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The Electricity Market 2003

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foreword

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 countries, with the exception of Iceland.

The objective of the electricity market reform is to introduce increased competition, to give consumers greater freedom of choice and also, by open and increased 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 regularly compile and report current market information.

The purpose of "The Electricity Market 2003" publication is to meet the need for generalized and easily accessible information on the conditions on the Nordic market. Iceland is not included in the description. The publication also includes summaries of the information from recent years concerning power 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, May 2003

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Planning Director

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Introduction

The electricity market in Sweden is open to competition, and all users are free to choose their electricity suppliers. The Swedish electricity market is part of a common Nordic electricity market that includes all countries, with the exception of Iceland. Developments on the common 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 Regulations that obstructed trading in electricity were withdrawn, but grid operations remained a regulated monopoly.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 electricity consumption. This requirement was abolished by the changes in law that came into force on 1 November 1999. This enabled all electricity users to exercise 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 reformed, and the electricity markets of the Nordic countries became increasingly integrated. There is now also a common marketplace known as Nord Pool, and border 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 also describes the electrical systems, taxes and price developments in other Nordic countries, with the exception of Iceland.

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

Developments in the price of electricity

In the Nordic countries, the system price, i.e. the price of electricity on the Nordic electricity exchange, is highly dependent on variations in hydro power generation. During the period between 1997 and 2001, the availability of hydro power was very good, with hydro power generation records being broken year after year. Electricity prices during these years were also very low (with the exception of 2001, when hydro power generation was high in Sweden but lower in Norway).

One of the driving forces towards the deregulated market was to use increased competition for creating the conditions for efficient utilization of resources, thus minimizing the electricity prices. The new conditions on the deregulated market led to a substantial reduction in the excess capacity in the power generation system.

The deregulated market suffered a first shortage of hydro power generation capacity in 2002. The levels in the water reservoirs in Norway and Sweden continued dropping as the year progressed. As a result, the market reacted strongly, with record electricity prices. The electricity prices during December were high in the historical perspective and by no means reflected the variable generation costs in the system. The high price of electricity instead reflected the expectations and the anxiety prevailing on the market.

The past winter has given rise to a new understanding of how the new market performs. It became obvious that very wide variations could occur, which was not the case in the former non-competitive market. The question that may be of interest to ask in this situation is whether the high electricity price level will persist. Forward contracts, i.e. agreements between buyers and sellers for deliveries of predetermined quantities of electricity at a contracted price during a certain period of time for the coming two years, showed traces of the high price of electricity prevailing during last winter. Electricity prices in firm agreements concluded for customers are currently also relatively high. However, it is more difficult to determine what effect the electricity price peak will have in the longer term.

The price of electricity to end consumers does not reflect the price of electricity prevailing on the Nordic electricity exchange. The total cost of electricity to the end consumers consists of three items, i.e. the price of electricity, network charges and taxes. The price of electricity dropped between 1997 and 2000, but rose again to all electricity customers during 2000 and 2001. During the same period, the network charges remained largely unchanged, while tax on electricity increased steeply. This led to an increase in the total cost to domestic customers, whereas the cost to industrial customers, who were exempt from taxes, was lower.

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 the Nordic countries have either taken over or bought holdings in competing companies on the Nordic market. Power companies and electricity trading companies are being developed into 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 ineffective competition, although there is no evidence that companies are using their market power towards promoting their own ends. The study considers that competition is working relatively well.

Competition between companies also depends on how active customers are in choosing their electricity suppliers.

The complex of power problems

Competition between companies on the deregulated electricity market has increased, and the generation capacity has gradually been adjusted to suit the demand. The earlier excess capacity has thus been reduced, and increased apprehension is discernible of power shortage on the market. Svenska Kraftnät (the Swedish grid utility) is now entrusted with the task of safeguarding power balance. Svenska Kraftnät has therefore purchased reserve generation capacity for use during power demand peaks. In 2002, Svenska Kraftnät presented the results of an assignment it has received to develop a system that would ensure power balance in the short and long terms. It is suggested that the system should be based on market economy mechanisms. Until a commercial solution has emerged, the Government proposes an interim system in its draft bill 2002/03:85. The interim system will involve Svenska Kraftnät continuing to procure power reserve capacity, although this will be for a period restricted to February 2008.

In the past, there was apprehension that southern Sweden in particular would suffer power shortages. However, Svenska Kraftnät has demonstrated that there were no limitations in the transmission capacity to southern Sweden for the power peaks experienced so far. So in the Svenska Kraftnät power balances, separate balances are no longer made for southern and northern Sweden, but the entire country is treated as a whole.

Continued adjustment of the power system

In March 2003, the Swedish Government submitted a new draft bill "Vissa elmarknadsfrågor" 2002/03:85 (Certain electricity market issues). In this draft bill, the Government mainly presents its appraisal of whether the conditions set by Parliament for shutting down Barsebäck 2 will be met before the end of 2003.

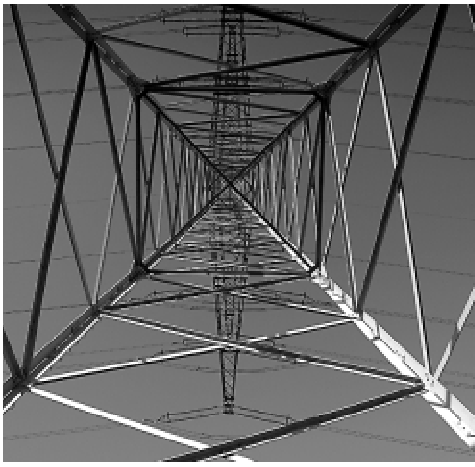
The Government considers that the conditions for shutting down will not be met before the end of 2003, particularly as regards power balance and the influence on the environment and the climate. Moreover, the Government proposes that shutting down of Barsebäck 2 should be included in the negotiations between the Government and industry concerning continued decommissioning of the remaining reactors. However, the Government considers that the scope available for early shut-down of Barsebäck 2 within the framework of the negotiations should be given special consideration. If a solution cannot be reached by negotiation, the Government intends to take a decision on the shut-down of the reactor on the basis of the Law on Nuclear Power Decommissioning, after the necessary measures have been taken. The Government thus intends to ensure that additional measures are taken. Particular emphasis should be placed on improving the efficiency of electricity consumption. In the opinion of the Government, preparations and implementation of this can be achieved before the end of April 2004.

Trading in electricity certificates was introduced in May 2003. The objective is to increase the power generation from renewable sources by 10 TWh by 2010 compared to the level in 2002. The development of the electricity certificate price depends principally on the demand in relation to the supply of power generation capacity entitled to certification. The demand, in turn, is determined by the mandatory quotas imposed on electricity users. The mandatory quotas will be increased annually in order to stimulate increased generation of electricity from renewable sources.

In the Budget Bill (2002/03:1), the Government gives notice of changes in the taxation of combined heat and power (CHP) generation. The heat generated in a CHP plant now attracts half the energy tax and full carbon dioxide tax. In the changed CHP taxation, the heat generated in CHP plants would be put on the same footing as heat generation in industry, i.e. tax would be reduced to 26% carbon dioxide tax and no energy tax. This would encourage CHP generation compared to condensing power generation in which waste heat is not put to use.

