stations that are used both by industry and in district heating networks. The difference between these two is that generation is based on different thermal loads. The amount of the electrical energy generated in district heating networks, for example, is largely dependent on the outdoor temperature. In industry, the attainable electrical energy generated is dependent instead on the company's process heat demand. The amount of electricity generated is also determined by the market price of electricity.

Conventional thermal power in Sweden
During 2001, the electrical energy generated in Sweden by conventional thermal power amounted to 9.8 TWh, which corresponds to roughly 6 % of the total electricity generated. Tables 11 and 12 show the electrical energy generated and the share of different fuels in conventional thermal power plants in the Nordic countries in 2001.

In CHP stations in district heating networks, coal and also blast furnace gases accounted for 52 % and fuel oil for 16 % of the fuel supply for electricity generation in 2001. The proportion of fuel oil has dropped since 1999. Natural gas and biofuels, peat, etc. accounted for 5 % and 27 % respectively. For taxation reasons, the proportion of fossil fuels in electricity generation is high. Biofuels and fuel oil dominate in industrial CHP generation and accounted for 49 % and 48 % respectively of the fuel supply for electricity generation during 2001.

Several Swedish condensing power stations have been decommissioned since 1996. Due to the stiff competition on the market, power utilities do not consider it economically viable to operate the power stations, since they were used only for peak-load as power reserve. On the Nordic electricity market, the power utilities instead import electricity from neighbouring countries. In 1996, there were seven major condensing power plants with a total rating of about 2 820 MW. Today, only one of these plants, with an output of around 340 MW, is available for generation. In addition to this plant, a couple of additional plants have been procured by Svenska Kraftnät for safeguarding electricity generation capacity in very cold weather. These plants serve as a power reserve. Further information on the procurements is given in the chapter entitled *Power balance issues.*

Conventional thermal power in other Nordic countries
In 2001, conventional thermal power in Denmark accounted for 32 TWh of the total electrical energy generated, which represents 88 %. During 2001, coal and natural gas accounted for most of the electricity produced, at 54 % and 28 % respectively. About 6 % originates from biofuels.

In Finland, the proportion of conventional thermal power during 2001 accounted for 51 % or 36 TWh of electricity. Biofuels accounted for 40 % of the energy generated, coal for 29 % and natural gas for about 25 %.

In Norway, the electrical energy generated by conventional thermal power was less than 1 % of the total electricity production.

Electricity from renewable energy sources

The concept of renewable energy source means that energy from that source can be reproduced at the same rate as it is utilized. These energy sources include hydro power, wind power, bioenergy, solar energy and geothermal energy. Figure 6 shows the percentages of renewable energy sources in the total electricity generated in the Nordic countries.

Sweden
A large proportion of the electricity in Sweden is generated from renewable energy sources. In 2001, hydro power accounted for 78.4 TWh, which was 50 % of the total electrical energy generated in Sweden. The use of biofuels in combined heat and power (CHP) generation in district heating systems has increased. During 2001, biofuels were used for generating about 3.7 TWh of electricity in CHP generation in district heating systems and in industrial back-pressure plants, which corresponded to 39 % of the electricity generated in these systems.

The number of wind power plants in Sweden has steadily increased. Contributory reasons for this trend are the falling costs, increased awareness of climatic issues, expected increased revenues from electricity sales, and also the State subsidies system. In recent years, the size of the wind turbines installed has increased. The average rating of the turbines taken into operation in 2001 was 900 kW, whereas in the year 2000, it was 660 kW. The contribution of wind power to the electrical energy generated during 2001 was 0.48 TWh, which is an increase of 7 % on the year 2000. Wind power accounted for 0.3 % of the total electrical energy generated during 2001. Almost 50 new wind power plants rated in excess of 50 kW were built in Sweden, and there were 569 such wind turbines in operation at the end of the year. The total power output of Swedish wind power was 293 MW at the end of 2001, which is an increase of 20 % on the preceding turn of the year. The low increase in the electricity generated is due to 2001 being a poor wind year compared to the year 2000.

Denmark

Out of the 36 TWh of electricity generated in conventional thermal power stations in Denmark, biofuels accounted for only 1.9 TWh. The interest in wind power in Denmark is greater than it is in Sweden, which is largely due to the Danish support system. At the end of 2001, the total installed power was 2486 MW. During 2001, the total electrical energy generated by Danish wind power plants was 4.3 TWh, which corresponded to 12 % of the total electricity generated.

Norway

In Norway, hydro power produced 121 TWh of electricity in the year 2000, which corresponds to 99.3 % of the total electrical energy generated. The amount of installed wind power is relatively low. At the end of 2001, the power was 17 MW and the electrical energy generated was 0.03 TWh.

Finland

Hydro power accounted for 13.3 TWh of electricity or 19 % of the total electrical energy generated during 2001. About 9.0 TWh or 12.6 % of the electrical energy in Finland is generated by means of biofuels in conventional thermal power stations. The electrical energy generated by wind power amounted to 0.07 TWh and the installed capacity at the end of 2001 was 39 MW.

New power generation technology

For new technology to achieve commercial breakthrough, it must be competitive and must have a clear market in the foreseeable future. Even though the Swedish energy market is of special interest, Swedish technology-developing companies must generally have the stimulus of a potential international market. In addition to its technical potential, the competitiveness of a new technology is determined by several other factors, such as the expected development of electricity prices, fuel prices, taxes, grants and the prospect of obtaining the necessary permits. An outline is presented below of the electricity generation technology, including CHP, that according to the report entitled ”El från nya anläggningar” (Report No. 2000:1 published by Elforsk, the Swedish Electrical Utilities’ R&D Company Electricity from new plants) is nearest to achieving commercial breakthrough during the period up to 2010. The report will soon be updated by the Swedish Energy Agency in cooperation with Elforsk.

The *evaporative gas turbine (EvGT)* is a technology designed to increase the efficiency of a gas turbine by putting to use the energy in the hot exhaust gases. The system is capable of achieving the same efficiency as a combined cycle – a process that yields more electricity than direct combustion, since part of the fuel is first converted into gas. The investment cost of the EvGT is lower, and the system is a strong competitor to natural gas fired combined cycle plants and other gas turbine processes.

In the *gasification of biofuels*, the gas produced is used in a combined cycle, which leads to a higher electrical effi- →

Figure 7 • Variable generation costs in the existing electricity generation system, öre/kWh

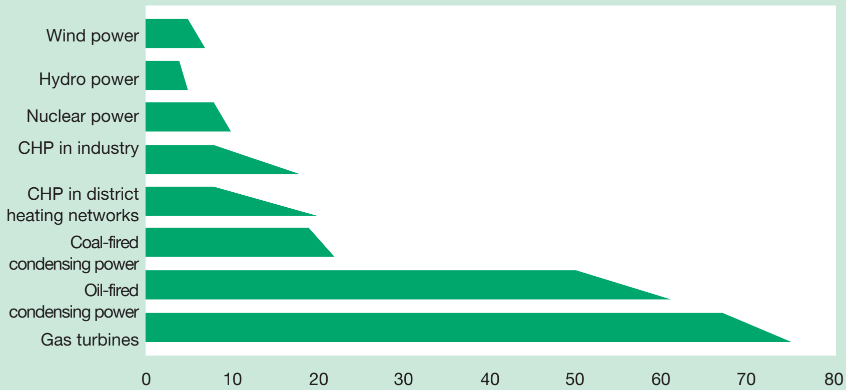
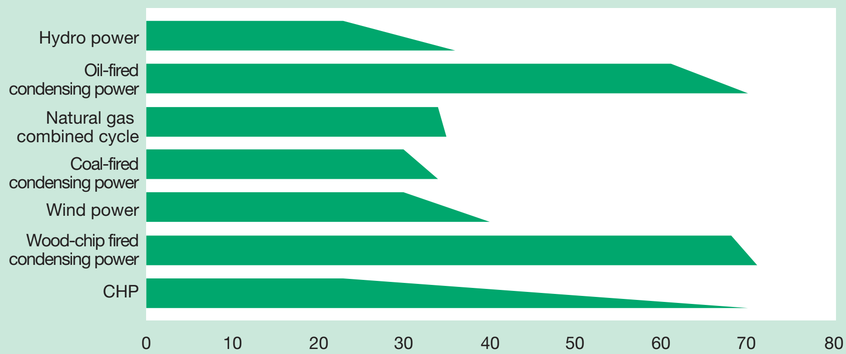
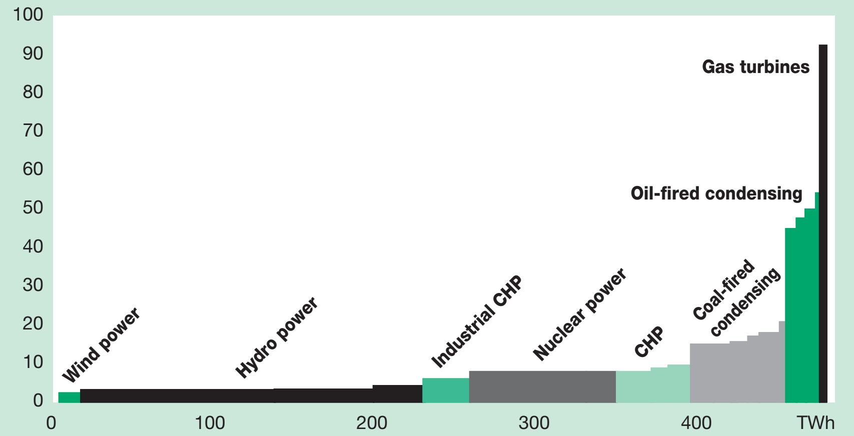


Figure 8 • Total electricity generation costs in new plants, öre/kWh



Source: Information compiled and processed by the Swedish Energy Agency from the Swedish Electric Utilities R&D Company report 2000:01, *El från nya anläggningar (Electricity from new plants).*

Figure 9 • Generation capacity from different energy sources in the Nordic countries in a normal year, and their variable generation costs in 2000/2001, öre/kWh



ciency. The electrical efficiency of demonstration plants is estimated to be just over 30 %, but in an optimized commercial-scale plant, the attainable electrical efficiency could be between 40 % and 45 %. Swedish interest will be dependent on the price of electricity and the political regulatory measures adopted to promote renewable power generation systems.

In an *indirectly-fired gas turbine*, the fuel is burned in a conventional solid fuel boiler, and the heat is transferred to the working medium of the turbine by means of a heat exchanger. The benefit of this arrangement is that there is no risk of the turbine being damaged by impurities from the fuel. The limitation lies in the capacity of the heat exchanger. The technique, which is an alternative to efficient solid fuel fired CHP generation, may be of interest to Sweden, principally when linked to biofuels.

Microturbine is the name given to turbines with an electrical output of between 30 and 200 kW. These could be used for distributed electricity generation and for small-scale CHP generation. The automotive industry is also showing keen interest in microturbines. Sweden is in the forefront of development, thanks to the efforts of Vattenfall and Volvo.

The *Stirling engine* is a heat engine with external combustion and uses air or a gas as the working medium. Stirling engines are used today in various applications, such as submarines. Another interesting application is for hybrid vehicles. In a perspective of more than 10 years, small-scale biofuel-fired CHP generation incorporating Stirling engines may become of interest.

In a *fuel cell*, electrical energy is generated directly from chemical energy by means of an electrochemical cell. The design of this cell is roughly the same as that of a battery, with one electrode on each side of an electrolyte. The difference is that the electrodes are not consumed, since the reacting elements, i.e. hydrogen and oxygen, are continuously supplied. Fuel cell technology is being developed mainly in North America and Japan. The strong driving force is the interest in applications in the field of transport. The technique may also be employed for small-scale CHP generation.

Solar cells can be used for converting solar light directly into electricity. The technique is considered to be too expensive for conventional power generation. As a result, the solar cell technique will continue to be used only in certain niche markets. Solar cells are typically used today in places to which it would be difficult to run ordinary power supply cables, such as remotely located lighthouses.

Support for new technology

By supporting research and development in the field of energy, the Swedish Energy Agency promotes the development of new technology capable of contributing towards the emergence of an economically and ecologically sustainable energy system. During 2001, seven research programmes were in progress in the field of new power generation technologies, for which a large proportion of the financing was provided by the Swedish Energy Agency. These programmes comprise both fundamental and applied research in the fields of solar electricity, wind power and fuel cells, and also in the development of artificial photosynthesis. The Swedish Energy Agency also provides support for development and demonstration projects aimed at developing new solutions for how the new technologies can be implemented in existing power generation systems. Moreover, the Swedish Energy Agency also provides partial funding for a number of development programmes and competence centres in the field of electrotechnology.

Generation costs

Disregarding taxes and grants, the costs of electricity from the various generation sources are roughly the same in the Nordic countries. The electricity generation costs shown in Figures 7 and 8 are based on Swedish electricity generation, but also show the approximate levels of electricity generation costs in all Nordic countries.

The calculations relate to costs but exclude any grants. In Sweden, electricity generation has basically no taxes. For the generation sources that are taxed, the taxes are included in the calculated costs shown below. For further information on this, see the chapter entitled Regulatory instruments.

Variable generation costs

The variable electricity generation costs in the existing system consist of fuel costs, and also the operation and maintenance costs. The fuel prices in the year 2001 were used in the calculations.

For *hydro power*, the variable costs, including taxes, are between 3 and 7 öre/kWh. The variable generation costs of *wind power* are between 5 and 7 öre/kWh, depending on the wind conditions and availability. The average variable generation costs of *nuclear power* are estimated to be about 8 öre/kWh, including tax and nuclear waste charge.

Considering *combined heat and power generation in industry*, the pulp and paper industry has access to fuel that is basically free of charge, i.e. bark and black liquors. The plants also use fossil fuels. The variable generation costs vary with the fuel costs, which are lower for biofuel and higher for oil. The variable generation costs for *combined heat and power generation in district heating networks* also vary with the fuel used. The lowest costs are for waste-fired generation, and the highest for biofuels.

The variable generation costs in *oil-fired condensing power stations* vary between 50 and 55 öre/kWh if heavy fuel oil is used. If light fuel oil is used, the costs are between 50 and 61 öre/kWh.

Gas turbines fired with light fuel oil have the highest variable generation costs. *Coal-fired condensing power stations* have a variable generation cost of just over 21 öre/kWh.

New power generation plants

The total electricity generation costs in new power generation plants consist of variable costs, capital costs and other fixed costs. The costs shown in Figure 8 should be used with caution, since every plant is unique, and local conditions are of major importance to the total costs. This applies particularly to costs in condensing plants, since no such new plants have been built in Sweden during the past 25 years. The figure shows the range of costs, and the variations are due to different assumptions concerning interest rates, write-off time, fuel used, utilization time, size of the plant and the magnitude of heat crediting in CHP plants.

The generation cost in new, large-scale *hydro power* stations is around 25 öre/kWh. For individual large hydro power stations, the upper cost limit is estimated to be around 35 öre/kWh.

The total generation cost of land-based *wind power* plant varies between 30 and 36 öre/kWh (without support), depending on the wind conditions. The costs of offshore wind power are somewhat higher at over 40 öre/kWh.

The revenue from heat generation reduces the electricity generation costs in *combined heat and power plants*, which is known as heat crediting. Crediting is calculated on the heat generated and its level in relation to the alternative heat generation cost. In this case too, the generation costs vary widely. The scatter is due to the effect of plant size, the fuel used and the crediting selected.

Supply curve

The total generation capacity of the Nordic electricity supply system is highly dependent on the water inflow to the hydro power systems in Norway and Sweden. The difference between a dry year and a wet year in the Nordic countries may amount to 70 TWh. Figure 9 shows the Nordic supply curve during a normal year. The electricity generation costs shown are the variable costs. The figure gives a general picture of how the generation capacity is used with regard to the cost.

Environmental impact

Due to the high proportion of hydro power and nuclear power in the Nordic countries as a whole, electric power generation accounts for only a small proportion of the environmentally harmful emissions. The exception is Denmark, where power generation is based on firing with fossil fuels. Hydro and nuclear power plants are not entirely devoid of environmental impact, but they are virtually emission-free during normal operation.

Fuel-fired power generation

Combustion of a fuel will give rise to various types of atmospheric emissions. →

Table 13 • Emissions of carbon dioxide, sulphur dioxide and nitrogen oxides in Sweden in 1990 and 1995–2000

	1990	1995	1996	1997	1998	1999	2000
Carbon dioxide, million tonnes							
Electricity generation	1.4	2.8	5.1	3.9	3.8	2.9	1.4
Total in Sweden	**56.1**	**58.6**	**62.1**	**57.1**	**58.1**	**56.5**	**55.9**
Nitrogen oxides[1], thousand tonnes							
Electricity generation	2	3	5	4	4	2	1
Total in Sweden	**349**	**309**	**309**	**291**	**277**	**267**	**247**
Sulphur dioxide, thousand tonnes							
Electricity generation	3	4	8	6	6	3	1
Total in Sweden	**111**	**69**	**74**	**66**	**63**	**54**	**58**

The statistics have been revised compared to the earlier issue and exclude sinks, biofuels and bunkering.
[1] Measured as NO_2.
Source: Statistics Sweden MI 18.