Adjustments to the energy system still include changes that will affect the electricity market. At the same time, work is continually in progress aimed at creating the best conditions for a competitive electricity market, both in the Nordic countries and in the EU. ■

The market



The electricity market is open to competition, and a large proportion of the price is determined by supply and demand. Other factors that govern the price are various regulatory instruments, such as taxes, grants and certificates. The price that 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 price of electricity 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 2003, the price of electrical energy was 40%, the network tariff amounted to 20% and taxes accounted for 40% 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 Economic regulatory instruments.

The electricity market

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

The Nordic electricity market was 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, while the demand for hourly metering was abolished in Sweden in November 1999. To Danish domestic customers, the electricity market was opened in January 2003.

Although the hourly metering requirement 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

The 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 in bilateral trade agreements. Just under 30% of all electricity trade in the Nord Pool region now takes place through the electricity exchange.

On the Nord Pool exchange, electricity is traded on the spot market and on the forward market. The spot market serves as a price reference for the 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 during the hours after the electricity exchange has closed.

The spot market is the Nord Pool market for physical deliveries of electric power. On this market, the players trade in hourly contracts for delivery in the next 24-hour period. Before 1200 hours, the players submit 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. 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 between the supply and demand curves.

FACTS – THE MARKET

As a result of the electricity market reform, all consumers have free choice of electricity supplier and all trading in electricity must take place in competition. However, the grid operations remained a regulated monopoly. On the present electricity market, there must be clear distinction between generation, trading in electricity and network operations. This means that a corporate body that pursues network operations may not pursue trading in or generation of electricity.

The price quoted to the consumer on his electricity bill consists of three parts. One of these is the price of electricity, the second is the network charge, and the third represents the taxes. The part that the customer himself is able to influence is the price of electricity. The network charge is paid to the network owner in the area.

The network owner provides the physical transmission of electricity and is responsible for the electrical energy being transmitted from the generation plants to the users. A network owner must have a network concession from the Energy Agency. The network concession entitles the holder to build and operate electric power lines.

Electricity generators produce electric power and feed it into the electricity network. The generator owns generation plants and sells electrical energy to electricity trading companies, either on the electricity exchange or directly to end customers. An electricity trading company buys electricity from a generator or on the electricity exchange, and sells it to a consumer. Electricity trading companies can also sell electricity that they have generated themselves.

An electricity trading company can also act as a 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 commitment of the company. An electricity trading company can either be a balance provider itself or can purchase the service from another company.

The electricity supplier sells electricity on the electricity market in competition with other suppliers. The term electricity supplier is a collective term for all those who sell electricity on the market, and includes both power generators and electricity trading companies.

The price of electricity in electricity trading is not regulated, and it is assumed that the electricity user can switch to a new electricity supplier if he can thereby obtain better terms. The price of electricity is set as agreed between the buyer and the seller, and this information is not published unless the parties decide to do so.

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 equally by the system operators in Norway (Statnett) and Sweden (Svenska Kraftnät). Nord Pool organizes trading in electricity on a physical market and a financial market, and offers clearing services.

The physical market covers the products of spot and base electricity. Spot electricity is a 24-hour market for short-term trading in physical electricity contracts. The system price is determined on the spot market (spot price) 24 hours in advance for every hour of the 24-hour period. The system price is determined as an equilibrium price based on the collective buying and selling bids in the area. Physical transmission limitations between the Nordic countries give rise to periodically different price areas on the spot market. Base electricity 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 or night.

On the financial market, players can assure the price of electricity against spot price changes. This takes place by means of the Electricity forward and Electricity option products. On the Nord Pool forward market, the players can assure the price of electricity by means of futures and forwards for a period of up to four years. Trading can take place on 24-hour, weekly, block, and seasonal and annual contracts. Electricity options are a financial instrument for risk management and price assurance of future revenues and costs associated with trading in electricity contracts.

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

A relatively large part of the electricity traded in the Nordic countries is done through Nord Pool. Trading is also done by means of bilateral contracts, in which trading takes place by agreements being concluded between two players.

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 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 price and the area price is the capacity price in each area. If the 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 hedging 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 result for the buyer will be a gain or 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 an underlying reference for forward prices.

Higher exchange prices in 2003

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 sharply right up to the end of 2000. The average price in 1997 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 these years and also to the keener competition on the common electricity

TABLE 1

Developments in the prices of electrical energy, excluding taxes and network tariffs, to different customer categories between 1 July 1996 and 1 January 2002, mean values, öre/kWh

	1/1 1997	1/1 1998	1/1 1999	1/1 2000	1/1 2001	1/1 2002	1/1 2003
Apartment	29.2	29.0	27.1	25.8	27.0	35.6	51.9
Single-family house without elec. heating	27.6	26.8	26.3	23.4	24.2	31.6	47.1
Single-family house with elec. heating	25.9	25.1	24.4	21.8	22.5	29.6	44.7
Agriculture and forestry	24.9	24.1	23.1	21.4	22.1	29.3	44.5
Commercial operations	25.8	24.5	23.3	21.0	22.1	28.8	43.6
Small industrial plant	25.6	24.1	22.8	20.4	22.0	28.5	44.3
Medium-sized industrial plant	24.4	23.1	21.6	19.6	21.7	28.3	44.8
Electricity-intensive industrial plant	23.7	22.7	22.5	19.7	22.6	28.3	48.0
Large electricity-intensive industrial plant	23.4	22.0	22.0	19.2	22.7	28.3	48.8

Note: The price statistics for the year 2000 differ from the particulars for earlier years. The latter apply under a delivery concession. As from the year 2000, electricity prices are reported for normal price agreements, i.e. agreements until further notice. See the consumption profiles of various customer categories in the Facts box.

Source: Statistics Sweden EN 17

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 the Swedish electricity generators reduced the outputs of nuclear power stations.

The trend reversed during the spring of 2001, and the system price rose sharply. The average price in 2001 was 21.3 öre/kWh. The highest average monthly system prices were in February and April, 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, it was 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 the import of electricity to Norway, and gave rise to some apprehension that the year would be dry.

During 2002, the average system price was 24.6 öre/kWh, i.e. a distinct increase compared to the previous year. The year began with a mild winter and early spring floods. This was followed by a dry and warm summer and autumn. This resulted in substantially lower hydro power generation in Sweden and Norway during the second part of 2002. Due to the low hydro power generation rate, more expensive types of power generation plant were taken into service in the system in order to meet the electricity demand, which gave rise to historically high system prices during the last part of 2002. Due to the low levels in the water reservoirs, the price of electricity continued to be high during the first months of 2003. During the period between January and April of 2003, the average system price was 43.8 öre/kWh. In the corresponding period of 2002, the system price was 18.5 öre/kWh. The average forward price for 2004 was 24.7 öre/kWh (according to information received on 30 April 2003). Figure 1 shows an overview of the development of exchange prices since 1997 and the forward prices on 30 April 2003.