Table 14 • Emissions of sulphur dioxide, nitrogen oxides and carbon dioxide per kWh of electrical energy generated in Denmark, Finland and Sweden in 1990 and 1995–2000

	SO_2 (mg/kWh)			NO_2 (mg/kWh)			CO_2 (g/kWh)		
	Denmark	Finland	Sweden	Denmark	Finland	Sweden	Denmark	Finland	Sweden
1990	3 167	1 014	30	2 503	734	30	604	189	11
1995	1 659	388	28	1 322	436	28	478	210	22
1996	1 784	423	51	1 486	473	59	534	272	31
1997	1 050	380	14	1 131	420	21	460	220	12
1998	776	280	13	918	330	20	415	170	11
1999	559	280	13	768	320	19	373	170	11
2000	203	208	13	678	310	18	381	170	12

Source: Nordel.

Carbon dioxide, nitrogen oxides and sulphur dioxide are described below in somewhat more detail. In addition to these, emissions also include dust, hydrocarbons, carbon monoxide, reduced nitrogen (ammonia) and nitrous oxide (N_2O). Dust (particulates) contributes towards fouling, but may also give rise to human respiratory tract ailments. Certain hydrocarbons are carcinogenic and contribute to the formation of photochemical smog, i.e. ozone. If inhaled, carbon monoxide impairs the oxygen absorbing capacity. To some extent, ammonia is oxidized to nitrate, nitrogen oxides and pure nitrogen, but most of it is deposited on the ground with precipitation in the form of ammonium (NH_4^+). Nitrous oxide contributes to the greenhouse effect.

Out of the fossil fuels used, natural gas is the "lowest emitting" fuel, being practically free from heavy metals and sulphur, while the carbon dioxide emissions are lower than from both oil and coal. The combustion of biofuels is assumed to cause no net contribution to the carbon dioxide emissions to atmosphere, provided that the biomass harvesting rate does not exceed the growth rate. On the other hand, the emissions of methane and nitrous oxide (greenhouse gases), carbon monoxide and ammonia are somewhat higher than those caused by fossil fuels. Peat includes sulphur, the content of which varies with the type of peat. Peat extracted in the vicinity of sulphurous soil and rock strata often has sulphur contents of up to 10 % measured on the dry weight.

Carbon dioxide emissions

Carbon dioxide (CO_2) is a gas formed during combustion. Emissions of carbon dioxide lead to increased greenhouse effect. Carbon dioxide also leads indirectly to breakdown of the ozone layer, since it causes a temperature rise in the atmospheric layer nearest to the earth, which leads to a corresponding temperature drop in the layers beyond it, and ozone depleting compounds are increasingly active at decreasing temperatures.

Nitrogen oxides and sulphur dioxide

Nitrogen and sulphur oxides (NO_x and SO_2) are formed during combustion. The nitrogen originates mainly from the combustion air, which contains almost 80 % nitrogen. The sulphur originates from the fuel. In the atmosphere, these gases are converted to nitric acid (HNO_3) and sulphuric acid (H_2SO_4). These are deposited with the precipitation, which is known as "wet deposition", or are deposited directly as sulphur dioxide or nitrogen oxide, which is known as "dry deposition". Nitrogen oxides contribute to acidification, but mainly to over-fertilization, since nitrogen is absorbed by biomass in a larger proportion than sulphur. Nitrogen oxides also contribute to the formation of photochemical smog, which causes damage to the flora and to the respiratory tracts of animals and people. Sulphur oxides contribute principally to acidification.

Hydro power

Unlike the environmental impact caused by the emission of atmospheric pollutants, the environmental impact of hydro power is mainly local and regional. The construction of hydro power plants affects the environment by changing the landscape pattern and the biotopes, by reducing the biological diversity, and by disturbing fisheries, the care of cultural relics and open-air activities. The damage caused by hydro power to the landscape is serious and basically irreparable, and is not confined to the run of the river, but also affects the surrounding landscape.

Nuclear power

The limit values for radioactive emissions have been set so that individuals (personnel at the power stations) who are exposed to it will not receive an annual dose in excess of 0.1 mSv. Compared to this, natural background radiation gives an annual dose of 4 mSv. Under normal circumstances, the emissions are far below the limit value. The environmental impact of nuclear power lies in the management of the radioactive waste occurring during operation, the risks of major emissions in the event of an accident, and also in the mining of uranium.

Wind power

The environmental impact of wind power consists of the changes it causes to the landscape scene, since large areas of land are needed if wind power is to make a significant contribution to the total electricity generated. When running, wind turbines can also emit sound that may be perceived as disturbing, and they may also cause radio communication interference. In the construction of offshore power plants, disturbances may also be caused to the fauna, principally to birds. There is no evidence of any other direct environmental effects.

Electricity distribution

The transmission of electricity causes intrusion in nature, the clearest example of which are the lanes cut for power lines. The environmental disturbances are moderate and are of a local nature, but the impact on forestry may be more serious. The electromagnetic field occurring around a high voltage transmission line may be harmful to health, although research has not yet yielded any definite results. The general opinion is that low-frequency electromagnetic fields should be treated with caution, since no limit values are available.

Emissions from electricity generation in Sweden

In the year 2000, the carbon dioxide emissions from power generation amounted to 1.4 million tonnes, which is 2.5 % of Sweden´s total carbon dioxide emissions. Power generation is exempt from carbon dioxide tax, which has led to an increase in the use of fossil fuels for electricity generation.

Sulphur dioxide emissions from power generation have varied between 2000 and 4000 tonnes annually during the 1990s, with the exception of 1996–1998 and 2000. Nitrogen oxide emissions have varied between 3000 and 6000 tonnes annually during the same period. Since 1996 was a dry year, the electricity generated by hydro power stations was low and generation in fuel-fired plants increased, which led to increased emissions. The situation was reversed in 2000, which was a wet year. During 2000, the emissions of sulphur oxides from electricity generation amounted to 890 tonnes and the emissions of nitrogen oxides to 880 tonnes.

Most of the sulphur and nitrogen deposition in Sweden originates from sources abroad. This is because sulphur and nitrogen compounds have a residence time in the atmosphere of between a couple of days and sometimes up to a week before they are deposited on the ground. Sweden, which is in the west wind belt, is exposed to low pressures and fronts from the west and north west. Winds from the south also carry large quantities of air pollutants to Sweden when high pressures build up over the Continent. But Sweden also exports atmospheric pollutants to neighbouring countries, mainly to Russia, Finland, Norway, Poland and the Baltic States, although most of the pollutants are deposited into the sea.

Emissions per kWh have displayed a downward trend throughout the 1990s, with the exception of 1996, which was due to the low hydro power generation rate during that year. Table 13 shows Sweden's total carbon dioxide, sulphur dioxide and nitrogen oxide emissions between 1990 and 2000. Table 14 shows the emissions per kWh during the same period.

Regulations on nitrogen oxide and sulphur dioxide emissions

The Swedish Parliament has set guidelines for nitrogen oxide emissions from combustion plants. Guideline or limit values are specified for each individual plant.

When the Environmental Act (1998:808) came into force, an ordinance (1998:897) on environmental quality standards was also issued. The environmental quality standards list the 24-hour, weekly and annual mean values that must not be exceeded in population centres of a certain size, and also annual mean values for protecting the vegetation outside these centres. Environmental quality standards for sulphur dioxide have now been set and, from 1 January 2006, standards will be in force for nitrogen dioxide. In addition to these, there are also standards for lead (only annual mean value). The various municipalities are entrusted with task of checking conformance to the standards. No permit may be granted for new operations if the environmental quality standard would thereby be exceeded. In such cases, disturbances from existing sources would have to be reduced to create a window for the new operations within the framework of the environmental quality standard.

Since 1992, an environmental charge has been levied on emissions of nitrogen oxides from boilers and gas turbines with an energy output of at least 25 GWh/year. The sulphur content of fuel oils is regulated by a special ordinance. This ordinance also contains limit values for sulphur for certain coal-fired plants. A sulphur tax is levied on fuels that contain sulphur. Biofuels are exempt from the sulphur tax.

Emissions from power generation in the Nordic countries

Power generation in Norway is based on hydro power, and the country therefore has virtually no emissions from power generation. The emissions of sulphur and nitrogen oxides from power generation in Denmark are the highest among Nordic countries in terms of both total emissions and emissions per kWh of electricity generated (see Table 14). This is due to the fact that power generation in Denmark is based principally on firing with fossil fuels. Finland also has a relatively high proportion of electricity generation based on fossil fuels. The picture is the same for carbon dioxide emissions. Table 14 shows the emissions per kWh of SO_2, NO_2 and CO_2 in Denmark, Finland and Sweden between 1990 and 2000. However, these emissions have dropped since 1990. This is due mainly to improved combustion efficiency and, in the case of Denmark, also to the heavy investments in wind power.

Transmission

Electricity is transmitted from power stations to consumers by a network of power lines. The network is normally classified into three levels, i.e. national grid, regional networks and local networks. The consumption and generation of electricity must be in balance at every instant, which is achieved by balance control. Every country has a system operator who is entrusted with the task of maintaining this balance and being responsible for the national grid.

The national grid comprises 220 kV and 400 kV lines and most of the links with neighbouring countries. The regional networks, which normally operate at voltages of 70–130 kV and, in certain cases, at 220 kV transmit electricity from the national grid to local networks and sometimes also to electricity users with high consumption, such as major industrial plants and local network utilities. From the local networks, normally at a maximum of 20 kV, electricity is transformed in the distribution area to the normal domestic voltage of 380/220 volt.

Sweden

Sweden has about 15 200 km of 220 kV and 400 kV transmission lines with stations. Svenska Kraftnät is responsible for the grid and has system responsibility. Around 150 transformer and switching stations are provided for linking the networks together. Owners of power stations or regional networks can connect their systems to the national grid and can use it for transmitting electricity. At the end of 2001, 29 companies were connected to the national grid. One third of these companies are regional network owners, and the remainder are power station owners.

Charges on the national grid

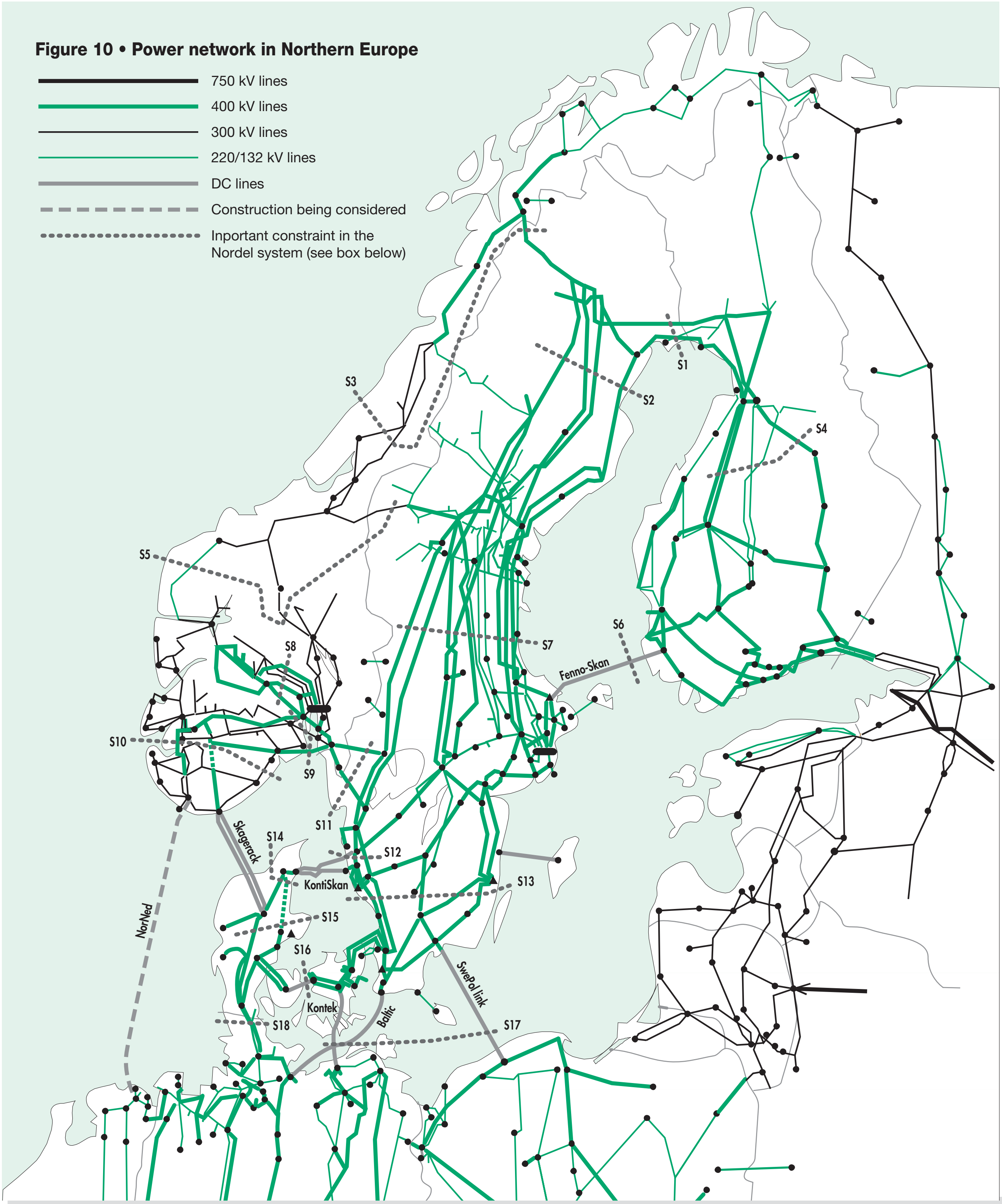
Svenska Kraftnät applies a spot tariff on the national grid. This means that a customer who is connected to the grid has access to the entire electricity market and can do business with any other player for the same network charge. This is an important condition for the open electricity market.

The dominating flow of power in the national grid is from the north to the south. The grid has largely been built to enable hydro power to be transmitted from the Norrland region in the north to central and southern Sweden, where the electricity consumption is high. To make the grid charge fair, it has been made dependent on the geographical location of the infeed and outtake. In northern Sweden, the charges for infeed of electricity into the national grid are high, since this increases the load on the national grid, whereas the outtake charges are low. The converse applies in southern Sweden. The average cost of transmitting electricity on the national grid is 1.2 öre/kWh.

An objective for the Nordic national grid companies is that the market conditions for the infeed of electricity on the Nordic national grids should be harmonized, so that competitively neutral rules can be safeguarded for the players. Svenska Kraftnät has therefore made amendments to its tariff.

The change lies in the relationship between the infeed and outtake charges on the Swedish national grid being changed from about 35/65 to around 25/75. The Swedish tariffs are thereby adjusted to the conditions in most European countries, where the infeed from electricity →

Figure 10 • Power network in Northern Europe



Important constraints in the Nordel system (numbered from north to south)

S1	RAC
S2	Sweden, constraint 1
S3	Nordland constraint
S4	Finland, constraint P1
S5	Trøndelag constraint
S6	RDC
S7	Sweden, constraint 2
S8	Hallingdal/Numedal constraint
S9	Flesaker constraint
S10	Sørland constraint
S11	Hasle constraint
S12	West Coast constraint
S13	Sweden, constraint 4
S14	Denmark, constraint A
S15	Denmark, constraint B
S16	
S17	
S18	

generators accounts for a smaller proportion of the national grid tariff.

The new tariff reduces the competitive disadvantages that the Swedish electricity generators have had in comparison with Finnish and Danish electricity generators. The change is also in line with the recommendation now in the course of being developed for the entire European electricity market.

Balancing service

The system responsibility of Svenska Kraftnät includes responsibility for maintaining the balance in the country between electricity generation and consumption. At the 2000/2001 turn of the year, Svenska Kraftnät had balance responsibility agreements with 36 companies in Sweden. These companies bear the responsibility for continuously planning for balance between infeed and outtake. This means that these balance provider companies accept economic responsibility for the Swedish electrical system being supplied, during every hour, with as much electricity as that consumed by the electricity users for whom they bear balancing responsibility. During 2001, twelve balance provider companies have given up their operations. Three new balance provider companies have come into the picture during the year.

Balance provider companies are responsible for sending consumption forecasts and generation plans per constraint region to Svenska Kraftnät. These plans are needed for planning the operation in the next 24-hour period. They must also report matters such as trading values, including trade with Nord Pool and foreign trade.

The unbalance that may still occur at the operating stage due to the balance providers being unable to achieve balance within their operating regions is corrected by the balancing service of Svenska Kraftnät during the actual operating hour, and this is known as balance control. The balancing service also ensures that sufficient reserves are available in the power system to cover disturbances. The reserves may consist, for example, of quick-starting gas turbines.

Balance control

The central control room at Svenska Kraftnät is manned around the clock in order to ensure that the grid frequency will always be maintained between the limit values of 49.9 and 50.1 Hz. Balance control takes place by primary regulation and secondary regulation. Primary regulation involves fine adjustment of the physical balance in the electrical system by the outputs of a number of hydro power stations being automatically increased or decreased. A Nordic agreement specifies the regulating power that every country must have available for primary regulation.

Secondary balance regulation is a manual procedure for raising or lowering a controlled load, and takes place in the form of power transactions between the balance providers who have concluded agreements with Svenska Kraftnät concerning participation in balance control.

Balance providers who are able to adjust their generation rate during the operating hour can submit bids to the Svenska Kraftnät balancing service for upward or downward regulation. The bids are submitted no later than 30 minutes before the beginning of the operating hour and specify the price (SEK/MWh) and the power (MW). When necessary, the balance engineer at Grid Control then places orders against the bids in price order.

Table 15 • Links with foreign countries in Northern Europe

	Trading capacity, MW	
Sweden–Norway	To Sweden	From Sweden
Northern Norway	1 400–1 550	900–1 550
Central Norway	450–680	450–680
Southern Norway	1 850	1 850
Sweden–Finland	To Sweden	From Sweden
Northern Finland	1 100–1 300	1 500
Southern Finland	550	500
Sweden–Denmark	To Sweden	From Sweden
Jutland	610	580
Zealand	1 650	1 350
Denmark–Norway	To Denmark	From Denmark
Jutland–Southern Norway	1 000	1 000
Norway-Finland	To Norway	From Norway
Northern Finland	100	70
Outside Nordic countries	To Nordic countries	From Nordic countries
Sweden–Germany	372–396	456
Sweden–Poland	200–400	600
Norway–Russia	50	50
Finland–Russia	1 050	60
Denmark–Germany	1 800	1 800

Note. The table differs from that in Electricity market 2001, in which the maximum transmission capacity was reported. This year, the approximate trading capacities for the cables are reported instead, i.e. the capacities available for the players on the market.
Source: Nordel Balancing group.

Table 16 • Consumption peaks

Dates	Consumption, MWh/h
1996-01-04	26 100
1996-02-07	26 300
1999-01-29	25 800
2000-01-24	26 000
2001-02-05	27 000
2002-01-02	25 800

Note. The figures are the gross electricity consumptions, i.e. including internal electricity consumption in the industry.
Source: Svenska Kraftnät.

Charges for balancing service

The energy for the Svenska Kraftnät trade in balancing power and regulating power is priced and settled with the relevant balance provider. Svenska Kraftnät levies a

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settlement charge for trade in contracted power[1] between balance provider companies in Sweden, and between balance providers and foreign players outside the spot market of the electricity exchange. The purpose of the balance settlement is to:

- Calculate the costs to every balance provider of unbalance between generation/purchase and consumption/sale
- Distribute the costs of the Svenska Kraftnät balance regulation between the balance providers who have contributed to the unbalance in the system.

The balance settlement also includes the preliminary profile settlement, whereas the final profile settlement takes place in a separate process.

Bottlenecks

The Swedish national grid was originally built with the aim of transmitting electricity generated by hydro power from the surplus areas in the north to the shortfall areas in the south. The connections from north to south have certain limitations known as "constraints". The most important bottleneck in Sweden today is in constraint 2 between northern and central Sweden, which limits the power that can be transmitted from northern to central Sweden to between 6700 and 7000 MW. After strengthening and other measures, the transmission capacity between central and southern Sweden has been raised to 4 000–4 500 MW. Another bottleneck is in constraint 4 between central and southern Sweden.

The link between southern Norway and Sweden (Hasle) is also an important bottleneck. When consumption in the Oslo region is high, the capacity on the link to Sweden is substantially reduced. During 2001, the capacity on this link has been increased by upgrading of the switchgear in Borgvik in Värmland County and by corresponding measures in Norway. As a result of these measures, the capacity has been increased by about 300 MW in both directions. Bottlenecks usually lead to different price areas arising. The most important bottlenecks in the Nordic countries are shown in Figure 10.

Bottlenecks in Sweden are handled by counter-purchases. If the transmission capacity of the national grid is insufficient for transmitting the electrical energy to meet the actual requirements of the customer, Svenska Kraftnät applies a counter-purchase. This reduces the physical energy flow on the grid, without the trade of customers being affected.

Other Nordic countries

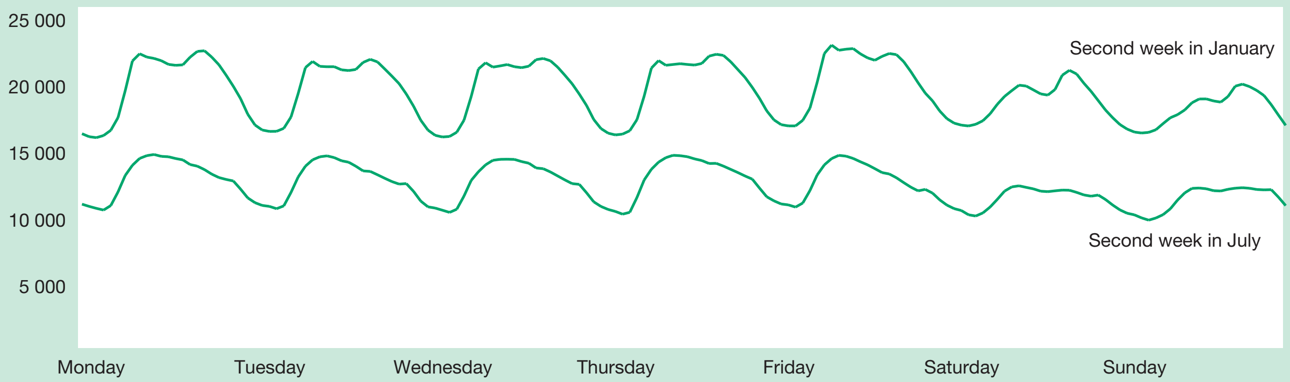
Figure 10 shows the national grids in northern Europe. The grid in Norway is owned mainly by Statnett, which has system responsibility. Around 20% of the grid is owned by other players. Statnett bears responsibility for the operation and expansion of the entire national grid, and is also responsible for the links with foreign countries. The balance between generation and consumption is handled by the regulating power market, which is run within Statnett.

In Finland, Fingrid bears system responsibility and owns the national grid in Finland, and also the links with foreign countries. Fingrid System Oy ensures that the electricity system in Finland performs well technically, and that reliability is maintained. They also manage balance control and settlement, and also monitor and plan the operation in the national grid. Every party on the electricity market is responsible for balance between electricity generation and electricity consumption being maintained at all times. Today, there are more than 30 balance provider companies. The conditions for the balance providers are regulated in agreements. After the electricity exchange has closed and up to two hours before the delivery time, scope is available for trading with balance power on the Elbas market. In the event of unbalance during the operating hour, Fingrid uses balance control.

Denmark has two national grid companies with system responsibility, namely Eltra which is responsible for the national grid in Jutland and Funen, and Elkraft which is the national grid company in Zealand. Just like other national grid companies, Eltra and Elkraft own the 400 kV grid and the links with Sweden and Germany. The transmission line systems of Eltra and Elkraft are not currently interconnected with one another.

[1] The term contract power means that power is predefined in volume before the delivery period begins and cannot be altered after the delivery period. As a result, the defined volume must be paid for regardless of whether or not it has been consumed. Trading on Nord Pool spot market is an example of contracted power delivery.

Figure 11 • Power demand during a summer week and a winter week of 2000, MW



Note: For industrial consumption, relates to the net consumption, i.e. excluding internal consumption.
Source: Svenska Kraftnät.

Remainder of Northern Europe

The Nordic electricity exchange region includes many transmission links between the member countries. In addition, there are links between the electricity exchange region and the neighbouring countries. The links for electricity trade in Northern Europe are shown in Table 15.

The transmission capacities given in Table 15 are the approximate trading capacities[2] of the cables, i.e. the capacities available for the players on the market. In addition, capacity is reserved for measures taken by the system operators. The power that can be transmitted at a given instant is dependent on a number of factors. In certain operating situations, the transmission capacity may be substantially restricted. The transmission capacity from Sweden to Zealand has been reduced from 1700 to 1350 MW as a result of the decommissioning of Barsebäck 1.

Additional limitations may be due to restrictions in the network capacity and/or the supply situation in the relevant area. If the load in the Oslo region is high, the capacity for transmission from southern Norway to Sweden will be substantially reduced. The links with Germany and Poland cannot be fully utilized at the present time due to limitations in both countries. The import capacity on the cable from Poland is restricted by the capacity of the Polish system.

[2] This is a change from the Electricity market 2001 report, in which the transmission capacity was reported.

Nord Pool publishes its forecast for the trading capacity on the various links hour by hour, i.e. the capacity available on the links to the players on the market. Trading capacities may vary widely between high-load and low-load periods. Certain limitations may be particularly serious just when the transmission capacity is needed most.

Whether or not power is available to purchase in a given situation is dependent on the availability of spare generation capacity in the surrounding world. An important factor that may determine the direction of the flows is the price relationship between the Nordic countries and Germany.

Planned links

In Denmark, a link is planned across the Great Belt in order to join together the network systems in eastern and western Denmark. The cable is scheduled for taking into operation before 2005, and the planned capacity is around 300 MW.

In the past, there were ambitious plans for cable links between Norway and the Continent, but these plans have been severely restricted. The Viking Cable project between Norway and the Continent has been abandoned. A 600 MW cable between Norway and Germany or the Netherlands is still being discussed. Statnett is prepared to meet 90 % of the investment costs, but no other players are currently interested. A concession application has been made for a DC North Sea Interconnector cable between Norway and Great Britain. The cable is expected to be taken into operation in 2006.

Power balance issues

In recent years, the instantaneous electricity consumption – the power demand – has reached new peaks as shown in Table 16. However, these high levels occur only during individual hours in very cold weather.

Before the electricity market reform, certain delivery criteria determined the generation capacity that was needed. Today, this capacity is guided instead by profitability considerations. Plants with high variable costs compete with less expensive peaking capacity in neighbouring countries, and the high-cost plants are therefore used increasingly rarely. These plants are then difficult to finance.

As a result, generators have taken out of service the gas turbines that are not included in the disturbance reserve and most of the oil-fired condensing power plants that previously served as a reserve for situations such as cold winter days. In addition, Barsebäck 1 has been decommissioned. In total, a substantial amount of capacity has been taken out of operation in southern and central Sweden. During consumption peaks, southern and northern Sweden are dependent on the supply of electricity both from northern Sweden and from neighbouring countries.

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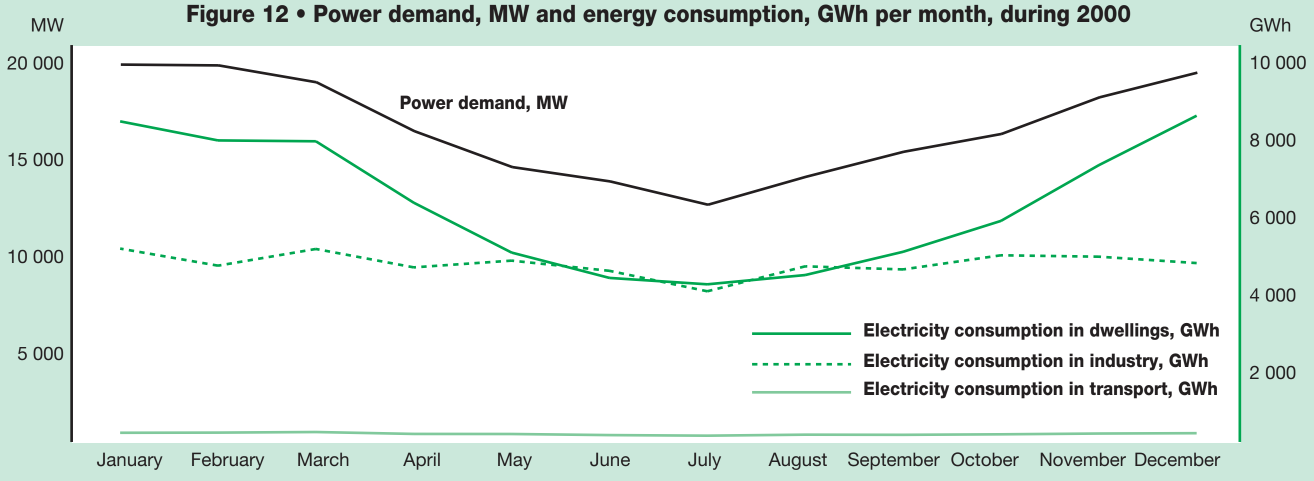
Figure 12 • Power demand, MW and energy consumption, GWh per month, during 2000



Note: For industrial consumption, relates to the net consumption, i.e. excluding internal consumption. Source: Svenska Kraftnät.

As a result, the power balance in southern and central Sweden has been weakened, which has led to growing concern for possible power shortages in southern and central Sweden.

Before the 2000/2001 winter, Svenska Kraftnät purchased a power reserve consisting of plants that had previously been decommissioned. A further procurement was subsequently made, which also included a reduction in consumption in a number of major industrial plants.

Power consumption

Electricity consumption varies between different hours of the day, between weekdays and holidays, and between different seasons of the year. This applies regardless of the more long-term variations related to business activity cycles and the relationships between oil and electricity prices.

The highest hourly value, which normally occurs during the morning hours of a winter day, is three times higher than the lowest hourly value. The latter usually occurs on a summer night. Temperature is the most important reason for the variation. The temperature in the winter may drop quickly, and additional power will then be needed at short notice. A rule of thumb is that a temperature drop of 1°C in the winter corresponds to a power demand increase of 400 MW. Changes in weather can generally be predicted, but the forecasts are uncertain as regards the time and place. Sudden temperature drops can thus give rise to high additional power demands at short notice.

Figure 11 shows the power demand in the second week of January and the second week of July 2000. During the winter 2000 week, the power consumption was somewhat higher than in 1997 and 1998.

Figure 12 shows the monthly power demand and the energy consumption by month and by sector in 2000. The figure also shows that the power curve follow the curves for electricity demands of dwellings and commercial premises.

The consumption peaks occur principally in cold weather, which is due to the high proportion of electrically heated houses in Sweden.

Over several years, older oil-fired boilers in single-family houses have gradually been replaced by heat pumps. Heat pumps are very energy-efficient at normal temperatures. However, they do not perform equally well at low temperatures, and the heat pump must therefore be supplemented with an electric heater element. This means that a less efficient heat source must be used during cold periods, which leads to a further increase in power consumption.

The highest peak power demand so far has been recorded on Monday 5 February 2001 at 8–9 am, and amounted 27 000 MW. Svenska Kraftnät had issued a power shortage warning the day before, with a special request that households should avoid using electricity-demanding equipment during the critical hours, which was largely observed. The high spot price (211.7 öre/kWh) served as an incentive to customers who are sensitive to the spot price to review their power demand during the critical hours. A number of industrial and district heating customers switched over from electric boilers to fuel oil. The demand of 27 000 MW was met by 25 700 MW of domestic generation, of which 772 MW was from the power reserve, and with 1300 MW of imported power.

The Svenska Kraftnät forecast for that Monday morning was that the demand would be 29 000 MW. The difference between the demand and forecast may have been due partly to the uncertainty in forecasting and partly to the compliance measures by the consumers. Due to the free electricity market, both of these uncertainty factors have increased.

A reason for the forecasting uncertainty is that electricity customers are not obliged to inform their suppliers of their planned load reductions. As a result, the supplier finds it difficult to assess before expected cold periods whether all of the forecast load will have to be covered. A further reason for the uncertainty of the supplier forecasts is that a very large proportion of customers, including temperature-sensitive customers in electrically heated houses, have profile metering. In addition, due to supplier changes, a supplier may have customers spread all over the country.

In the longer term, it will probably be possible to meet parts of the power demand by measures on the consumer side. However, in the foreseeable future, most of that demand will have to be met by reserve generation capacity and/or by imports.

The fundamental problem related to power reserves is that the highest power demands occur very seldom, and the reserve capacity may thereby be needed perhaps for only a few hours a year. How should this type of reserve be financed? To what extent can we rely on the loads in different countries evening each other out when the electricity market is integrated? How do bottlenecks between countries and regions affect the scope available for quickly changing the flows?

Power reserves

In Sweden, a distinction is made between reserves in the form of regulation power, disturbance reserves and high-load capacity. High-load capacity refers to the resources needed in generation and consumption for physically managing the power balance in very cold weather, given that the disturbance reserve or other emergency measures for the safety of the power system must not be used for commercial power deliveries.

The generation reserves previously available in Sweden in readiness for shortage situation have been gradually reduced.

Before the winter of 2000/2001, Svenska Kraftnät considered that the power balance in southern Sweden was worryingly weak. During the period between 1996 and 1999, a generation capacity of around 2500 MW, which corresponds to 10 % of the maximum load on a normal winter day, was taken out of operation because the costs of keeping these plants in a state of readiness could not be met. The capacity lost by the decommissioning of Barsebäck 1 and the future decommissioning of Barsebäck 2 is expected to be largely made up by imports. A significant part of the import capacity will then be employed for continuous imports and will thus be unavailable for meeting suddenly occurring demands. Against this background, a temporary solution has been adopted for the winters of 2000/2001 and 2002/2003. The solution lies in Svenska Kraftnät procuring about 1 000 MW of the shut-down plants to serve as power reserve. The fixed cost of keeping this reserve in a state of readiness is paid by the balance providers in accordance with an addendum to the balance agreement. The agreements also regulate how the plants will be made available to Svenska Kraftnät and to the plant owners. In November 2001, Svenska Kraftnät was entrusted with the task of short-term strengthening of the power balance for the winters of 2001/2002 and 2002/2003 by 400–600 MW, and of drawing up a system, in consultation with the Swedish Energy Agency and representatives of the industry, for safeguarding the power balance in the short term and in the long term. The system should contain clear incentives for increased flexibility on the user side. About 500 MW were procured before the winter of 2001/2002 within the framework of this assignment, of which 130 MW consists of preparedness for reducing the consumption in industry. The fixed costs for this reserve are paid by the State by reduced yield requirements on Svenska Kraftnät.