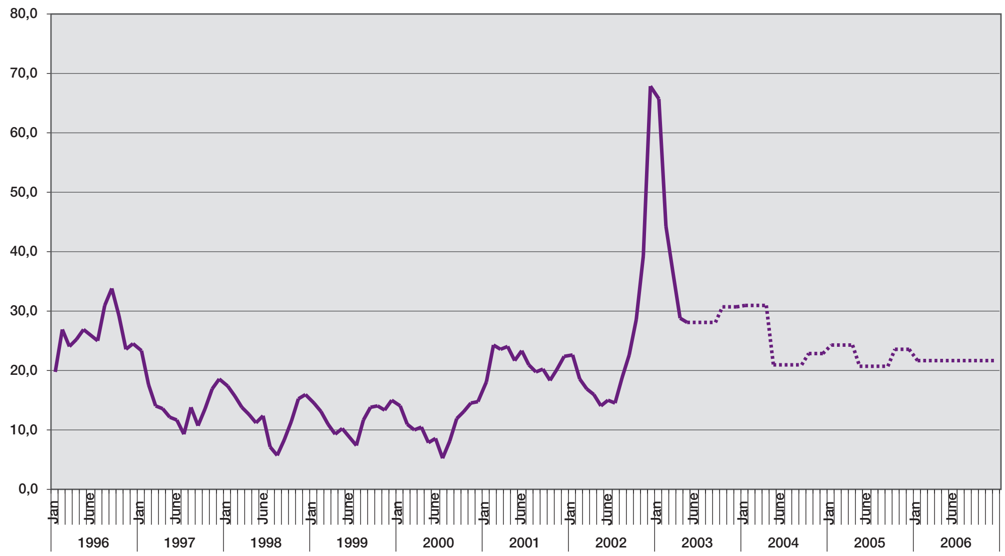
Price of electricity to end customers in Sweden

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, electricity trading prices have been dropping steadily since 1996. The trend was broken at the beginning of 2001 and 2002, and prices began to rise as a consequence of developments on the spot market.

On 1 January 2003, the price of electricity to customers living in apartments was an average of 46% higher in current monetary values than on the corresponding date of 2002. The price to customers living in singe-family houses without electric heating rose by 49%, and to customers with electric heating by an average of 51%. These price increases principally affect customers with "until further notice" contracts. The price to bigger customers such as industrial plants and agriculture also increased sharply. This reflects the low availability of hydro power in the Nordic system, which has resulted in a sharp rise in electricity prices on the Nordic electricity exchange. However, it is important to point out that electricity-intensive industry also trades in long-term bilateral contracts. As a result, these players are not affected to the same extent by short-term variations in the spot price of electricity. Table 1 shows the prices to customers

FIGURE 1

Historical system prices and forward prices on Nord Pool between 1996 and 2006, öre/kWh



Note: The dashed line shows the consumer prices on 29 April 2003.

Source: Nord Pool

with normal price agreements, i.e. until further notice for the years 1997–2003.

Network tariffs in Sweden

The term network tariff denotes the charges levied and other conditions imposed 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 to 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 time tariffs. 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 fact that consumers are interested in low and stable prices. Moreover, consideration must be given to justifiable demands of the network owners for a reasonable yield from their 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 a 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 a major part of the total tariff.

In the spring of 2002, Swedish Parliament decided on certain amendments to the Electricity Act. One of the changes is in the crite-

TABLE 2

Network charges on 1 January 1997 and 1 January 2003, and the percentage change, öre/kWh

	UPPER QUARTILE			MEDIAN			LOWER QUARTILE		
	1997	2003	%	1997	2003	%	1997	2003	%
Apartment	47.2	50.7	7.0	41.3	43.4	5.0	33.1	36.2	9.0
Single-family dwelling without elec. heating	42.0	44.8	7.0	36.0	38.2	6.0	29.7	32.7	10.0
Single-family dwelling with elec. heating	24.6	24.3	-1.0	21.3	21.1	-1.0	18.6	18.3	-2.0
Agriculture and forestry	26.4	25.4	-4.0	22.2	22.8	3.0	19.3	19.5	1.0
Commercial operations	17.6	18.3	4.0	15.4	15.6	1.0	13.2	13.9	5.0
Small industrial plant	18.6	18.0	-3.0	16.7	15.4	-8.0	14.2	13.4	-5.0
Medium-sized industrial plant	10.6	10.9	3.0	9.3	9.7	4.0	8.0	8.3	4.0
Electricity-intensive industrial plant	6.9	6.8	-1.0	5.4	6.2	15.0	4.3	4.4	2.0

Source: SCB EN 17

TABLE 3

Electricity prices to industrial and domestic customers in the Nordic countries in 2001 and 2002, including taxes and VAT[1], öre/kWh

	NORWAY				SWEDEN			
	2001		2002		2001		2002	
	1/1	1/7	1/1	1/7	1/1	1/7	1/1	1/7
Small industrial plant[2]	36.0	41.7	46.1	44.9	33	39	31.9	31.4
Medium-sized industrial plant[3]	26.5	32.8	34.5	36.2	24.1	30.8	26.1	25.6
Large industrial plant[4]	19.6	25.4	26.2	26.9	20.7	27.8	23.5	23.1
Domestic customer, 3 500 kWh	102.1	117.1	119.5	116.5	91.6	100.7	104.5	103.4
Domestic customer, 20 000 kWh	65.3	76.9	77.8	71.8	74.8	84.2	86.9	85.8

	FINLAND				DENMARK			
	2001		2002		2001		2002	
	1/1	1/7	1/1	1/7	1/1	1/7	1/1	1/7
Small industrial plant[2]	41.6	43.9	45.4	46.0	-	58.8	65.2	62.0
Medium-sized industrial plant[3]	36.6	39.0	40.8	41.1	-	-	-	-
Large industrial plant[4]	26.4	28.2	30.3	30.5	-	-	-	-
Domestic customer, 3 500 kWh	76.7	83.2	86.4	87.4	183.8	195.4	203.2	201.6
Domestic customer, 20 000 kWh	48	51.0	53.7	54.6	158.2	168.9	175.6	174.3

Note: Bank of Sweden foreign exchange rates for that particular month were used.

Source: Eurostat, Statistics in Focus

[1] The prices to industrial customers are given without VAT.
[2] 1.25 GWh annually, 0.5 MW, 2500 hours
[3] 10 GWh annually, 2.5 MW, 4000 hours
[4] 770 GWh annually, 10 MW, 7000 hours

ria 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 came 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 suited to the market for regulating the network tariffs than the present method. The new model will be taken into use in 2004.

The way the network charges to various customer categories have developed between 1997 and 2003 is shown in Table 2. Between 1997 and 2003, the median of the network charge has increased by 5% to customers in apartments and by 6% to customers in single-family houses without electric heating. During the same period, 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 has risen by 3% during the period. The biggest change and increase in the tariff level has taken place in the category of oil-intensive industrial plants. Since 1997, the tariff level has increased by 15%.

The task of the supervisory authorities is to ensure that the network companies run their operations in such a manner that the interest of customers in cost effectiveness is met. They must also ensure that the tariffs are reasonable and objective. In Sweden, Norway and Finland the network tariffs are regularly published.

Electricity prices in the Nordic countries

Electricity prices to domestic and industrial customers in the Nordic countries are shown in Table 3.

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 largely 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.

Network tariffs in other Nordic countries

A common feature in the Nordic countries is that the network monopoly is monitored. Su-

FACTS – CUSTOMER CATEGORIES

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 meter fuse rating
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% of the companies have a value that is higher than the upper quartile.

pervision in Norway is carried out by Norges Vassdrag- och Energidirektorat, NVE (the Norwegian Water Resources and Energy Directorate). In Finland, the Energy Market Authority is the special supervisory authority formed for this task. Since 1 January 2000, Denmark also has a special supervisory authority for network operations – the Danish Energy Agency.

Norway and Denmark have revenue regulation, which means that the authorities determine the total revenues in advance. In Sweden and Finland, the tariffs are reviewed in arrears.

Finland has much lower network tariffs than Sweden for customers living in apartments. On the other hand, the network tariffs for commercial operations/agriculture and small industrial plant categories are much higher in Finland. Norwegian network tariffs for the various customer categories are basically on a par with Swedish tariffs. However, the average of the network charges in the various countries shows that they are lowest in Sweden (see Table 4).

Economic regulatory instruments

Today's economic regulatory 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 regulatory instruments must be designed so that they take into the account the international competitive situation in certain industries.

The economic regulatory instruments that affect developments on the electricity market are taxes on the generation and consumption of electricity, and support for various power generation methods. Trading in electricity certificates was also introduced in May 2003, and trading in emission rights may possibly be introduced in 2005.

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

Swedish Parliament decided in the spring of 2000 to implement a green tax exchange reform on a total of around SEK 30 billion over a ten-year period. The tax exchange during 2003 comprises SEK 2.6 billion in raised taxes on energy, balanced by lower taxes on work. As from 2003, the carbon dioxide tax was raised by 12 öre/kg of carbon dioxide to 76 öre/kg. The electricity tax to domestic customers was also raised by 2.9 öre to 22.7 öre/kWh in southern Sweden, while the increase in northern Sweden was 2.8 öre to 16.8 öre/kWh. Tax on the consumption of electricity is payable at the rate shown in Table 5. 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 19.2 öre/kWh in northern Sweden and 22.7 öre/kWh in the remainder of the country. 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, mining industry and commercial greenhouse operators have been exempt from electricity tax since 1994. As from 1 July 2000, agriculture, forestry and aquaculture are also exempt from electricity tax.

All fuels used for power generation are currently exempt from energy and carbon dioxide taxes. However, part of the fuel, namely 5% in condensing power generation

TABLE 4

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

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

Note: Bank of Sweden foreign exchange rates on 2 January 2002 were used.

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

TABLE 5

Electricity taxes at consumer level in Sweden, öre/kWh

	1996		1997		1998	1999	2000	2001	2002	2003
	01-Jan	01-Sept	01-Jan	01-Sept	01-Jan	01-Jan	01-Jan	01-Jan	01-jan	01-jan
Northern Sweden										
Electricity, gas, heat and water supplies	4.3	5.3	7.4	8.2	9.6	9.5	10.6	12.5	14.0	16.8
Industrial operations	0	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	16.8
Remainder of Sweden										
Electricity, gas, heat and water supplies	7.5	9.1	10.7	11.5	12.9	12.8	13.9	15.8	17.4	20.2
Industrial operations	0	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	22.7

Source: Tax authorities

and 1.5% (a reduction from 3% as from 1 July 2002) in CHP generation, is considered to be for in-house consumption and is taxed. In addition, fuels used for power 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 other stationary combustion plants. The nitrogen oxide charge is levied on plants with an annual energy output of at least 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% by weight to 0.05%. If the sulphur content exceeds 0.05% by weight but not 0.2%, the value is rounded off upwards to 0.2%.

Fuels used for heat generation are taxed differently, depending on whether the heat is generated in a boiler plant, a CHP plant or an industrial plant. Energy taxation in Sweden is currently being reviewed.

The Tax Reduction Committee (SNED) was entrusted by the Government with the task of reviewing the Swedish energy taxation, and has proposed a tax model in which the whole of commerce and industry is taxed equally. For further information, see the chapter entitled Energy and environmental policies. The proposal was circulated for comments during the spring of 2003.

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. In addition, 0.15 öre/kWh delivered 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 on spent nuclear fuel. From 1 January 1996, all power generation plants have been paying a property tax amounting to 0.5% of the taxable value.

Denmark

Taxes payable by domestic customers are particularly high in Denmark, as shown in Table 6. These consist of carbon dioxide tax and electricity tax. Taxes at 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

TABLE 6

Electricity taxes in the Nordic countries on 1 January 2003, öre/kWh

	Denmark	Finland	Norway	Sweden
Households	61.6[1]	6.8	11.9	22.7
Industry	0[2]	4,1	0	0
VAT, percent	25	22	24	25

[1] The tax is applicable to electrically heated dwellings with an annual consumption of more than 4000 kWh. Other consumption is taxed at the rate of 69.6 öre/kWh. A carbon dioxide charge is also payable at the rate of 12.3 öre/kWh.

[2] A carbon dioxide charge is payable by industry. The charge is lower if an agreement is 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.

Sources: www.finlex.fi, Ministry of Trade and Industry, Department for Oil and Energy, www.resinfo.dk, Danish Energy Agency, www.skat.dk, Tax Authorities in Sweden.

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 24.6 DKK per kg of sulphur emitted.

Finland

Finland has only two spot taxes on 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, and so are all electricity customers in Nord-Troms and Finnmark. Power generation in Norway is dominated by hydro power. A natural resource tax is levied at generation level, and this is transferred to hydro power municipalities and counties. An investment tax was also levied in the past, but that was discontinued in October 2002.

Support measures

The Nordic countries and the EU are engaged on promoting the expansion of power generation capacity based on renewable energy sources. To enable generators of such electricity to survive on the market, support is needed in some cases. The support measures vary between different countries and currently also between different generation technologies. The forms of State support for electricity generation from renewable energy sources are being reviewed in several countries.

Sweden

Support for power generation from renewable energy sources has been amended from the year 2003. Up to and including 2002, investment support was available for biofuel-fired CHP generation plants, wind power and small-scale hydro power. Further support was also available for wind power in the form of tax relief at the rate of 18.1 öre/kWh. A special grant of 9 öre/kWh was allowed for electricity generated in all types of plants with a rating below 1500 kW.

A system of electricity certificates was introduced in Sweden on 1 May 2003. This is a market-based support system in which the price of the certificates (support) is not determined beforehand and is the result of the relationship between supply and demand. In this system, the generation of electricity from renewable energy sources, with the exception of existing large-scale hydro power plants, is supported by the generator being allocated electricity certificates by the State at the rate of one for every MWh. The generator sells his electricity as usual, and also receives an income from the sale of the certificates. According to the Electricity Certificate Act, electricity suppliers or electricity users are obliged to buy certificates at a certain proportion of the electricity they use. The first year was 2003, when electricity suppliers and users were obliged to buy seven certificates for every hundred MWh they used. The quota will then be increased from year to year in order to stimulate investments in power generation from renewable energy sources.

In order to provide generators with protection against excessively low certificate prices, a price guarantee for the electrical certificates is given during an introductory period (2003 – 2007). However, the price guarantee is not payable until the end of the year. For wind power, the tax relief of 18.1 öre/kWh is retained during 2003. Tax relief will then gradually be scaled down. In addition, support is also available for market introduction of wind power technology. The support may be used for technology development and market introduction of large-scale wind power plants.