The assignment from the Government was preceded by a study arranged by Svenska Kraftnät during 2001, which serves as a base for the work. The results show that, in power shortage situations, the pricing on the electricity market for physical trading, principally on Nord Pool Elspot, is uncertain. Greater price sensitivity on the consumer side is therefore of major importance for stabilizing the pricing at reasonable levels and for reducing the risk of Nord Pool having to set quotas for buy bids due to a shortage of sell bids.

Measures for restricting the instantaneous electricity consumption (power consumption) are established only to a very small extent on today's electricity market. In fact, earlier projects and customer-oriented programmes with this orientation were discontinued due to the lack of clear incentives after the electricity market reform. It is therefore obvious that the effectiveness of such measures must be assessed against the costs in order to maintain the capacity on the generation side.

Various Nordic solutions

The Nordic countries have so far solved the power problems in different ways. The solution chosen by Norway differs from that in Sweden. Before the latest winters, Statnett has procured power reserves in the form of hydro power and load reductions in industry. The experience gained is favourable and the concept is gradually being developed. In Finland, Fingrid has purchased gas turbines. In addition, for preparedness reasons, capacity has been purchased in a coal-fired condensing power plant that was threatened with closure. In Denmark, reserve capacity is still available in coal-fired condensing power stations.

A study is in progress in the Nordic Council of Ministers with the aim of finding common solutions to the power problem on the Nordic electricity market. ■

The market

The electricity market is open to competition, and a large proportion of the price is controlled by supply and demand. Other factors that govern the price are different regulatory instruments, such as taxes, grants and certificates. The price that the customers pay consists of the price of electrical energy, network charges and taxes. The price of electrical energy can be influenced by the choice of electricity supplier. Nord Pool is a common marketplace for trading between the Nordic countries. The prices on Nord Pool can be used as reference on the increasingly integrated electricity market.

Electricity prices and network charges

The total electricity price varies between different customer categories, between urban and rural areas, and between individual Nordic countries. This is due to varying distribution costs, differences in taxation, subsidies, state regulations and the structure of the electricity market.

The total price of electricity charged to the customer consists of:

- price of electrical energy
- a network tariff – price of the network service, i.e. for the transmission of electricity
- taxes – energy tax and VAT.

On 1 January 2002, the price of electrical energy was 34 %, the network tariff accounted for 24 %, and taxes for 42 % of the total price of electricity to a customer with an electrically heated single-family house. So it is about one third of the total electricity price that can be influenced by active choice of electricity supplier or by agreement. The price of electricity and the network charges are described in this chapter. For further information on taxes, see the chapter entitled Regulatory instruments.

The electricity market

On a reformed electricity market, electricity is bought and sold in competition. Once the customer is connected to the network, he is free to buy electricity on the market and to choose a suitable supplier. Supply and demand thus determine the market price. Trading takes place either through the electricity exchange or through bilateral contracts between two parties.

The Nordic electricity market has been opened in stages to small electricity customers. In Norway, domestic customers gained the opportunity to change their electricity supplier free of charge when profile settlement of consumption was introduced in 1995. A similar change was introduced in Finland in November 1998, and the demand for hourly metering was abolished in Sweden in November 1999. The electricity market will be opened to Danish domestic customers in 2003.

Although the demand for hourly metering was abolished in Finland, the delivery obligation system remains. Delivery obligation covers customers who have not changed their electricity supplier and places the obligation on electricity trading companies to sell electrical energy to these customers. The rules in delivery obligation are different from those in competition. It is specified by law that the price of electrical energy shall be reasonable and that the electricity seller shall have a published price list of the electricity tariffs.

Spot and forward markets

Nord Pool electricity exchange is an organized marketplace for trading in electricity. A benefit of trading on the exchange is that the transaction costs are lower than those for bilateral trade agreements. Just under 30 % of all electricity trade in Nord Pool region now takes place through the electricity exchange.

On Nord Pool exchange, electricity is traded on the spot market and the forward market. The spot market serves as a reference for Nord Pool forward market and for the remainder of the electricity market. Since 1 March 1999, electricity is also traded on the EL-EX balance adjustment market the hours when the electricity exchange has closed.

The *spot market* is Nord Pool market for physical deliveries of electrical power. On this market, the players trade in hourly contracts for delivery in the next 24-hour period. Before 1200 hours, the players send in their bids for all hours of the next 24-hour period. Buyers state how much electricity they want to purchase hour by hour and what they are prepared to pay for it. The sellers submit corresponding selling bids. The bids of the players are compiled into a supply curve (sales) and a demand curve (purchasing). The price is determined as an equilibrium price at the point of intersection of the supply and demand curves.

In the event of network limitations, known as bottlenecks, the bidders must specify the part of the system in which electricity is to be purchased or sold, which is known as the notification area. Sweden and Finland each represents one notification area, since bottlenecks in the respective country are handled by counter-purchases. Norway has several notification areas, since bottlenecks are handled by price areas and capacity charges. Denmark has two notification areas. The price mechanism is used for regulating the flow of power in situations in which there are capacity limitations in the network. If the power flow between two areas should exceed the capacity, the price is reduced in the surplus area and is increased in the shortfall area until the transmission requirement has been reduced to the capacity limit. The spot market can therefore be regarded as a combined energy and capacity market.

There are different prices depending on the pattern of power flow. The *system price* is calculated without taking into account any transmission limitations. If price calculations show that the power flow between two or more notification areas exceeds the capacity limit, two or more *area prices* will be calculated. The difference between the system and area prices is the capacity price in each area. If the transmission capacity between notification areas is not exceeded, there will be only one price area. In this case, the area price will be equal to the system price, and the capacity price will be zero.

The *forward market* is purely a financial market without physical deliveries and represents an organized market for price assurance and risk management. The players on the forward market can use financial contracts to assure the prices of buying and selling power up to four years ahead in time. The results for the buyer will be a gain or a loss on the price difference between the price on the exchange at the delivery date and the price at the buying date. The system price on the spot market serves as the underlying reference for forward prices.

Exchange prices

The first year of the reformed electricity market in Sweden was a dry year, and the system price therefore rose right up to the end of the year. The average system price in 1996 was 26.6 öre/kWh, and the price then dropped substantially right up to the end of the year 2000. In 1997, the average price was 14.6 öre/kWh, in 1998 it was 12.3 öre/kWh, in 1999 it was 11.8 öre/kWh, and in 2000 it was 10.8 öre/kWh. The drop was mainly due to the abundant precipitation during those years, and also due to the keener competition on the common electricity market. The most notable feature during 2000 was that the Swedish area price differed from the system price more than it did previously. Throughout the year 2000, the area price in Sweden was higher than the system price. An explanation for this is that Swedish electricity generators reduced the production in the nuclear power stations.

This trend was reversed during 2001, and the system price rose appreciably. The average price in 2001 was 21.3 öre/kWh. The highest average monthly system prices were in February and April,

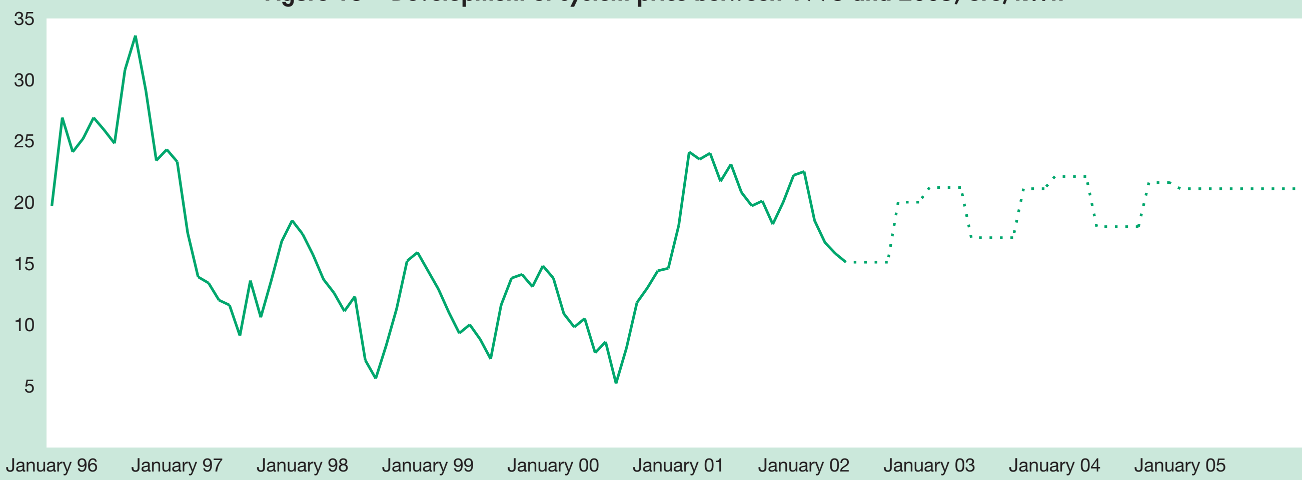
→

Table 17 • Developments in the prices of electrical energy, excluding taxes, to different customer categories, between 1 July 1996 and 1 January 2001, mean values, öre/kWh

	1/7 1996	1/1 1997	1/1 1998	1/1 1999	1/1 2000	1/1 2001	1/1 2002
Apartments	28.2	29.2	29.0	27.1	25.8	27.0	35.6
Single-family dwelling without electric heating	26.7	27.6	26.8	26.3	23.4	24.2	31.6
Single-family dwelling with electric heating	24.7	25.9	25.1	24.4	21.8	22.5	29.6
Agricultural and forestry	23.7	24.9	24.1	23.1	21.4	22.1	29.3
Commercial operations	-	25.8	24.5	23.3	21.0	22.1	28.8
Small industry plant	24.0	25.6	24.1	22.8	20.4	22.0	28.5
Medium-sized industrial plant	22.3	24.4	23.1	21.6	19.6	21.7	28.3
Electricity-intensive industrial plant	22.0	23.7	22.7	22.5	19.7	22.6	28.3
Large electrcity-intensive industrial plant	-	23.4	22.0	22.0	19.2	22.7	28.3

Note: The price statistics for the year 2000 differ from the particulars for earlier years. The latter apply under a delivery consession. As from the year 2000, electricity prices are given for normal price agreements, i.e. agreements until further notice. See the consumption profiles of various customer categories in the fact box.
Source: Statistics Sweden EN 17.

Figure 13 • Development of system price between 1996 and 2005, öre/kWh



Note: The dashed curve shows the forward prices on 30 April 2002. Source: Nord Pool.

Table 18 • Network charges on 1 January 1997 and 1 January 2002, öre per kWh, and percentage changes

	Upper quartile			Median			Lower quartile		
	1997	2002	%	1997	2002	%	1997	2002	%
Apartment	47.2	48.5	3	41.3	42.4	3	33.1	35.1	6
Single-family dwelling without electric heating	42.0	42.9	2	36.0	37.5	4	29.7	31.9	7
Single-family dwelling with electric heating	24.6	23.4	-5	21.3	21.0	-1	18.6	18.8	1
Agriculture and forestry	26.4	24.8	-6	22.2	22.1	0	19.3	18.8	-3
Commercial operations	17.6	17.7	1	15.4	15.3	-1	13.2	13.5	2
Small industrial plant	18.6	17.4	-6	16.7	15.2	-9	14.2	13.0	-8
Medium-sized industrial plant	10.6	10.7	1	9.3	9.5	2	8.0	8.2	3
Electricity-intensive industrial plant	6.9	7.0	1	5.4	5.7	6	4.3	4.5	5

Source: Statistics Sweden EN 17.

Table 19 • Electricity price to industrial and domestic customers in the Nordic countries in 2000 and 2001, including taxes and VAT[1], öre/kWh

	Norway				Sweden			
	2000		2001		2000		2001	
	1/1	1/7	1/1	1/7	1/1	1/7	1/1	1/7
Small industrial plant[2]	35.5	31.5	35.8	43.9	39.4	38.0	33.0	39.0
Medium-sized industrial plant[3]	26.1	23.3	26.3	32.4	27.5	28.1	24.1	30.8
Large industrial plant[4]	19.5	16.7	19.5	25.2	23.1	24.2	20.7	27.8
Domestic customer, 3 500 kWh	87.5	78.8	101.6	117.2	87.7	82.9	91.6	100.7
Domestic customer, 20 000 kWh	53.8	46.2	65.1	77.0	72.7	72.2	74.8	84.2

	Finland				Denmark			
	2000		2001		2000		2001	
	1/1	1/7	1/1	1/7	1/1	1/7	1/1	1/7
Small industrial plant[2]	40.5	39.5	41.5	43.5	49.0	47.4	-	58.4
Medium-sized industrial plant[3]	35.6	34.8	36.5	38.6	-	-	-	-
Large industrial plant[4]	25.5	25.2	26.3	27.9	-	-	-	-
Domestic customer, 3 500 kWh	74.8	73.3	76.7	82.5	154.8	164.9	183.7	193.8
Domestic customer, 20 000 kWh	46.3	45.3	47.5	50.6	132.3	139.6	158.1	167.5

Note: Bank of Sweden foreign exchange rates for that particular date were used.
1 The prices to industrial customers are given without VAT.
2 1.25 GWh annually, 0.5 MW, 2 500 hours.
3 10 GWh annually, 2.5 MW, 4 000 hours.
4 70 GWh annually, 10 MW, 7 000 hours.
Source: Eurostat, Statistics in Focus.

when they rose to more than 24 öre/kWh. During June, the price was 21 öre/kWh, in July it was 23 öre/kWh and during the autumn, around 20 öre/kWh. The main reason for the price increase was that the inflow of water was lower than normal in Norway in the early part of the year. This created a higher demand for imported electricity to Norway, and some apprehension that the year would be dry.

During the period between January and April 2002, the average system price was 18.4 öre/kWh. In the corresponding period of 2001, the system price was 22.5 öre/kWh. As a result, the forward prices also fell. For the year 2003, the average price was 19.6 öre/kWh (according to the figures on 30 April 2002). Figure 13 shows an overview of the development of the exchange price since 1997, and the forward prices on 30 April 2002.

Price of electricity to the end customer in Sweden

While the exchange prices vary widely over the year and from year to year, consumer prices have remained more stable. Due to the increased competition, electricity trading companies have been obliged to adjust their prices. As a result, the electricity trading prices have been dropping steadily since 1996. The trend was broken at the beginning of 2001, and prices began to rise as a consequence of developments on the spot market.

On 1 January 2002, the price of electricity for customers living in apartments was an average of 32 % higher in current monetary value than on the corresponding date of 2001. The price to customers living in single-family houses without electric heating increased by 31 %, and to customers with electric heating by an average of 32 %. The price to bigger customers such as industrial plants and agri-

FACTS

Apartment	2 MWh/year, 16 A meter fuse rating	
Single-family dwelling without electric heating	5 MWh/year, 16 A meter fuse rating	
Single-family dwelling with electric heating	20 MWh/year, 20 A meter fuse rating	
Agriculture and forestry	30 MWh/year, 35 A meter fuse rating	
Commercial operations	100 MWh/year, 50 A meter fuse rating	
Small industrial plant	350 MWh/year, 100 kW power demand or 160 A fuse	
Medium-sized industrial plant	5000 MWh/year, 1 MW power demand	
Electricity-intensive industrial plant 140 GWh/year,	20 MW power demand	
Large electricity-intensive industrial plant 130 kV,	500 GWh/year, 66 MW power demand.	

The median is the value of the variable for the middle company when the companies are arranged in the order of magnitude of the variable. Half the companies have a value that is lower than the median, and half have a value that is higher than the median. In a corresponding manner, 25 % of the companies have a value that is lower than the *lower quartile*, and 25 % have a value that is higher than *upper quartile*.

culture also increased. Table 17 shows the prices to customers with normal price agreements, i.e. agreements until further notice for the years 2000–2002.

Table 20 • Network charges, number of subscribers and number of network companies in the Nordic countries on 1 January 2002

	Norway	Sweden	Finland	Denmark
Network charges (öre/kWh)	22.6	21.0	29.3	21.7
Number of subscribers, million (2001)	2.0	5.2	2.9	3.0
Number of network companies	177	200*	100*	140*

*Note: Bank of Sweden foreign exchange rates on 2 January 2002 were used. * approxi.*
Source: Norwegian Water Resources and Energy Directorate (NVE) at www.nve.no, Finnish Electrical Energy Association Adato Energia OY at www.energia.fi, Danish Energy Association at www.danskenergi.dk.

Network tariffs in Sweden

The term network tariff denotes the charges and other conditions for the transmission of electricity and for making the connection to a power line or a power line network. Payment of the network charge entitles a player to access the whole of the transmission system, and enables him to buy and sell electricity throughout the electricity market area. To customers who buy electricity from a local network, the regional and grid charges are included.

The network tariffs are published and are supervised by the Swedish Energy Agency. The network tariffs must be reasonable and must be set on objective and non-discriminatory grounds. Customers may be classified into groups according to cost pattern, e.g. customers with electric heating or with a time tariff. On the other hand, customers in the same customer category must be charged the same network tariff. When the reasonableness of a network tariff is assessed, special consideration must be given to the interest of the consumers in low and stable prices. Moreover, consideration must be given to justifiable demands of the owners for a reasonable yield from their network operations. The tariffs must be correctly costed and must be based on costs that are related to the network operations. However, the tariffs must not be set differently depending on where in an area the customer is located. The Electricity Act does not specify whether the tariffs should consist of a fixed part and a variable part. In recent years, several of the network companies have modified their tariffs so that the fixed charge is the larger part of the total tariff.