Denmark

In Denmark, the support system for renewable power generation was altered due to the political agreement concluded in June 2002. As from 2003, support for wind power consists of a fixed payment made until the unit has run for a certain number of full-load hours or, in certain cases, for ten years, and of a price supplement. The main principle is that, for existing plants, the fixed payment and price supplement amount to a maximum of 74 öre/kWh, while for new plants, the support amounts to 53 öre/kWh. When a unit has achieved its requisite full-load hours, the support is reduced to a price supplement of 12 öre/kWh. However, for existing plants that are less than ten years old but have operated for the requisite full-load hours, the support amounts to 53 öre/kWh. The price supplement of 12 öre/kWh has a time limit and will be paid for a maximum of 20 years. A ceiling has been set for the price supplement and the electricity price, whereby these together must not exceed 44 öre/kWh.

Other electricity from renewable sources is entitled to a price supplement of 33 öre/kWh. Investment support is also available for the development and demonstration of renewable energy sources.

In addition, support at the rate of 10 öre/kWh is available for existing natural gas-based decentralized plants with a total capacity not exceeding 25 MW, and this is payable up to an annual energy output of 8 GWh. In addition, limited-duration support of 9 öre/kWh is available for natural gas-based back-pressure generation and waste-fired CHP generation plants.

Norway

In Norway, wind power is subsidized by 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 farms with a total installed power of more than 1500 kW and in which every unit has a rating of at least 500 kW. The investment grant amounts to 10% of the approved cost, up to 6 million NOK/MW. In addition, there is financing support for energy generation in plants that employ renewable energy sources other than wind, e.g. wave energy and solar heat plants. The grant amounts to 25% of the approved project cost.

Finland

Investment support is available in Finland for development and investment projects that promote the use of renewable energy sources, etc. Grants of up to 25 – 40% of the approved investment sum are allowed for such investments, the actual percentage depending on the nature of the investment. In addition, a minor amount of generation support is allowed for electricity generated by wind power plants, small hydro power plants, small peat-fired CHP plants, or plants fired with wood, biogas, forest chips, waste fuel, waste gases from metallurgical processes or with reaction heat from chemical processes. The generation grant for wind power plants is 6.3 öre/kWh, for plants fired with waste fuel the grant is 2.3 öre/kWh, and for other plants, it is 3.8 öre/kWh.

The EU

The Council and 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 power generation. In the document, the Council and 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 development does not progress in the desired direction, the Commission may suggest binding measures aimed at attaining the indicative objectives.

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

Electricity certificates

The support forms that have been approved by the EU for assisting investments aimed at protecting the environment include “green certificates” or electricity certificates. In addition to Sweden, other countries that have electricity certificate systems are Belgium, the Netherlands, Great Britain, Italy and Australia. In addition, there is the international Renewable Energy Certificate System (RECS). This is a voluntary system for international trading in electricity certificates, which was launched in 1999 as European cooperation between the Netherlands, Denmark and Great Britain. At the present time, about 120 members from 18 countries, including Sweden, participate in the RECS cooperation.

Trade in emission rights

The EU Ministers for the Environment agreed in December 2002 on a draft EC Directive on trading in emission rights. In this Directive, demands are made for all power and heat generators with a power input of more than 20 MW and most of the energy-intensive industry to be obliged to have permits for emitting carbon dioxide. Each country will determine the allocation of emission rights on the basis of a number of general criteria. The country shall then determine the quota for each individual plant. The national legislation necessary for following the Directive shall come into force no later than 1 January 2005. Emission rights will be allocated free of charge during the period between 2005 and 2007, and 90% of the emission rights will be allocated free of charge as from 2008.

Preparations are in progress in **Sweden** for introducing the Directive. A parliamentary committee has been entrusted with the task of preparing a proposal for a Swedish system and regulations for the flexible mechanisms of the Kyoto Protocol. An interim report will be submitted to the Government in May 2003 with a proposal for the principles for drawing up a national allocation plan in accordance with the EU proposal for trade in emission rights. The final report on the assignment will be presented in December 2003.

Trade in electricity

Trade in electricity takes place between a variety of player types, both in Sweden and across the national borders of Nordic countries, via the spot market. The players trade by bilateral contacts or through the Nord Pool 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. Formalized Nordic cooperation was then started for the transmission of electricity.

Nordic electricity exchange

In Sweden, 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. Trade with Finnish electricity generators initially took place on the EL-EX exchange, and the electricity base market has been accessible to Swedish and Finnish players since 1999. Today, EL-EX is used only by Swedish and Finnish players for selling or buying electricity in the same 24-hour period in which delivery is to take place, in order to achieve balance between generation and sales of electricity. Nord Pool AS today owns 100% of the shares in EL-EX, which has been a wholly-owned subsidiary of Nord Pool Spot AS since July 2002. In 2002, Nord Pool ASA was split into three companies as a result of the concessions as exchange and clearing house, and the broadening of ownership in the spot market operations. Nord Pool ASA has exchange concession for financial trading, and is owned equally by Svenska Kraftnät and Statnett. Nord Pool Clearing ASA has a concession as a clearing house and is wholly owned by Nord Pool ASA. Nord Pool Spot AS has marketplace concession for physical trading in electricity, and is owned by the Nordic system operators and by Nord Pool ASA.

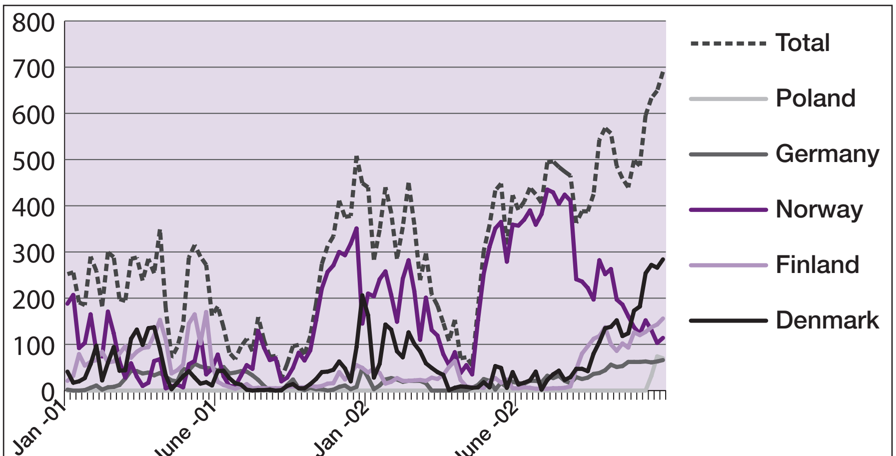
Trade volumes and number of players

The players at Nord Pool include power generators, distributors, industrial companies and other end users, and portfolio managers. The electricity exchange markets consist of a spot market (delivery in the next 24-hour period), a financial market (contracts of up to four years for hedging in the longer term) and clearing operations (opposite party responsibility). In April 2003, there were 319 players on the various Nord Pool markets, which is 14 more than in the previous year. The players come mainly from Nordic countries, but the proportion of players from outside the Nordic countries has increased in recent years. There are 80 Swedish players, 39 Finnish, 155 Norwegian and 21 Danish. The remaining 24 players are from 8 other countries.

Trade on the spot market has increased every year since deregulation of the electricity market. During 2002, the physical market turnover was 124 TWh, which was more than 11% higher than in 2001. Trade on the financial markets increased to 1019 TWh during 2002, which represents an increase of more

FIGURE 2

Sweden's electricity imports in 2001 and 2002, GWh per week



Source: Energy in Sweden, Swedenergy

than 12% compared to 2001. In addition, 2089 TWh were cleared in standardized bilateral contracts during 2002, which is an increase of around 20% on 2001. Clearing of exchange contracts and reported bilateral contracts involves Nord Pool Clearing acting as the opposite party to sellers and buyers. For this service, Nord Pool Clearing levies a clearing charge and requires the companies to deposit a security sum based on their actual portfolio. This may consist of cash in a blocked bank account or by means of bank guarantees aimed at covering the risk taken by the electricity exchange in acting as the opposite party.

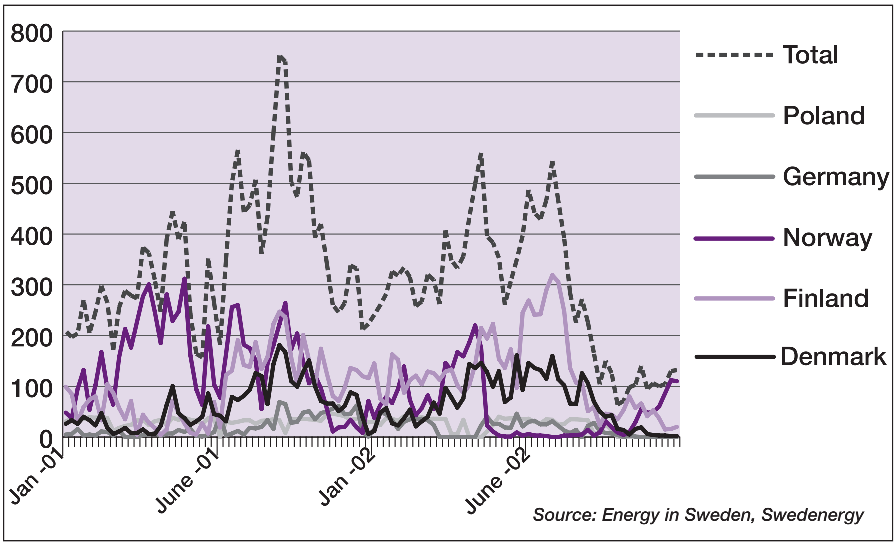
Electricity trade between Nordic countries

As a result of the changes on the electricity markets 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 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 determinant for the trade flows 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 net exporters of electricity during the spring and summer.

FIGURE 3

Sweden's electricity exports in 2001 and 2002, GWh/week



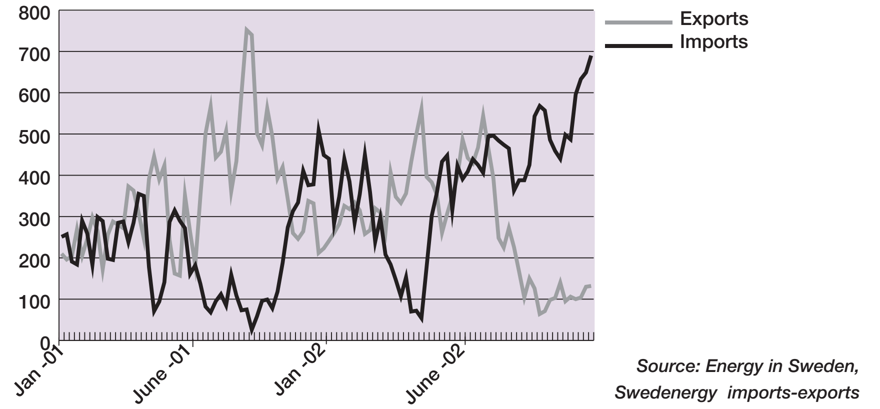
Source: Energy in Sweden, Swedenergy

In wet years when the water inflow is good and the reservoir levels are high, 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 flow 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. In August 2000, a DC link (Swepol cable) was commissioned between the Swedish County of Blekinge and northern Poland, which marked the beginning of electricity trade with Poland. Trade between Denmark and Germany is the most extensive trade in electricity with countries outside the Nordic group. Figures 2, 3 and 4 show how the trade flows have changed between 2001 and 2002.

Table 7 shows Sweden's foreign trade in electricity. 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 these years, with the exception of 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. Electricity imports dropped during 2001 to 11.1 TWh, compared to 18.3 TWh during 2000. Almost half of Sweden's electricity imports came from Norway. During the 2002/2003 season, the levels in the water reservoirs were lower than they were for a very long time (see the chapter entitled The electricity system). Sweden's total exports of electricity to neighbouring countries during 2002 amounted to 14.8 TWh, which is 3.7 TWh lower than in 2001. Exports to Denmark and Finland increased slightly, whereas those to Norway and Poland dropped substantially. Exports to Germany remained relatively unchanged. Sweden exported 2.8 TWh to Norway, which is 4.7 TWh lower than in 2001. Sweden's net imports during 2002 amounted to 5.4 TWh. ■

FIGURE 4

Sweden's electricity trade with foreign countries in 2001 and 2002, GWh/week



Source: Energy in Sweden, Swedenergy imports-exports

TABLE 7

Sweden's electricity trade with foreign countries in 2001 and 2002, GWh/week

		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*	*5.5*	-	-	*-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	0.4	0.7	13.6
	imports-exports	*-1.8*	*-7.4*	*14.8*	*-0.3*	*-0.6*	*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*	*-2.3*	*0.1*	*-1.7*	*-7.3*
2002	imports	4.1	2.5	12.0	1.4	0.2	20.2
	exports	3.5	6.5	2.8	0.9	1.1	14.8
	imports-exports	*0.6*	*-4.0*	*9.2*	*0.5*	*-0.9*	*5.4*

Note. Rounding-off discrepancies occur. After the electricity market reform, 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, Swedenergy

Competition in 2002

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 covers the part of the market that is open to competition, i.e. generation and trading.

Generation

The electricity market in Norway was deregulated back in 1991. For Sweden and Finland, 2002 was the seventh year of reformed electricity market. Since the reforms were introduced, the ownership conditions have changed on the power generation side. The description below begins with market conditions for power generation in Sweden and in other Nordic countries.

Market structure

Power generation in Sweden is highly concentrated to a few companies. The five biggest electricity generators account for around 90% of the power 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 2002, as shown in Table 8. In the Nordic perspective, the two biggest Swedish generators had a market share of 25% of the total Nordic production. The clearly dominant company was Vattenfall, with an 18% share of the market, followed by Fortum with 12%. Critics claim that the market shares in Sweden provide the means for the companies steering the market towards furthering their own ends. Above all, this applies in situations in which the demand is very high and the transmission links to foreign countries represent a constraint. 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 in the Nordic countries, and the fifth biggest in Europe. During 2002, Vattenfall generated 70 TWh. The Swedish market is still the biggest to Vattenfall, but sales in Finland and Norway are growing. 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 2002, the total electrical energy generated by the Sydkraft group of companies amounted to 24.7 TWh. In addition, Sydkraft has access to 10.1 TWh of generation capacity in associated companies. Excluding minority shares that amounted to 6.3 TWh, this means that Sydkraft had access to 28.5 TWh during 2002. Since 2001, Sydkraft has had two large owners, i.e. the German company E.ON Energie with 56.5% of the voting shares, and the Norwegian company Statkraft with 43.4% of the voting equity.