In the spring of 2002, Swedish Parliament decided on certain changes to the Electricity Act. One of the changes is in the criteria for reasonable network tariff. According to the new provisions, the assessment of reasonableness shall be made on the basis of the performance of the network concessionaire. Performance shall be assessed on the basis of the objective conditions of running network operations in the relevant area, and on the way that the network concessionaire runs the network operations. The new regulations will come into force on 1 July 2002.

In its work of developing further the Swedish overall control model, the Swedish Energy Agency is in the course of developing a model – the electricity network utility model – for assessing the network tariffs. In the model, the reasonableness of the tariffs is based on the performance of the network companies in accordance with the new definition of reasonableness in the Electricity Act. This is considered to be a more effective instrument that is better adapted to the market for regulating the network tariffs than the present method. The new model is expected to be taken into use during 2003.

The way the network charges for domestic customers have developed between 1997 and 2002 is shown in Table 18. Between 1997 and 2002, the median for the network charge has increased by 3 % to customers in apartments and by 4 % to customers in single-family houses without electric heating. During the same pe- →

Table 21 • Electricity taxes at consumer level in Sweden, öre/kWh

	1996 01-Jan.	01-Sept.	1997 01-Jan.	01-July	1998 01-Jan.	1999 01-Jan.	2000 01-Jan.	2001 01-Jan.	2002 01-Jan.
Northern Sweden									
Electricity, gas, heat and water suppliers	4.3	5.3	7.4	8.2	9.6	9.5	10.6	12.5	14.0
Industrial operations	0	0	0	0	0	0	0	0	0
Other users	4.3	5.3	7.4	8.2	9.6	9.5	10.6	12.5	14.0
Remainder of Sweden									
Electricity, gas, heat and water suppliers	7.5	9.1	10.7	11.5	12.9	12.8	13.9	15.8	17.4
Industrial operations	0	0	0	0	0	0	0	0	0
Other users	9.7	11.3	13.8	13.8	15.2	15.1	16.2	18.1	19.8

Source: Tax authorities.

riod, the charge for the category of customers living in single-family houses with electric heating has decreased by 1 %. The tariffs for the agricultural customer category have remained unchanged during the period. The biggest change and reduction in the tariff level has taken place in the category of small industrial plant customers. Since 1997, their tariff level has dropped by 9 %.

Supervision has been focused on the increases that certain network utilities have made on the network tariffs for the years 1999 and 2000. Whenever the companies were unable to justify acceptably the need for raising the network charges, the Swedish Energy Agency has directed the companies to lower their charges. In total, if and when the decisions become legally binding, this means that electricity subscribers will be entitled to refunds amounting to SEK 255 million. During 2001, supervision has been focused on the companies that have made further increases, and on companies that have not made any increases in the past but have now raised their tariffs.

Electricity prices in other Nordic countries

Electricity prices to domestic and industrial customers in the Nordic countries are shown in Table 19.

Denmark has the highest electricity prices to all customer categories. Danish domestic customers pay up to three times higher electricity prices than other Nordic domestic customers. This is due to the high taxes on electricity consumption payable by domestic customers. The electricity prices to industrial customers are lowest in Sweden and Norway, whereas the prices to domestic customers are lowest in Finland. However, the prices in Sweden, Norway and Finland are relatively similar.

Table 22 • Electricity taxes in the Nordic countries on 1 January 2002, öre/kWh

	Denmark	Finland	Norway	Sweden
Households	57.1[1]	6.4	10.7	19.8
Industry	0[2]	3.9	0	0
VAT, percent	25	22	24	25

Note: Bank of Sweden foreign exchange rate on 1 January 2002 were used.

[1] The tax is applicable to electrically heated dwellings with an annual consumption of more than 4 000 kWh. Other electricity consumption is taxed at the rate of 65.2 öre/kWh. A carbon dioxide charge is also payable at the rate of 12,4 öre/kWh.

[2] A carbon dioxide charge is payable by industry. The charge is lower if an agreement has been concluded concerning carbon dioxide restriction measures. For energy-intensive processes, the charge is between 0.4 and 3.1 öre/kWh, and for energy-lean processes, it is between 8.4 and 11.2 öre/kWh.

Network tariffs in other Nordic countries

Supervision of the network monopoly and the regulatory system does not differ significantly between the Nordic countries, except in Denmark. In Norway, the Norwegian Water Resources and Energy Directorate (NVE) handles the supervision. In Finland, the Energy Market Authority is a special supervisory authority formed for this purpose. On 1 January 2000, Denmark has also set up the Energy Supervisory Board to supervise the network operations. The task of the supervisory authority is to ensure that the network utilities run their operations in such a manner that the cost effectiveness interests of the customers are met. The authorities must also ensure that the tariffs are reasonable and objectively set. In Sweden, Norway and Finland, the network tariffs for the whole country are published at regular intervals.

The network tariffs for customers living in apartments are much lower in Finland than they are in Sweden. On the other hand, the network tariffs for the categories of commercial operations/agriculture and small industrial plants are appreciably higher in Finland. The network tariffs for the various customer categories in Norway are basically on a level with those in Sweden. However, an average for the various countries shows that the network charges are lowest in Sweden (see Table 20).

Economic instruments

Today's economic instruments in the field of energy have several objectives. They are intended to produce revenue for the

State, stimulate the use of renewable energy, restrict emissions, give the incentive for energy efficiency improvements, and curb the demand for energy. The economic instruments must have reasonable conditions that take into account the international competitive situation in certain industries.

The economic instruments that affect developments on the electricity market are taxes on the generation and consumption of electricity, and support for various electricity generation methods. New instruments, such as trade in certificates, are the subject of lively discussion today.

Taxes

All Nordic countries levy taxes on electricity at consumer level. The taxes are differentiated for domestic and industrial customers. Industry pays low taxes or, as in Norway and Sweden, no taxes at all. Electricity at the generation stage is taxed in Norway and Sweden.

Sweden

In the spring of 2000, Swedish Parliament decided to implement a green fiscal reform on a total of around SEK 30 billion over a ten-year period. Tax exchange continued during 2002 and covers SEK 2 billion in higher taxes on energy, which is balanced by lower taxes on labour. The carbon dioxide tax was raised, which makes electricity less expensive in relation to other energy. The electricity tax to domestic customers was therefore also raised by 1.7 öre to 19.8 öre/kWh in southern Sweden, and the increase in northern Sweden[3] was 1.5 öre to 14.0 öre/kWh.

In the consumption of electricity, tax is payable at the rate shown in Table 22. Since November 1998, electricity consumption for electric boiler plants with an installed power in excess of 2 MW has been taxed during the winter season (1/11–31/3). The tax rate is 16.4 öre/kWh in northern Sweden and 19.8 öre/kWh in the remainder of Sweden. Since 1994, the electricity tax has been adjusted annually in line with the consumer price index. VAT on electrical energy is 25 % and is charged on the electricity price, including energy tax. The manufacturing industry, the mining industry and commercial greenhouse operators have been exempted from electricity tax since 1994. As from 1 July 2000, agriculture, forestry and aquaculture have also been exempt from electricity tax.

All fuels used for electricity generation are currently exempt from energy and carbon dioxide taxes. However, part of the fuel, namely 5 % in condensing power generation and 3 % in CHP generation, is considered to be for in-house consumption and is taxed. In addition, fuels used for electricity generation are subject to nitrogen oxide charges and, if applicable, to sulphur tax.

Nitrogen oxide emissions are subject to an environmental charge amounting to SEK 40 per kg of nitrogen oxides from boilers, gas turbines and stationary combustion plants. The nitrogen oxide charge is levied on plants with an annual energy output of at 25 GWh. The charge is neutral to State finances. The funds collected are returned to plants that have the lowest emissions in relation to their own energy generation, whereas plants with the highest emissions are net contributors.

The sulphur tax levied on coal and peat amounts to SEK 30 per kg of sulphur emission. For liquid fuels, the tax is SEK 27 per cubic metre for every tenth of one percent by weight of sulphur content in the oil. From 1 January 2002, the limit for sulphur tax on liquid fuels was lowered from 0.1 percent by weight to 0.05 percent. If the sulphur content exceeds 0.05 percent by weight but not 0.2 percent, the value is rounded off upwards to 0.2 percent.

Half the energy tax and also the carbon dioxide and sulphur taxes are payable for the fuels used in heat generation in CHP plants.

Since 1 July 2000, generation in nuclear power plants is subject to a power tax on the thermal power of the reactor, at a rate amounting to 5514 SEK/MW per month. In the past, the nuclear power tax was calculated on the basis of the electricity generated[4]. In addition, 0.15 öre/kWh is levied in accordance with the "Studsvik Act", and an average of 1.0 öre/kWh in accordance with the law on financing future expenditure for spent nuclear fuel. From 1 January 1996, all electricity generation plants have been paying a property tax amounting 0.5 % of the taxable value.

Denmark

Taxes payable by the domestic customers are particularly high in Denmark, as shown in Table 22. These consist of carbon dioxide tax and electricity tax. Taxes at several different levels are payable by industrial customers. The electricity tax is zero, but companies pay a carbon dioxide tax on the electricity they use. Taxes are differentiated depending on whether or not the plant is energy intensive. In addition, certain industrial plants have concluded agreements concerning carbon dioxide limiting measures and, in return, pay reduced carbon dioxide charges. Since the year 2000, a sulphur dioxide tax has been levied on electricity generation. This amounts to 23 DKK/kg of the sulphur emitted.

Finland

Finland has only two spot taxes for electricity. One of these relates to electricity consumption in industry, while the second relates to all other consumption. In addition, a supply preparedness charge is levied at consumer level. Electricity generation and the in-house consumption of power stations are not taxed.

Norway

Electricity tax is payable at consumer level. However, industry and commercial greenhouse operators are exempt from electricity tax. Electricity generation in Norway is dominated by hydro power. A natural resource tax is levied at production level, and this is transferred to hydro power municipalities and counties. In addition, an investment tax of 7 % is payable, but this will be abolished in October 2002. Certain investments, such as for wind power, bioenergy and district heating have already been exempt from investment tax. From 1 January 2001, exemption was also extended to hydro power plants.

Subsidies

The Nordic countries and the EU have an expressed policy of supporting expansion of power generation based on renewable →

[3] The lower tax applies in all municipalities in Norrbotten, Västerbotten and Jämtland Counties and the municipalities of Sollefteå, Ånge, Örnsköldsvik, Ljusdal, Torsby, Malung, Mora, Orsa and Älvdalen.

[4] Under certain operating conditions, the electricity tax corresponds to the earlier tax of 2.7 öre/kWh.

energy sources. For generators of such electricity to survive on the market, support is in certain cases needed. The support measures are designed in different ways in individual countries and currently vary between different technologies. The State subsidies for electricity from renewable energy sources are being reviewed in several countries.

Sweden
Investments in biofuel-fired CHP are entitled to state grants at the rate of 3000 SEK/kW installed, although not exceeding 25% of the investment cost. Grants are awarded to investment that provide an addition to the power generation capacity. Ten plants with a total rating of 164 MW and an estimated annual production capacity of 0.88 TWh have been awarded grants. The plants are being taken into operation successively from the year 2000, and all of the plants are expected to be in operation by 2003.

A special grant of 9 öre/kWh is payable to electricity generators in all types of plants with a rating below 1500 kW.

The support for investments in wind turbines rated at more than 200 kW and hydro power stations rated between 100 and 1500 kW has been amended from 15 % to 10 % of the approved investment cost. Operation of wind power plants is supported by a reduction of 18.1 öre/kWh equivalent to the current electricity tax. The sum payable for 2002 is the same as that for 2001.

The make-up of the State support for electricity generation from renewable energy sources will be altered and will be replaced by an electricity certificate system on 1 January 2003.

Denmark
Danish Parliament has decided to introduce a system of trading in certificates known as VE certificates. In the long term, the system is intended to replace the support for electricity generated from renewable energy sources. A transitional arrangement is now in force, whereby the financing of the earlier major State grants is transferred to the electricity users. The support for renewable energy sources consists of a fixed price that is guaranteed for 10 years for plants built before 2003, and an electricity generation supplement. In addition, there is an investment grant for the development and demonstration of renewable energy sources.

The Danish government that took over in the autumn of 2001 has concluded a number of political agreements during the spring of 2002 and has decided on a number of changes that concern the financing of energy generation and consumption. The changes have both short-term, direct effects and those that are of a more long-term nature.

Figure 14 • Electricity imports into Sweden in 2000 and 2001, GWh per week

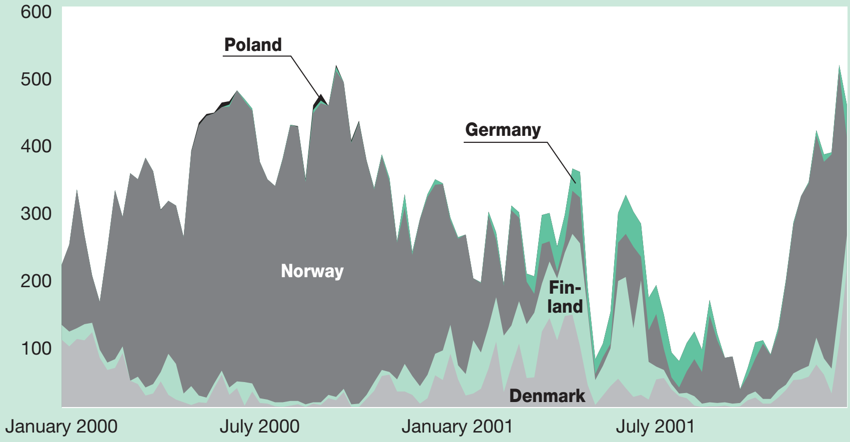


Figure 15 • Electricity exports from Sweden in 2000 and 2001, GWh per week

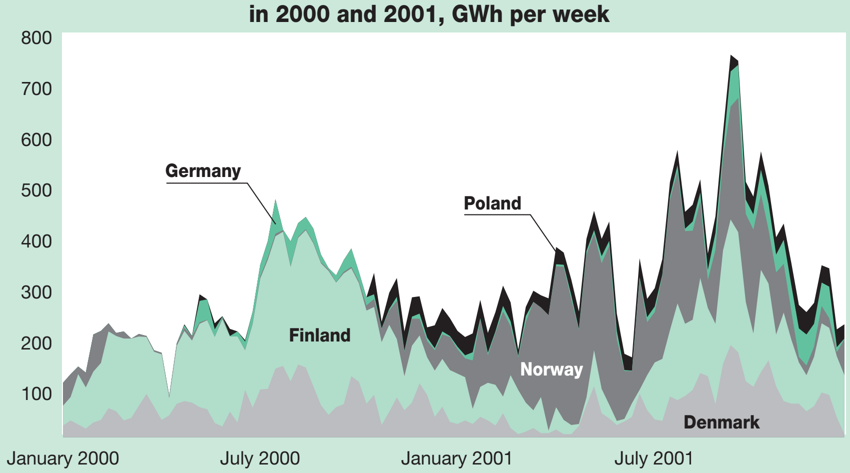
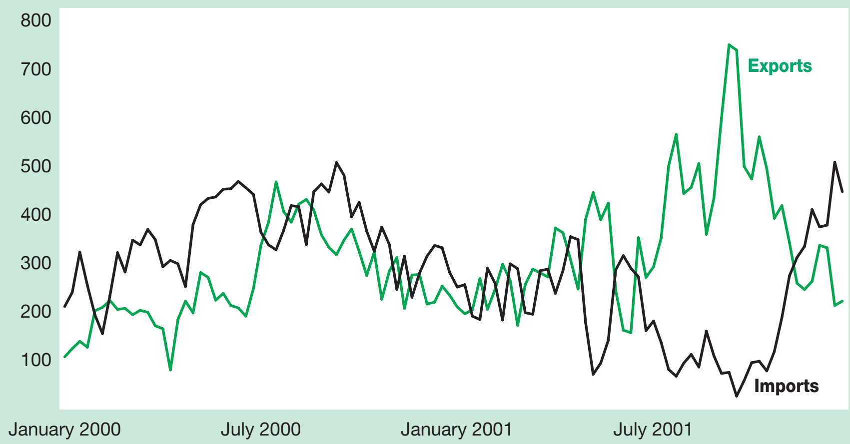


Figure 16 • Sweden´s electricity trade with foreign countries in 2000 and 2001, GWh per week



Source: Compilation of information from Swedenergy.

Norway

In Norway, wind power is subsidized by means of an investment grant and an operation grant. The operation grant corresponds to half of the Norwegian electricity tax, and investment grants are awarded to wind power farms with a total installed rating of more than 1 500 kW and in which every unit has a rating of at least 500 kW. The investment grant amounts to 25 % of the approved investment cost up to 8 000 NOK/kW.

Finland

An investment support system is operative in Finland for development and investment projects that promote the use of renewable energy sources, etc. Grants of up to 50 % of the approved investment sum are allowed for such investments, depending on the nature of the investment. In addition, a minor amount of generation support is allowed for electricity generated in small hydro power plants, smaller wood-fired or peat-fired CHP plants, and power stations fired with wood-based fuels or waste gas from metallurgical processes. Wind power plants receive higher generation grants that are equivalent to the electricity tax. The lower support in 2002 is 0.42 cent/kWh and the higher support is 0.69 cent/kWh.

The EU

The Council and the Parliament decided jointly in September 2001 on the Directive that promotes electricity generated from renewable energy sources on the single market for electricity. The Directive is intended to stimulate an increase in the contribution by renewable energy sources to electricity generation. In the document, the Council and the Parliament set up national guideline objectives for developing the use of such electricity in member countries. The Directive does not specify any binding measures but directs that, no later than the autumn of 2005, the Commission shall evaluate the development. If the development does not progress in the desired direction, the Commission may suggest binding measures aimed at the attainment of the indicative objectives.

Other items in the Directive deal with the guarantee of origin of electricity, access to markets for electricity from renewable energy sources, issues related to the calculation of the costs of access to networks, and also administrative procedures and how reporting is to take place.

Table 23 • Sweden´s foreign trade in electricity between 1990–2001, TWh

		Denmark	Finland	Norway	Germany	Poland	Total
1990	imports	0.2	0.4	12.3	-	-	12.9
	exports	7.9	6.4	0.4	-	-	14.7
	imports-exports	*-7.7*	*-6.0*	*11.9*	-	-	*-1.8*
1991	imports	0.8	0.7	4.7	-	-	6.2
	exports	1.8	2.7	3.1	-	-	7.5
	imports-exports	*-1.0*	*-2.0*	*1.7*	-	-	*-1.3*
1992	imports	1.5	0.7	6,7	-	-	8.8
	exports	5.4	4.5	1.2	-	-	11.0
	imports-exports	*-3.9*	*-3.8*	*5.7*	-	-	*-2.2*
1993	imports	1.3	0.4	6.3	-	-	8.0
	exports	4.0	3.1	0.5	0.9	-	8.6
	imports-exports	*-2.7*	*-2.8*	*5.8*	*-0.9*	-	*-0.6*
1994	imports	1.9	0.3	4.4	0.0	-	6.7
	exports	0.7	1.7	2.9	1.2	-	6.4
	imports-exports	*1.3*	*-1.4*	*1.6*	*-1.2*	-	*0.3*
1995	imports	0.6	0.2	6.9	0.0	-	7.7
	exports	2.1	3.8	1.2	2.3	-	9.4
	imports-exports	*-1.5*	*-3.6*	*5.6*	*-2.2*	-	*-1.7*
1996	imports	8.7	2.2	4.1	1.0	-	15.9
	exports	0.3	1.4	8.0	0.1	-	9.7
	imports-exports	*8.4*	*0.7*	*-3.9*	*0.9*	-	*6.1*
1997	imports	5.2	0.9	3.7	0.4	-	10.3
	exports	0.9	4.4	6.8	0.8	-	13.0
	imports-exports	*4.3*	*-3.4*	*-3.2*	*-0.4*	-	*-2.7*
1998	imports	2.2	0.9	3.0	0.1	-	6.1
	exports	1.9	5.4	7.3	2.3	-	16.8
	imports-exports	*0.3*	*-4.5*	*-4.3*	*-2.2*	-	*-10.7*
1999	imports	1.6	0.8	5.9	0.1	-	8.5
	exports	2.0	6.8	5.8	1.3	-	15.9
	imports-exports	*-0.4*	*-5.9*	*0.1*	*-1.2*	-	*-7,5*
2000	imports	1.6	0.8	15.7	0.1	0.1	18.3
	exports	3.4	8.2	0.9	0.7	0.4	13.6
	imports-exports	*-1.8*	*-7.4*	*14.8*	*-0.6*	-0.4	*4.7*
2001	imports	2.2	2.6	5.2	1.1	-	11.1
	exports	3.1	5.1	7.5	1.0	1.7	18.5
	imports-exports	*-0.9*	*-2.5*	*-2.2*	*0.1*	-1.7	*-7.3*

Note. Rounding-off discrepancies occur. After deregulation of the electricity market in 1996 the Swedish interchanges are reported in the form of physical values per country and they are therefore not entirely comparable with earlier years, when trade exchanges were reported.
Source: Statistics Sweden.

Electricity certificates

The support forms that have been approved by the EU for supporting investments aimed at protecting the environment include "green certificates". This means that member states may grant support for renewable energy sources by utilizing the market mechanisms. The price of the certificates (support) is not decided beforehand and is the result of the relationship between supply and demand.

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The Swedish and Danish Parliaments have decided to introduce certificate systems that are basically similar to one another. In Sweden, the electricity certificate system will come into force on 1 January 2003. Swedish Parliament will decide on the actual arrangement in June, and will legislate during the autumn of 2002.

The electricity certificate system involves supporting the generation of electricity from renewable energy sources, with the exception of existing large-scale hydro power stations, by the generators being allocated electricity certificates from the State, at the rate of one certificate for every MWh. The generator sells his electricity as usual and obtains an additional income from the sale of the certificates. According to the coming Electricity Certificate Act, electricity suppliers or those who use electricity will be obliged to purchase certificates at a rate corresponding to their electricity consumption. The first year will be 2003, during which they must purchase more than six certificates for every hundred MWh they have consumed. The quota will then be increased from year to year in order to stimulate investments in electricity generation from renewable energy sources.

Negotiations are currently in progress in Denmark between the political parties concerning postponement of the launch of the renewable energy (VE) certificate system. The first parts of the support arrangement were originally scheduled to come into force on 1 January 2002. The introduction date was then postponed to 1 January 2003. Whether and when introduction will take place is as yet unknown. The possibility of coordinating the Danish VE certificate system with a Swedish electricity certificate system may affect the Danish decisions.

Norwegian Parliament has requested information from the Government that would shed light on the problems and opportunities offered by a certificate system. The background material in the form of consultant reports has been submitted to the Government in April. The Government will submit its documentation to the Parliament in the spring of 2002.

Trade in electricity

Trade in electricity takes place between a variety of player types, both within Sweden and across overland national borders. The players trade by bilateral contracts or through Nord Pool, the Nordic electricity exchange.

Transmission of electricity between the Nordic countries began back in the early 1960s. Trade between countries was then managed by the dominating players in each country. All players who have paid the network charge for using the transmission links can now also buy electricity abroad.

The path to a Nordic electricity exchange

In Sweden, the Swedish power utilities have long had close cooperation. National joint operation was started in 1938, when Vattenfall and Krångede AB began interchanging power. Up to 1994, the biggest electricity generators had agreements concerning joint optimization of power generation. Temporary interchanges of power within the framework of generation optimization dominated sales among the generators. A new system was introduced in 1995, in which all electricity generators were included in the interchange of power. This optimization ceased at the 1995/96 turn of the year, when entirely new conditions were introduced for the players on the electricity market.

In January 1996, the existing electricity exchange in Norway, i.e. Statnett Marked AS, was made available to Norwegian and Swedish players on equal terms, and an office was opened in Stockholm. Statnett SF, the Norwegian grid utility, owned Statnett Marked AS. In April of the same year, the Svenska Kraftnät grid utility purchased 50 % of the shares. In conjunction with this, the name of the company was changed to Nord Pool – the Nordic electricity exchange.

The Finnish electricity exchange, known as EL-EX, began operations in August 1996. On 1 September 1996, the Finnish network utility, IVS, took over responsibility for the northern transmission links with Sweden which meant, in practice, that these links were opened to all players. Trade between Sweden and Finland had previously been handled by Vattenfall and Imatran Voiman Oy. Norwegian and Swedish trade with Finnish electricity generators initially took place on the EL-EX exchange. Today, EL-EX is used only by Swedish and Finnish players for buying and selling surplus generation capacity in the same 24-hour period in which delivery is to take place, in order to achieve balance between gen-

Table 24 • Trade in electricity in Nord Pool region and with countries outside Nord Pool region in 2001, GWh

	Exports from							
	Denmark	Finland	Norway	Sweden	Germany	Russia	Poland	Total imports
Imports to								
Denmark			1 942	3 145	3 516			8 603
Finland			33	5 072		7 685		12 790
Norway	2 787	232		7 527		207		10 753
Sweden	2 241	2 599	5 186		1 141			11 167
Germany	4 152			1 012				5 164
Russia								
Poland				1 702				1 702
Total exports	9 180	2 831	7 161	18 458	4 657	7 892		

Source: Nordel statistics for 2001.

eration and sales of electricity. Svenska Kraftnät now owns 50 % of the shares in EL-EX, and FINGRID, the Finnish grid utility, owns the remaining 50 %. Since 1998, the Finnish electricity generators have been able to sell electricity on Nord Pool and, in April 2002, there were 30 Finnish players.

During 1999, western Denmark joined Nord Pool as a price area, and eastern Denmark joined in October 2000. In April 2002, there were 18 Danish players.

Trade volumes and number of players

The players at Nord Pool include power generators, distributors, industrial companies and dealers or traders. In April 2002, there were 305 players, which represents an increase of 24 since the previous year. The players come mainly from the Nordic countries, but the proportion of players from outside the Nordic countries has increased during last year. The number of Swedish players has increased from 45 on 1 January 1999 to 72 in April 2002. Norway is represented by 159 players.

Electricity on Nord Pool is traded on the spot market (24-hours market) and at the forward market (hedging in the longer term). The spot market handles contracts for delivery during the next 24-hour period. The forward market is a financial market and handles contracts with a time horizon of up to four years.

Trade on the spot market has increased every year since the deregulation of the electricity market. During 2001, the physical market turnover was 111.9 TWh, which represents an increase of more than 15 % on 2000. Trade on the forward market increased to 909.9 TWh during 2001, which represents an increase of more than 250 % compared to 2000. In addition, 1 747.6 TWh were cleared in bilateral contracts during 2001, which represents an increase of almost 50 % on 2000. Clearing of bilateral contracts involves Nord Pool acting as the opposite party to sellers and buyers in bilateral forward contracts. The companies thereby eliminate the risk of the opposite party being unable to meet its contractual obligations. For this service, Nord Pool levies a charge and requires the companies to deposit a security sum in a blocked bank account in order to cover the risk taken by the electricity exchange in acting as the opposite party.

Table 25 • Largest Swedish electricity generators and the electrical energy they generated between 1999 and 2001, TWh

	1999	2000	2001
Vattenfall AB	79.6	69.3	76.6
Sydkraft AB	27.5	27.2	32.7
Birka Energi[1]	21	21.4	22.3
Fortum Kraft	6	6.4	7.3
Skellefteå Kraft	3	2.9	3.7
Graninge	2.6	3.2	3.6
Sum	139.7	130.4	146.2
Total in Sweden	**150.9**	**140.1**	**157.8**

Note. The generation figures exclude minority shares. Contracted-out power is included in the companies that have the power at their disposal.

[1] As from 1 March 2002, Birka Energi is wholly owned by Fortum Power and Heat AB.

Source: Swedenergy and Nordel.

Table 26 • Largest Swedish electricity generators and their installed capacity on 1 January of 1999 to 2002, MW

	1999	2000	2001	2002
Vattenfall	15 344	14 324	14 021	14 163
Sydkraft	6 008	5 878	5 981	6 296
Birka	4 568	4 399	4 440	4 553
Fortum	1 322	1 331	1 381	1 487
Skellefteå	598	598	758	758
Graninge	562	552	577	607

Source: Swedenergy.

Electricity trade between Nordic countries

As a result of the changes on the electricity market in the four Nordic countries, Swedish electricity traders are now able to sell electricity directly to customers in Denmark, Norway or Finland, and Swedish customers can purchase electricity from foreign electricity trading companies that wish to establish themselves on the Swedish market. Several Swedish electricity trading companies now have agreements with generators in the neighbouring Nordic countries for the import and export of electricity on long-term contracts. Long-term contracts with customers in other countries are also becoming increasingly common.

Trade in electricity can balance temporary national shortfalls or surpluses of electricity. The flows of trade between the Nordic countries vary over the year and from year to year, depending on the temperature, precipitation and fluctuations in the business climate. The most important guiding factor is the water inflow into the Swedish, Norwegian and Finnish reservoirs. During the winter, when the inflow into the reservoirs is low and the electricity demand is high, the need for imports in Sweden and Norway increases. During such periods, Sweden and Norway therefore import electricity from Denmark and Finland, both of which have a high proportion of condensing power generation capacity. This generation source has higher variable production costs than hydro power generation, but is not dependent on the weather and therefore serves as reserve power in the Nordic electricity system. In the spring and summer, the Swedish and Norwegian water reservoirs are well filled, and the electricity consumption is low. During this period, hydro power generation in the Nordic electrical system therefore covers a large proportion of the electricity needs in the Nordic countries. As a result, Sweden and Norway are then net exporters of electricity. →

In wet years, Sweden and Norway are net exporters of electricity all the year round. Electricity is exported to countries such as Denmark and Finland, since the variable generation cost of hydro power is lower than that of condensing power. During years with low precipitation, the directions of trade flows are reversed, and Sweden and Norway have greater need for importing electricity, mainly from Denmark, but also from Finland, both of which generate electricity in condensing power stations. Germany and Russia also participate in electricity trade with the Nordic countries, even though they cannot trade on Nord Pool. In August 2000, a DC link was commissioned between the Swedish County of Blekinge and northern Poland, which marked the beginning of electricity trade with Poland. Figures 14, 15 and 16 show how the trade flows have changed between 1999 and 2001.

1996 was a distinctly dry year and, although normally a net exporter of electricity, Sweden imported large amounts of electricity, principally from Denmark. The years between 1997 and 2000 were wet years, with higher than normal inflows of water, and Sweden was therefore a net exporter of electricity during those years, except in the year 2000. The net imports in 2000 were mainly due to the extremely low generation rate in nuclear power stations and the low price of electricity from Norwegian hydro power. The year 2001 was a wet year, and yet another record year was registered for hydro power. Sweden again became a net exporter of electricity. Electricity imports in 2001 dropped to 11.1 TWh, compared to 18.3 TWh in 2000. Almost half of Sweden's electricity imports came from Norway.

Sweden's total exports of electricity to neighbouring countries in 2001 amounted to 18.5 TWh, which is 4.9 TWh higher than in 2000. Exports to Denmark and Finland decreased, but those to Norway, Germany and Poland increased. Sweden exported 7.5 TWh to Norway, which is an increase of 6.6 TWh on the year 2000. Swedish net exports during 2001 amounted to 7.3 TWh.

Table 24 shows that Norway and Sweden are the countries in Nord Pool that trade most with one another. Exports from Russia to Finland increased substantially compared to 2000. During 2001, Sweden exported most electricity, and Finland imported most.

Table 27 • Largest Nordic electricity generators and the electrical energy they generated in 2001

Generators	Energy generated in 2001, TWh	Proportion in Nordic countries, %
Vattenfall	76.6	20
Sydkraft	32.7	8
Total for Sweden	**157.8**	**41**
Statkraft	33.3	9
Norsk Hydro	9.8	3
Total for Norway	**121.9**	**31**
Fortum	40.4	10
Pohjolan Voima Oy	15.9	4
Total for Finland	**71.6**	**18**
Elsam	16.1	4
Energy E2	11.8	3
Total for Denmark	**36**	**9**
Total for largest Nordic electricity generators	**236.6**	**61**
Total for the Nordic countries[1]	**387.3**	**100**

[1] Excluding Iceland.

Source: Nordel and annual reports.

Competition in 2001

The Swedish electricity market reform began on 1 January 1996, when new conditions for electricity trade were introduced. The reforms in Norway, Denmark and Finland were similar, but were introduced at different rates and in different ways. The following section describes the conditions for competition on the electricity market in Sweden and on those in other Nordic countries, and outlines the situation of the consumers. The section also covers the part of the market that is open to competition, i.e. generation and trading.

Generation

The electricity market in Norway was reformed back in 1991. For Sweden and Finland, 2001 was the sixth year of reformed electricity market. Since the reforms were introduced, the ownership conditions have changed on the electricity generation side. A description below begins with market conditions for electricity generation in Sweden, and is followed by the conditions in other Nordic countries.

Market structure

Electricity generation in Sweden is largely concentrated to a few companies. The six biggest electricity generators account for around 93 % of the electricity generation in the country. Sweden's two biggest power generators, i.e. Vattenfall and Sydkraft, together accounted for 69 % of the total electrical energy generated in the country in 2001, as shown in Table 25. From a Nordic perspective, the two biggest Swedish generators had a market share of 28 % of the total Nordic production. The clearly dominant company was Vattenfall with a 20 % share of the market. This was followed by Fortum with 10 %. Critics claim that the large market shares in Sweden provide the means for benefiting in terms of market dominance. Above all, this applies in situations in which the demand is very high and the transmission links to foreign countries represent a restriction. The six biggest generators in Sweden are reviewed below, and a description is given of the competitive conditions on the generation market.

Vattenfall AB generates and delivers more than half the electricity used in Sweden. The company is the biggest electricity generator on the Nordic market and is the fifth biggest in Europe. During

2001, Vattenfall generated 77 TWh. The Swedish market is still the biggest to Vattenfall, but sales in Finland and Norway are increasing. In the Nordic countries, Vattenfall has a market share of around 20 %. Outside the Nordic countries, Vattenfall also has operations in the Netherlands, Germany, the Czech Republic, the Baltic States, Poland, South-East Asia and South America.

Sydkraft AB is the second largest Swedish electricity generator. In 2001, the total electrical energy generated by the Sydkraft group companies amounted to 31 TWh. In addition, Sydkraft had access to 10 TWh of generation capacity in associated companies. Excluding minority shares that amounted to 8 TWh, Sydkraft thus had access to 33 TWh during 2001. Since 2001, Sydkraft has been owned by two large companies, i.e. the German E.ON Energie with 55 % of the voting shares and the Norwegian Statkraft with 44 % of the voting equity.