Birka Energi was formed in September 1998 by the merger of Stockholm Energi and Gullspång Kraft. From 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 holding of about 70%. The total electrical energy generated in 2002 was 24.5 TWh, excluding minority holdings and subcontracted power.

The generation system of Graninge is based entirely on hydro power and wind power. During 2002, the company generated 2.4 TWh of electrical energy in its own hydro power stations.

The power generation system of Skellefteå Kraft is based principally on hydro power. The

TABLE 8

Largest Swedish electricity generators and the electrical energy they generated between 1999 and 2002, TWh

	1999	2000	2001	2002
Vattenfall	79.6	69.3	76.6	70.3
Sydkraft	27.5	27.2	32.7	28.5
Birka[1]	21	21.4	22.3	
Fortum[2]	6	6.4	7.3	24.5
Skellefteå	3	2.9	3.7	3.4
Graninge	2.6	3.2	3.6	2.4
Sum	139.7	130.4	146,2	129.1
Total i Sweden	**150.9**	**140.1**	**157.8**	**143.4**

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 a wholly owned subsidiary of Fortum Power and Heat AB.

[2] For 2002, there is some uncertainty concerning the figure, due to the merger with Birka Energi.

Source: Swedenergy, Nordel

TABLE 9

Largest Swedish electricity generators and their installed capacities on 1 January 2000 to 2003, MW

	2000	2001	2002	2003
Vattenfall	14 324	14 021	14 163	13 738
Sydkraft	5 878	5 981	6 296	6 794
Birka[1]	4 399	4 440	4 553	
Fortum	1 331	1 381	1 487	6 182
Skellefteå	598	758	758	764
Graninge	552	577	607	607

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

Source: Swedenergy

company also has a minor holding in Forsmark. The total electrical energy generated in 2002 amounted to 3.4 TWh.

Power generation in other Nordic countries

Substantial restructuring has taken place in Denmark. On the generation side, upward of 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 about 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 basically classified into two groups. Fortum and Pohjolan Voima are the two most important generators. Vattenfall is the third in significance on the Finnish market.

Competition in generation

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 that a player could be able to control, due to his large market share, the availability of power, so that the price would then increase beyond the marginal cost on a defined market.

Single 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 could 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 the 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 breakdown 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 in which the electricity is to be distributed. Many of the Scandinavian electricity trading companies are still members of groups of companies 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 the electricity suppliers, to individual companies wanting to strengthen their strained finances. The large companies have forged ties with many electricity trading companies by take-overs or part ownership, or by concluding agreements. The three big companies are Vattenfall, Fortum/Birka Energi and Sydkraft, and they also dominate on the electricity trading market. The three together account for around 70% of sales to end customers.

Electricity trading companies in other Nordic countries

Around one hundred 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 have 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 that 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-overs of entire companies, by part-ownership or by 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 being restricted in their ability to make free and rational choices. One of the limitations is the difficulty of 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.

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

A Temo market survey commissioned by Swedenergy (the association of Swedish generating companies trading as Svensk Energi AB) has revealed that growing numbers of consumers have changed to different electricity suppliers or have re-negotiated their electricity agreements. The attitude towards the electricity market reform has become more cautious than it was a year ago. But more than 60% of Swedes still think that the electricity market reform is very good or good.

According to the electricity competition study, no evidence could be found to indicate that prices to 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 to companies have increased during last year. ■

TABLE 10

The five largest Nordic electricity generators and the electrical energy they generated in 2002

Generator	Electrical energy generated in 2002, TWh	Proportion in Nordic countries, %
Vattenfall	70.3	18
Fortum	46.5	12
Statkraft SF	40.4	11
Sydkraft	28.5	7
Pohjolan Voima Oy	16.6	4
Total for biggest Nordic electricity generators	**202.3**	**53**
Total for Nordic countries	**383.1**	**100**

[1] Excl. Iceland.

Source: Nordel, Swedenergy and annual reports

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, power generation, the environmental impact of the electricity system, power generation costs, and the transmission of electricity in the Nordic perspective.

Electricity consumption

The development of electricity consumption is dependent on the growth of the national economy. Since 1990, total electricity consumption in the Nordic countries has risen by an average of 1.2% annually. The greatest increase has taken place in the residential and services sectors, which can be explained in part by the growing services sector that uses more electrical equipment, and by 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 risen at the rate of almost 3% annually. The increase was steep during the 1970s, and then tapered off. During the period between 1990 and 2001, the actual electricity consumption increased by a total of 7.6%, but after temperature correction, the figure for the period is 5.8%. In 2002, the residential, commercial, services, etc. sector accounted for half of the total electricity consumption, while industry accounted for less than 40%. A forecast for the Swedish electricity consumption for the 2010 is shown in Table 11.

Industry

Electricity consumption in industry is linked to the economic activities in the various industrial sectors. 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 substantially, which led to the electricity consumption dropping by 3.2% annually between 1990 and 1992. During the period between 1997 and 2002, electricity consumption increased at the rate of just over 1% annually. The upturn was due mainly to the high rate of growth in the pulp and paper industry.

Electricity consumption varies between different industries. In 2002, the electricity-intensive industries, i.e. the mining industry, pulp and paper industry, basic chemicals industry, ironworks, steelworks and non-ferrous metalworks accounted for almost 70% of the total industrial electricity consumption. The share of the engineering industry was 13%.

FACTS – ELECTRICITY SYSTEM

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

According to international standards, 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 3600 seconds in one hour, one watt hour is 3600 J. When large quantities of electricity 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. 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 power generation must constantly be controlled so that it is 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 maintain balance, Svenska Kraftnät cooperates with more than 40 players who have balance responsibility for one or more 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 load generating plants, which includes nuclear power, for example.

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

Controllable power generation is power generation whose output can be increased or reduced relatively simply and inexpensively to adjust the generation rate to variations in demand. This concept must not be confused with control power, i.e. power that the system operator must have at his disposal for instantaneously balancing the generation rate to suit 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 is limited. The proportion of uncontrollable power generation capacity is steadily increasing throughout northern Europe, since expansion is taking place principally in this category.