Birka Energi was formed in September 1998 by the merger of Stockholm Energi and Gullspång Kraft. The total electrical energy generated in 2001 amounted to 22 TWh, excluding minority shares and contracted-out power. From 1 March 2002, Birka Energi is a wholly owned subsidiary of *Fortum Power and Heat AB*. Fortum Power and Heat AB is a member of the Fortum Oy energy group that is quoted on the Finnish stock exchange and in which the Finnish state has a 70 % holding.

The generation system of *Graninge* is based entirely on hydro power and wind power. During 2001, the company generated 3.6 TWh of electrical energy in its own hydro power stations.

The power generation system of *Skellefteå Kraft* is based principally on hydro power. The company also has minority holdings in the Forsmark nuclear power station. The total electrical energy generated in 2001 amounted to 3.7 TWh.

Electricity generation in other Nordic countries

Substantial restructuring has taken place in Denmark. On the generation side, ten companies have become only three. Elsam is Denmark's biggest generator of electricity and heat for district heating, and its operations are in Jutland and Funen.

Electricity in Norway is generated by more than 100 generators, although around ten companies account for roughly 60 % of the production. Most of the companies are owned by the State or by municipalities and counties. Statkraft SF is Norway's biggest power generator and has around 30 % of the total generation capacity.

Finland has around 120 companies and 400 power stations that generate electricity. These companies and power stations are mainly classified into two groups. The Fortum share of the Finnish electricity generation amounts to 56 % and the Pohjolan Voima share is about 20 %. Vattenfall is the third significant player on the Finnish market.

Competition in generation

The discussions concerning competition on the electricity market often circle around market power due to the concentration of generation companies. The dominating position of Vattenfall is the main subject of discussion. The term market power means a player who, due to his large market share, would be able to control the availability so that the price would increase beyond the marginal cost on a defined market.

Individual ownership or control of the transmission links to Poland and Germany theoretically creates the opportunities for using market power. Differences in generation structure and demand structure have created price variations between countries. Companies that are correctly positioned on more than two geographically defined markets can put these price differences to use. Certain companies could theoretically export electricity to countries outside the Nordic region, so that the area price for Sweden is forced up in situations in which there is already a shortage of electricity on a domestic market.

Another theoretical example of the scope available for influencing the market is the annual overhaul shut-downs of nuclear power reactors. The extent and timing of the overhaul shut-downs affect the availability. If the overhaul shut-downs are timed for periods in which the availability of electricity is low, Sweden would run the risk of being a shortfall area, which would result in increased electricity prices.

Views differ on how competition performs. It is sometimes claimed that competition does not perform well throughout. According to the ”Konkurrensen på elmarknaden” (Competition on the electricity market) study, there are risks of ineffective competition, although there is no evidence that companies use their market power to further their own ends. The opinion of the study is that competition performs relatively well.

Trade in electricity

The break-down of the traditional electricity companies into network and electricity trading companies was an important element in exposing electricity trading in Sweden to competition. In Norway and Finland, the only demand made is for separate accounting of the network operations and other operations. All electricity customers in Sweden, Norway and Finland are now able to choose the electricity trading company from which they want to buy their electricity, but they must buy their network service from the network company that has a monopoly in the area where the electricity is to be distributed. Many of the Scandinavian electricity trading companies are still members of groups that also have network operations.

Market structure

Growing numbers of municipal and smaller energy utilities are being taken over by other companies. The reasons vary from small energy utilities wanting to hold their own on the new electricity market, trade on the electricity exchange and conclude favourable agreements with electricity suppliers, to individual companies wanting to strengthen their strained finances. The large companies have forged ties with many electricity trading companies by take-over or part ownership or by concluding agreements. The three big companies Vattenfall, Fortum/ Birka Energi and Sydkraft also dominate on the electricity trading market. The three together account for around 70% of sales to end customers.

A few examples are given below of acquisitions of generation and electricity trading companies during 2001:

The Vattenfall Group grew robustly during 2001 by the purchase of majority holdings in the German companies Hamburgische Electricitäts Werke AG (HEW), Vereinigte Energiewerke AG (VEAG) and Lausitzer Braunkohle AG (LAUBAG). The operations consist of HEW that gen- →

erates electricity and heat in Hamburg, VEAG that generates and transmits electricity in eastern Germany, and LAUBAG that has lignite mining operations for the VEAG power stations.

Towards the end of 2000, Sydkraft made substantial purchases that contributed to the turnover and earnings of the Group throughout 2001. Important company acquisitions included Norrköping Miljö & Energi, Nora Energi and SAKAB. Norrköping Miljö & Energi, which was previously an associated company, became a wholly-owned subsidiary of the Sydkraft Group at the 2000/2001 turn of the year. In May, Sydkraft disposed of its holding in HEW and, about the same time, purchased holdings in the Norwegian Hafslund company that is quoted on the Norwegian stock exchange, and in the Fredriksstads Group.

At the end of 2001, an announcement was made that Fortum Power and Heat AB bought the remaining 50 % of Birka Energi, in addition to its earlier holding. From 1 March 2002, Birka Energi is wholly owned by Fortum Power and Heat AB.

Electricity trading companies in other Nordic countries

Around 100 electricity trading companies operate in Finland. Most of these sell both electricity and network services. The biggest three are Fortum, Teollisuuden Sahkönmyynti and Vattenfall, the latter of which continues to gain market shares in Finland. The remainder of the electricity trading companies are principally local and regional electricity companies that had been operating on the market since before the electricity market reform.

Norway has a large number of electricity trading and network companies. This is because many of the companies are owned locally by the counties. There are just under 200 network companies in operation. During the 1990s, mergers amounted to an average of eight a year.

In Denmark, most of the electricity trading companies have emerged from the companies that existed before the 1999 reform. During 2001, there were about 30 electricity trading companies. It can generally be said about the Nordic countries that the number of players on the electricity market is high among network and electricity trading companies, but the development is towards fewer players.

Competition in electricity trading

In recent years, the three biggest electricity generators have become large owners of electricity trading companies by take-over of entire companies, part ownership or special cooperation agreements. The major generators, together with the companies linked to them, form three spheres that are believed to account for 70 % of sales to end customers. The limited number of companies can be regarded as problematic to effective competition. However, there are those who consider that the problem poses no threat to competition in Sweden.

In addition to considering the number of players on the market, the conditions for competition on the electricity market can also be viewed from a consumer perspective. Active consumers are a prerequisite for a market that performs well. The efficiency of the market is almost always disturbed by the consumers being limited or restricted in their ability to make free and rational choices. One of the limitations is the difficulty in meeting the information requirements of consumers. The need for special information efforts is greater on markets that have recently been opened to competition. Special information efforts have long been included among Swedish Government proposals for measures aimed at strengthening the position of consumers.

Another obstacle to action on the electricity market is the problems that have arisen in relation to the handling of supplier changes. Consumers who have tried to change to a different electricity supplier have been hampered by the inertia of the system, which has contributed to dissatisfaction with the electricity market reform.

Swedenergy, (the association of Swedish generating companies, Svensk Energi AB) has commissioned a market survey that revealed that growing numbers of consumers have changed to different electricity suppliers or have re-negotiated their electricity agreements for an active participation. In the past year, the proportion has increased from 30 to 37 percent. Out of the 37 percent, roughly half have changed to a different supplier and the other half have renegotiated the electricity price. Almost half of the electricity customers – 47 percent to be exact – still lack the interest to activate themselves on the electricity market. The attitude towards the electricity market reform has become more hesitant than it was a year ago. But two out of three Swedes (67 %) still think that the electricity market reform is very good or good.

According to the Government´s competition study, no evidence could be found to indicate that prices on the end customer market have been manipulated. The study therefore considers that here too, competition has performed quite satisfactorily. But some questions remain. As an example, it is claimed that the differences between purchase price and sale price have increased during last year. ■

An international perspective

The electricity industry is currently undergoing major changes in many parts of the world. New market conditions are an important component in this process of change, and the growing environmental demands are another. Within the framework of the EU single market, work is in progress in areas such as electricity, natural gas and power generation from renewable sources, which is discussed in this chapter. Particulars are also given of electricity prices in various countries. In international comparisons, it is of great importance to bear in mind the specific conditions in individual countries. In the case of Sweden, for example, the high electricity consumption is due to electricity-intensive industries and the cold climate.

Electricity consumption

The per capita electricity consumption in Sweden is relatively high compared to other countries. In 1999, Sweden was in fourth place in the world, after Norway, Iceland and Canada. The per capita electricity consumption in the United States was around 13 % lower than in Sweden. In some of the major European industrialized countries, such as Germany, France and Great Britain, the per capita electricity consumption was less than half of that in Sweden. Compared to the average among OECD countries, Swedish electricity consumption is about twice as high, and more than twice as high as the average in the EU.

Between 1990 and 1999, electricity consumption in EU member countries increased by 17 %. During the same period, consumption in Sweden grew by 2 %, while that in the Nordic countries increased by just under 13 %.

A common feature of countries that have a high per capita electricity consumption is that they have access to inexpensive hydro power and have a high demand for space heating by being in a relatively cold climatic zone. In Sweden, other natural resources, such as forests and ore, also lead to the specialization of industry in energy-intensive products. If the electricity-intensive industries are taken into account in the calculation of the per capita electricity consumption in Sweden, i.e. if the electricity consumption of the electricity-intensive industries is replaced by the average for industry, the per capita electricity consumption in Sweden would be 20 % lower. Canada, Norway and Finland also have a high proportion of electricity-intensive industries. All of these countries contribute in the international division of labour, since a large proportion of the electricity-intensive products is exported.

Electricity generation

The total electricity generated in the EU countries in 1999 was around two thirds

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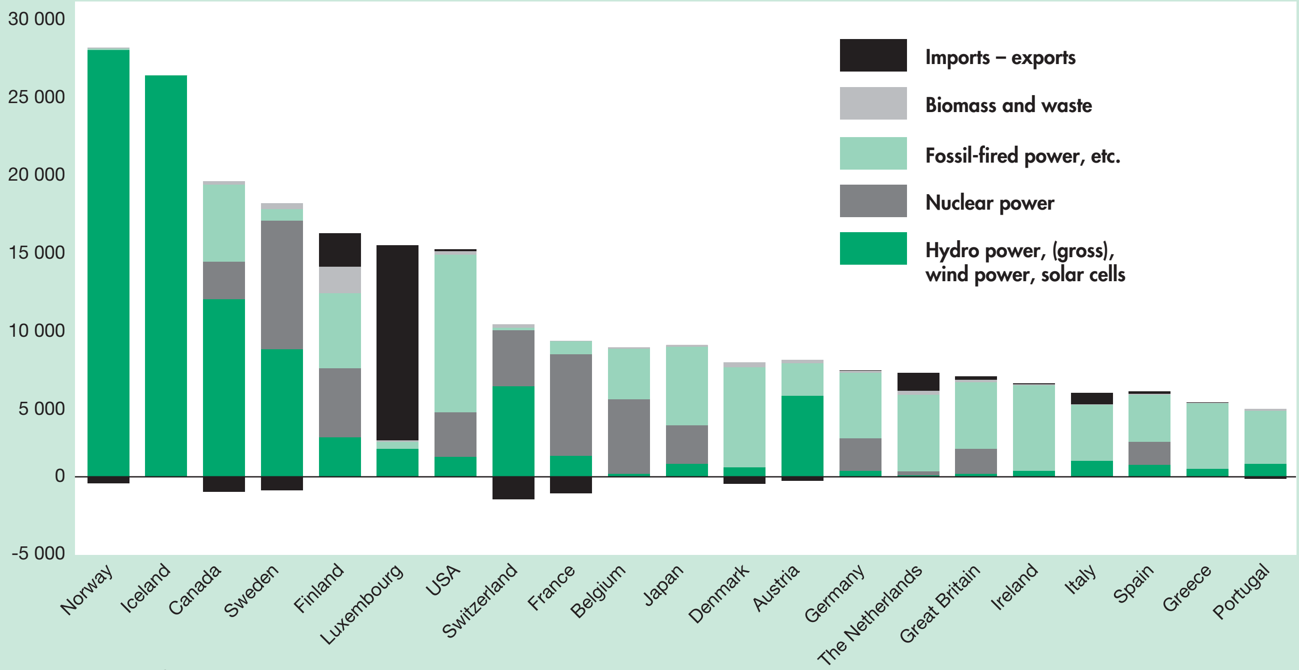
Figure 17 • Electricity consumption per inhabitant, with relative distribution per source of power, kWh



Source: Electricity information, IEA/OECD 2001.

Table 28 • Gross electrical energy generated in 1999, TWh, and electricity consumption, kWh per inhabitant

	Hydro power, wind power etc.[1]	Nuclear power	Fossil-fired power	Biomass and waste	Total gross generation	Imports –exports	Elec. cons. per inhab. kWh[2]
Belgium	2	49	33	1	85	1	8 356
Denmark	3	0	34	2	39	-2	6 880
Finland	13	23	25	9	69	11	15 590
France	78	394	50	3	524	-63	7 656
Greece	5	0	44	0	50	0	4 729
Ireland	1	0	21	0	22	0	5 947
Italy	57	0	207	2	266	42	5 339
Luxembourg	1	0	0	0	1	6	15 000
The Netherlands	1	4	78	4	87	18	6 648
Portugal	8	0	34	1	43	-1	4 248
Spain	28	59	119	3	209	6	5 444
Great Britain	9	96	254	8	367	14	6 403
Sweden	**72**	**73**	**7**	**3**	**155**	**-8**	**16 659**
Germany	29	170	347	9	555	1	6 777
Austria	42	0	17	2	60	-2	7 231
USA	341	778	2 758	63	3 940	29	14 540
Japan	99	317	634	16	1 066	0	8 415
Canada	346	73	151	7	577	-29	17 980
Norway	122	0	1	0	123	-2	27 085
Switzerland	41	26	1	2	70	-10	8 305
Iceland	7	0	0	0	7	0	25 714
Nordic countries	**217**	**96**	**66**	**14**	**393**	**-1**	**16 306**
EU total	**348**	**868**	**1 268**	**47**	**2 532**	**24**	**6 778**
OECD total	**1 439**	**2 216**	**5 607**	**142**	**9 404**	**7**	**8 430**

[1] Also includes electricity from solar and geothermal sources.

[2] Electricity consumption comprises her the electricity consumed in industry, in the residential, commercial and services sector, and in the transport sector, and also distribution losses and thr in-house comsumption in the electricity sector. Source: Electricity Information, IEA/OECD 2001.

of that generated in the USA, and generation in the USA was just over 40 % of that generated in OECD countries. The electricity generated in Sweden accounts for less than 1.6 % of that produced in the OECD countries, and about 6 % of that generated in the EU. The total electricity generated in the EU countries increased by 17 % between 1990 and 1999. In the same period, Swedish electricity generation increased by 6 %.

In the EU member states, half of the electricity is generated from fossil fuels, 34 % from nuclear power and 14 % from hydro power. Biomass accounts for less than 2 %. Electricity generation in Denmark is based predominantly on fossil fuels, while the generation mix in Finland in 1999 consisted of 36 % fossil-fired power, 33 % nuclear power and 19 % hydro power. In the international perspective, the proportion of electricity generated in Sweden from fossil fuels in 1999 was low at just over 4 %. Sweden is among the countries that have high proportions of hydro and nuclear power in their power generation systems. The countries that have the highest proportions of hydro power are Norway, Iceland, Luxembourg, Austria and Canada. Norway and Iceland are foremost in this area, with about 90% of the total electricity generated originating from hydro power.

The use of renewable energy sources, excluding hydro power, for electricity generation is low. On the other hand, the picture changes radically if hydro power is included. Iceland and Norway will then be seen to base virtually all of their electricity generation on renewable sources. Canada, Austria, Switzerland and Sweden will also be seen to have a high proportion of electricity from renewable sources. The use of biomass is highest in Finland, where it accounted for 12 % of the total electricity generated in 1999. In Sweden, about 2 % of the electricity generation is based on biomass.

Few countries have the conditions necessary for extracting geothermal heat. Iceland and Italy have the highest proportions at 15.8 % and 1.7 % respectively of the total electricity generated in 1999. In almost all of the countries reported, hydro power accounts for the highest proportion of electricity generation from renewable sources. The exceptions are Belgium, the Netherlands and Germany, in which waste utilization is predominant, and Denmark, with high levels of wind power. The proportion of solar power is very low in all countries. According to the statistics, only France and Canada

Table 29 • Electricity prices to domestic and industrial customers, including taxes and VAT, on 1 January 2001, öre/kWh

	Small industrial plant[1]	Medium-sized industrial plant[2]	Large industrial plant[3]	Domestic customer 3 500 kWh/year	Domestic customer 20 000 kWh/year
Australia, Sydney	47	36	28	57	34
Belgium	78	61	39	129	78
Denmark	-	-	-	184	158
Estonia	55	42	-	48	41
Finland	42	37	26	77	47
France	58	49	-	104	84
Greece	55	51	35	54	47
Ireland, Dublin	72	55	43	79	51
Italy	103	89	66	181	-
Japan, Tokyo	150	-	-	152	97
Canada, Montreal	56	37	26	66	45
Latvia	54	54	46	62	54
Lithuania	53	37	31	50	37
Luxembourg	71	40	34	110	68
The Netherlands, Rotterdam	91	-	-	133	120
Norway	36	26	19	102	65
Poland[4]	87	55	50	93	87
Portugal	65	58	39	112	73
Spain	57	48	44	93	61
Great Britain	65	51	39	79	54
Sweden	**33**	**24**	**21**	**92**	**75**
Germany, Hamburg	90	70	51	150	93
Austria	-	-	-	118	94

[1] 1.25 GWh annually, 0.5 MW, 2 500 hours.
[2] 10 GWh annually, 2.5 MW, 4 000 hours.
[3] 70 GWh annually, 10 MW, 7 000 hours.
[4] Prices are on 1 January 2002.

Note. The prices quoted to industry exclude VAT.
Note. The foreign exchanges rates are from 2 January 2001, and from Poland, 2 January 2002.
Source: Statistics in Focus – theme 8, No. 9 and 10 2001 Eurostat, and Prices of Electricity as of 1 January 2001 and 2002, Unipede.

generate electricity in tidal hydro power stations. In France, this accounts for around 17 % of the electricity from renewable sources, while the figure in Canada is less than 1 %.

Electricity prices

The electricity tariff payable by a customer is dependent on that customer's electricity consumption. In the first place, a distinction is made between domestic and industrial customers. Moreover, the prices of electricity can vary widely between different countries. In the OECD region, the real electricity prices to both domestic and industrial customers have steadily decreased during the 1990s. In most countries, domestic customers pay energy, environmental and/or value added taxes, and turnover tax. Industrial customers in more than 60 % of the countries listed in Table 30 pay no such taxes. In addition, exemption regulation are in force for industry.

Eurostat has studied price developments, excluding taxes, between 1998 and 2000 and has found that electricity prices payable by most households and industrial plants in the EU have dropped during this period. Prices to households have dropped most in Finland (by around 9–12 %), and in Sweden and Denmark (by 6–16 % and 9–13 % respectively). The Netherlands is the only country in which prices to all customer categories have risen since 1998. Industry in Germany has enjoyed the highest price decreases at 14–22 %. Prices to industrial customers have also dropped significantly in Sweden, Finland, Portugal, the Netherlands and Great Britain.

Electricity Market Directive

The electricity industry is currently undergoing vast changes in many parts of the world. This is mainly due to new market conditions and stricter environmental demands.

Work is in progress in the EU on creating a single market with increased competition and free pricing on a number of different markets. A single market for energy in the EU will contribute towards improved competitiveness of industry and increased welfare for the consumers. This will be achieved by measures such as higher efficiency, lower prices, reliable deliveries and a better environment.

The Electricity Market Directive on "common rules for the single market for electricity" was issued in December 1996. The aim of the Directive is to set up com-

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Table 30 • Electricity from renewable sources and waste in 1999, GWh[1]

	Hydro power excl. pumped storage	Biofuel	Waste	Wind	Sun/ tidal	Geothermal	Sum	Proportion of tot. generated, %
Belgium	341	267	941	13	-	-	1 562	1.8
Denmark	32	678	1 073	3 029	-	-	4 812	12.4
Finland	12 780	8 363	333	49	-	-	21 525	31.0
France	72 410	1 071	1 800	36	-	580[2]	75 897	14.5
Greece	4 592	-	195	150	-	-	4 937	9.9
Ireland	846	133	-	187	-	-	1 166	5.3
Italy	45 365	801	1 023	403	6	4 403	52 001	19.6
Luxembourg	85	1	50	18	-	-	154	15.1
The Netherlands	90	286	3 667	645	6	-	4 694	5.4
Portugal	7 274	1 081	157	123	1	80	8 716	20.1
Spain	22 863	1 705	1 197	2 744	17	-	28 526	13.7
Great Britain[3]	5 352	K	K	897	1	-	6 250	1.7
Sweden	**71 597**	**3 019**	**424**	**371**	**-**	**-**	**75 411**	**48.6**
Germany	32	415	9 023	5 528	28	-	115 026	2.7
Austria	40 485	1 603	154	42	1	-	42 285	70.0
USA	288 518	41 960	21 504	4 533	873	17 381	374 769	9.5
Japan	86 416	10 947	5 299	37	-	3 451	106 150	10.0
Canada	345 478	7 099	-	203	3	32[2]	352 815	61.1
Norway	120 904	243	58	13	-	-	121 218	98.8
Switzerland	40 004	160	1 355	3	9	-	41 531	59.7
Iceland	6 047	-	-	-	-	1 136	7 183	99.9
Nordic countries	**211 360**	**12 303**	**1 888**	**3 462**	**-**	**1 136**	**230 149**	**58.5**
EU total	**284 144**	**19 423**	**20 037**	**14 235**	**60**	**5 063**	**350 688[4]**	**13.8**

[1] Hydro power and peat are not listed in this table.
[2] Tidal power.
[3] 7 726 GWh of electrical energy are generated from unspecified sources.
[4] Note 3 is included in the total, and EU in total is therefore not summated
K= confidential information.
Source: Energy Balances of OECD countries, IEA/OECD 2001.

mon rules for the generation, transmission and distribution of electricity. According to the Directive, the market for electricity should be gradually opened to competition both in trading and the establishment of electricity generation plants on the EU electricity markets. The Directive states that 28 % of the electricity markets were to be open to competition by the year 2000, and 33 % by the year 2003. However, several countries have chosen to go beyond the provisions of the Directive.

According to a report from the EC Commission (December 2001), the entire electricity markets in Austria, Finland, Germany, Sweden and Great Britain were open to competition in the year 2000. France, Greece, Ireland and Portugal were the countries that had the lowest proportion of their electricity markets open to competition. These countries were also the ones that had not yet reached 33 %. All countries had attained the target set up for the year 2000. The report claims that the countries that have adopted strategies in line with the draft Directive are those that have achieved the best results on the electricity market. This is mainly due to the proportion of customers who have switched electricity suppliers. Moreover, the electricity prices in the Nordic countries have dropped at the highest rate and are therefore generally lower than the average.

Natural Gas Directive

Other important parts of the single energy market in the EU are the markets for natural gas and electricity generation from renewable sources. The deregulations of the various markets are linked together, and there are several parallels between the Electricity Market Directive and the Natural Gas Directive.

In June 1998, the EU issued the Natural Gas Directive on "common rules for the single market for natural gas". This will enable the natural gas market to be gradually opened to competition, just like the electricity market was opened by the Electricity Market Directive. According to the Natural Gas Directive, 20 % of the natural gas market should have been opened to competition by the year 2000. The proportion was then to increase to 28 % five years after the Directive came into force, and to 33 % after ten years. The member states are given relatively wide freedom for the implementation, and a number of countries intend to go beyond the provisions of the Directive.

In 2000, the natural gas markets in Great Britain and Germany had already been totally deregulated. At that date, only France and Denmark had not come up to 33 % of the natural gas market being opened to competition and did not expect to achieve this before year 2008 either. For Sweden, the proportion was 47 %.

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Electricity generation from renewable sources

An objective in the EU is to increase the proportion of energy generated from renewable sources. In many cases, the cost of electricity generated from renewable sources is high compared to conventional sources, and several member countries are therefore working on supporting electricity generation from renewable sources.

In relation to the total energy generation, the average proportion of electricity from renewable sources in 1999 was 58.5 % in the Nordic countries and 13.8 % in the EU as a whole. Iceland and Norway have by far the highest proportions of electricity from renewable sources at 99.9 % and 98.9 % respectively. In Sweden, the proportion in 1999 was 48.6 %.

FACTS

The standard international unit for measuring energy is the joule (J). However, the watt hour (Wh) is often used in Sweden. 1 joule is equivalent to 1 watt second, and 1 watt hour is consequently 3600 J. The tonne oil equivalent (toe) unit is often used in international comparisons. 1 toe corresponds to the heat liberated in the combustion of 1 tonne of oil, which amounts to 11.6 million Wh. The joule, watt hour and even the tonne oil equivalent are impractically small units when large quantities of energy are considered. Multiples of the basic unit, such as thousands or millions of watt hours, are used instead, and these are abbreviated as shown below.

Multiple name	*Symbol*	*Numerical value*
kilo	k	10^3= 1 000
mega	M	10^6= 1 000 000
giga	G	10^9= 1 000 000 000
tera	T	10^{12}= 1 000 000 000 000
peta	P	10^{15}= 1 000 000 000 000 000

Power is measured in:
1 000 watt (W) = 1 kilowatt (kW)
1 000 kW = 1 megawatt (MW)
1 000 000 kW = 1 gigawatt (GW)

Energy is obtained by multiplying time by power. Energy is measured in:
1 000 kilowatt hours = 1 megawatt hour (MWh)
1 000 000 kWh = 1 gigawatt hour (GWh)
1 000 000 000 kWh = 1 terawatt hour (TWh)

In practical use
1 kWh is roughly the electricity used by an electric cooker plate in one hour.
1 MWh is roughly the electricity used by a household over a period of two months.
1 GWh is roughly the electricity used in one year by 50 electrically heated single-family houses of normal size.
1 TWh is roughly the electricity used by the whole of Sweden over a period of three days.

Further information

The *Energy Market Authority* in Finland is a Government department under the Finnish Ministry of Trade and Industry. The Authority was formed in 2000, when the new Finnish Electricity and Natural Gas Market Act came into force. The Authority replaced the Electricity Market Authority that was formed in 1995 when the Finnish Electricity Market Act came into force. The main task of the Energy Market Authority is to monitor conformance to the Electricity and Natural Gas Market Act, and to promote the operations on the electricity and natural gas markets that are now based on competition.

Phone: +358 9 622 0360
www.energiamarkkinavirasto.fi

The *Swedish National Electricity Safety Board* is responsible for the State electrical safety work, issues regulations, participates in standardization, and exercises market inspection of products.

Phone: +46 8 519 112 00
www.elsak.se

The *Danish Energy Agency* is engaged on matters related to the generation, distribution and utilization of energy, and is entrusted with the task of ensuring, on behalf of the Government, that energy in Denmark is developed efficiently from the national economy, environmental and safety aspects.

Phone: +45 33 92 67 00
www.energistyrelsen.dk

The *Swedish Competition Authority* is a central authority for competition matters, and its task is to promote effective competition in private and public activities, to the benefit of the consumers. The Authority is actively engaged on counteracting and taking action against restrictive practices that are harmful to consumers, and promotes a competition-oriented attitude in society.

Phone: +46 8 700 16 00
www.kkv.se

The Swedish Environmental Protection Agency works towards reducing emissions in Sweden and in other countries, and improving the environment by encouraging governmental, sectoral, regional and local authorities, as well as companies and the general public to take decisions and adopt measures that will lead to the objectives that have been set up.

Phone: +46 8 698 10 00
www.naturvardsverket.se

Nordel is an organization that promotes Nordic cooperation in the field of electricity. The organization was founded in 1963 and is an advisory and recommending body entrusted with the primary task of creating the conditions and developing an effective Nordic electricity market. Nordel serves as a cooperative body for system operators and as a forum for interaction between the market players and system operators in the Nordic countries.

Phone: +47 22 52 70 00
www.nordel.org

Nord Pool is the Nordic electricity exchange and organizes markets for spot trading and price assurance.

Phone: +46 8 555 166 00
www.nordpool.com

The *Norwegian Water Resources and Energy Directorate* (NVD) is accountable to the Norwegian Department for Oil and Energy, and is responsible for managing the Norwegian water and energy resources.

Phone: +47 22 95 95 95
www.nve.no

Swedish Ministry of Industry, Employment and Communications

Phone: +46 8 405 10 00
www.naring.regeringen.se

The *Swedish Nuclear Power Inspectorate* (SKI) plays a supervisory role in ensuring that nuclear engineering operations are pursued in a safe way. Companies that have received permits for pursuing nuclear engineering operations also bear full responsibility for safety in the plants and for safe management and terminal storage of spent nuclear fuel.

Phone: +46 8 698 84 00
www.ski.se

Statistics Sweden is responsible for keeping official statistics in collaboration with the relevant authorities.

Phone: +46 8 506 94 00
www.scb.se

The *Swedish District Heating Association* is the trade organization for district heating companies.

Phone: +46 8 677 25 50
www.fjarrvarme.org

The *Swedish Association of Local Authorities* is entrusted with the task of supporting and developing the autonomy of local authorities, advancing the interests of local authorities, promoting cooperation between local authorities, and assisting them in their operations.

Phone: +46 8 452 71 00
www.svekom.se

Svenska Kraftnät is entrusted with the task of commercially managing, operating and developing a cost-effective, reliable and environmentally appropriate power transmission system, selling transmission capacity, and pursuing other operations associated with the power transmission system. The task of Svenska Kraftnät is to ensure that the national electricity system operates as a coherent system with satisfactory reliability.

Phone: +46 8 739 78 00
www.svk.se

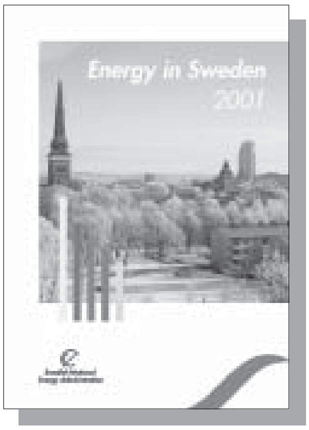
Swedenergy is an association of Swedish electricity supply companies.

Phone: +46 8 677 25 00
www.svenskenergi.se

Publications

Energy in Sweden 2001

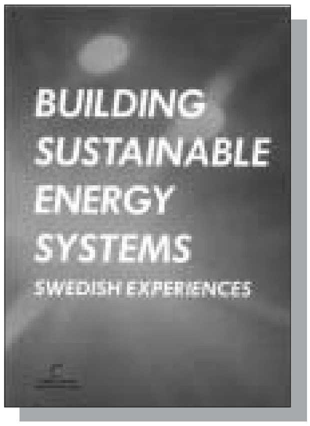
Item no. 1445



The publication comes out annually, and the 2001 edition is the 18 th in succession. Energy in Sweden gives generalized and easily understandable information on the composition and development of the Swedish energy system. The publication consists of an abundantly illustrated text version and a tabular appendix entitled Energy in figures. The tabular appendix includes time series from 1970 and onward and it serves as a numerical basis for the figures in the text version. Some of the time series given include the total energy consumption in Sweden, consumption distributed onto sectors, distributed per energy bearer, and also prices and taxes of various energy bearers and users. The publication is also available in English.

Building Sustainable Energy Systems Swedish Experiences

Item no. 1390



The book is an anthology that focuses on the changes that have taken place in the energy sector in Sweden during the past 30 year. The Swedish Energy Agency has invited 25 authors to contribute to the book and give their views on the changes in the energy system in Sweden. They have selected different points of departure, depending on their particular disciplines. The themes in the various chapters include, for example, the energy policy and its economic effects, technological development, the electricity market reform, biomass and ethanol, and investments and efficiency improvement measures. This book does not reflect the views of the Swedish Energy Agency, but is intended as a discussion forum.

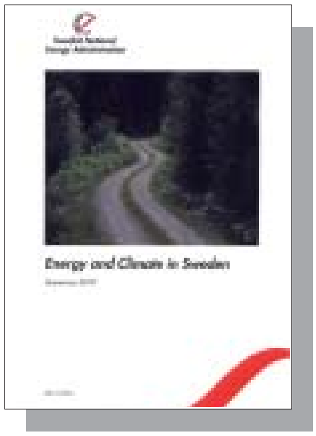
The climate report 2001

Item no. 1465

The report serves as source information that the Swedish Energy Agency submitted on the occasion of Sweden's third national report to the Climate Convention. The report gives a collective description of the measures that have been taken in the energy sector for restricting the emissions of greenhouse gases. In addition, scenarios are presented for Sweden's energy supply during the period up to 2020.

Energy and Climate in Sweden Scenarios 2010

Item no. 1376



The Swedish Energy Agency has produced a number of scenarios of Sweden´s carbon dioxide emissions, extending to 2010, as part of the work called for the Climate Convention, The results are presented in this publication.

Orders

All of these publications can be ordered from the Swedish Energy Agency, Publications Service Department, P.O. Box 310, SE-631 04 Eskilstuna, Sweden

Fax: +46 16 544 22 59 e-mail: forlaget@stem.se

For further information on Swedish Energy Agency publications, visit www.stem.se

Electricity market 2002 on the Internet

This publication can also be downloaded as a pdf file from the Swedish Energy Agency home page at www.stem.se. There are several search paths, although the simplest is to click on Publications and then search for Electricity market. A list of all earlier editions of the Electricity market will then be displayed.

It is difficult to give any general instructions on how the files should be downloaded, since this depends on the type of computer, Internet link, operating system, etc. to which the user has access. So check the size of the file before starting to download it.

If you experience problems, please get in touch with the Swedish Energy Agency or the web editor by e-mail at stem@stem.se. The phone number to the Swedish Energy Agency is +46 16 544 20 00 (switchboard).

Efficient and environmentally sustainable energy system

The Swedish Energy Agency is engaged on promoting a secure, environmentally sustainable and efficient energy system in Sweden.

The Swedish Energy Agency is the central Swedish authority on energy. The Agency supports a large number of research and development programmes in the field of energy, in close cooperation with universities, institutes of technology and industry. Priority is given to renewable energy sources and alternative fuels.

The work on reducing the climatic impact of the energy sector is pursued on both national and international levels. The Agency also participates in a number of energy projects in the EU and in other international cooperation. Developments on the energy markets are continually analyzed.

The Swedish Energy Agency monitors the operations of network companies and promotes more efficient energy markets. By 2003, the Agency is responsible for the electricity certificate system. New efforts in training, information and advice are aimed at stimulating more efficient energy utilization by industry and households. In addition, the Swedish Energy Agency is also responsible for preparedness matters in the field of energy.

Swedish Energy Agency

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