TABLE 11

Electrical energy consumption in Sweden in 1990, 1996–2002 and forecast for 2010, TWh

	1990	1996	1997	1998	1999	2000	2001	2002	2010
Industry	53.0	51.5	52.7	53.9	54.5	56.9	56.2	56.0	58.6
Pulp and paper industry	20.0	19.3	20.5	21.1	21.6	22.8	21.6	21.7	23.2
Ironworks and steelworks	4.8	4.9	4.9	4.9	5	5.4	5.3	5	5.3
Chemical industry	6.2	5.5	5.8	5.8	5.9	5.8	6.1	6.6	7.0
Engineering industry	7.2	7	6.9	7.1	7	7	6.8	7.4	7.5
Residential, commercial. services. etc.[1]	65	71.6	69.6	69.9	69.1	69	73	73.4	74.2
Electric heating	25.8	27.3	26.1	23.9	21.5	21.4	22.2		27.6
Domestic electricity	17.9	19.3	18.6	19.4	16.9	17.7	19.1		21.1
Electricity for appliances	21.3	25	24.9	26.6	30.7	29.9	31.7		25.5
Transport	2.5	3.1	3	2.8	3	3.2	2.9	2.7	3.2
District heating, refineries	10.3	6.3	6.8	6.6	6.3	6.5	6.7	5	4.6
Distribution losses	9.1	10.2	10.7	10.9	10.6	11.1	11.6	11.6	11.4
Total net consumption[2]	139.9	142.7	142.6	144	143.5	146.6	150.5	148.7	152.0
Total net temperature-corrected consumption	**143.1**	**141.7**	**143.3**	**145**	**144.8**	**149.5**	**151.4**		**152.0**

[1] From 2001, a weekend cottage study shows that the consumption is much higher than the value estimated in the past.
[2] I.e. excluding in-house consumption for electricity and heat generation.
The information has been revised compared to the previous issue.

Sources: For the years 1990–2000, Energy in Sweden 2002, Swedish Energy Agency.For the years 2001 - 2002, Statistics Sweden. For 2010, Swedish Energy Agency climate report ER 13:2001, Swedish Energy Agency 2001.

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 in this sector. 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 space heating varies from year to year, depending on factors such as temperature conditions. Household electricity accounts for around 25% of the total electricity consumption in the sector. In spite of the increased number of households and domestic appliances, consumption has been relatively stable during the 1990s. This is due to technical development and the higher efficiency of new domestic appliances that are gradually replacing older products. Electricity for appliances, which currently accounts for just over 40% of the electricity consumption in this sector, has increased most during the 1990s. This increase is due mainly to the increasing number of electrical apparatus in the services sector.

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 is relatively stable and has amounted to 2.7 TWh in 2002.

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 1.3 TWh in 2002. The electrical energy input for heat pumps during 2002 amounted to 2.0 TWh. The electrical energy consumption of refineries is relatively constant and amounted to 0.7 TWh in 2002.

Forecast for 2010

Table 11 shows a forecast for the consumption of electricity in 2010. It should be noted that the forecast is based on assumptions concerning economic development and development in oil prices. Electricity consumption is expected to increase by just under 0.3% annually between 2002 and 2010.

Electricity consumption in Denmark, Norway and Finland

Electricity consumption between 1990 and 2002 has increased in all Nordic countries as

TABLE 12

Electrical energy consumption in Finland, Denmark and Norway in 1990 - 2002, TWh

	FINLAND				DENMARK				NORWAY			
	1990	1996	2001	2002	1990	1996	2001	2002	1990	1996	2001	2002
Industry (incl. the energy sector)	33	37	45	44	9	10	10	10	47	45	52	46
Residential, commercial, services, etc.	26	29	34	37	20	22	23	23	51	59	64	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	3	3	2.3	2.9	2.3	2.4	6.9	8.5	10	11
Total consumption	**62**	**69**	**82**	**84**	**31**	**35**	**35**	**35**	**105**	**113**	**125**	**121**

[1] For 2001 and 2002, transport is included in the residential. commercial and services sector in all countries.

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

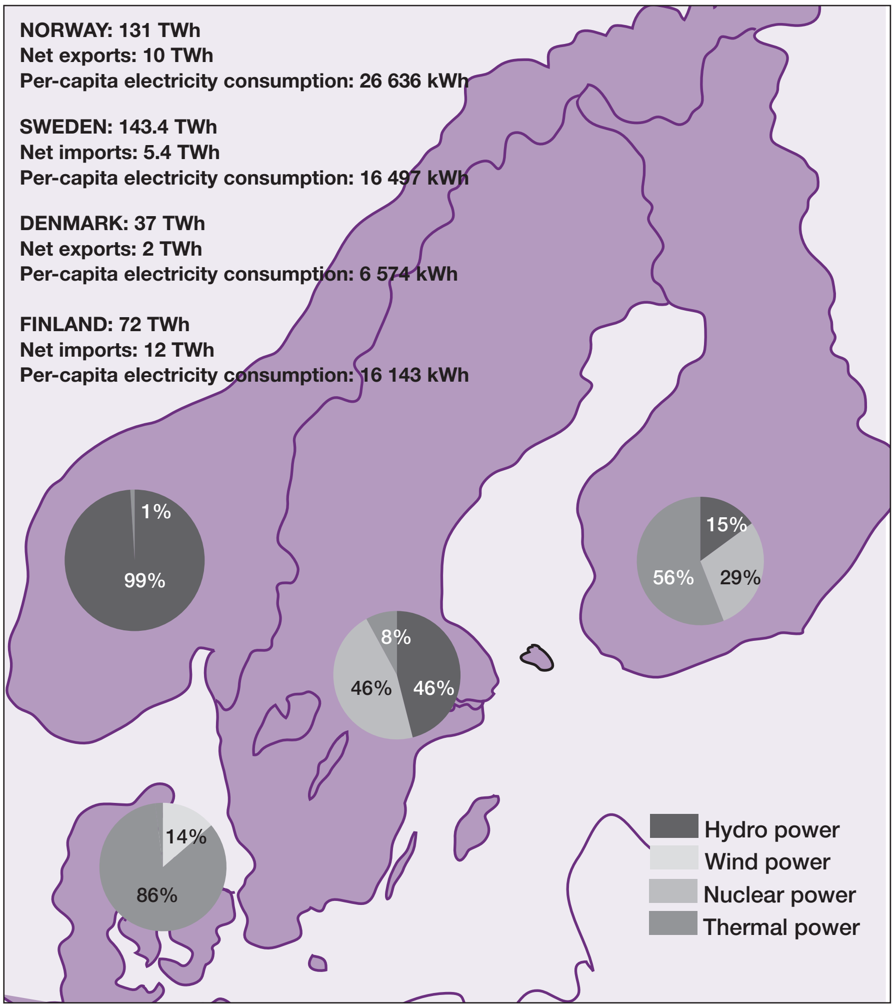
shown in Table 12. The highest rate of increase was recorded in Finland at an average annual rate of 2.6% since 1990.

In Norway and Finland, the industrial sector accounts for a large proportion of the total energy consumption at 38% and 53% respectively. This is because, just like Sweden, Norway and Finland have a large proportion of electricity-intensive industries. In Denmark, which has a different industrial structure, industry accounts for less than 30% of the electricity consumption. 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 industries and the cold climate. See also the section entitled “An international perspective”.

FIGURE 5

Electrical energy generated in the Nordic countries, TWh, and the per-capita consumption in 2002, kWh/inhabitant



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 predominantly by hydro power, and in Denmark, 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 6 shows the Swedish electricity balance week by week during 2001 and 2002. The power generation rate varies with the consumption, and generation is therefore high in 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 its lowest. 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 2002, hydro power and nuclear power each accounted for 46% of the Swedish power generation, and fossil-fired and biofuel-fired generation accounted for 8%. The total electrical energy generated was 14 TWh lower than in 2001, and amounted to 143 TWh. The reason for the reduction is that hydro power generation was at a record level in 2001. In addition, the energy generated by nuclear power was lower than in 2001. During 2002, Sweden was a net importer of electricity. Table 13 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 Swedish Parliament, assuming 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.

Power generation in Denmark

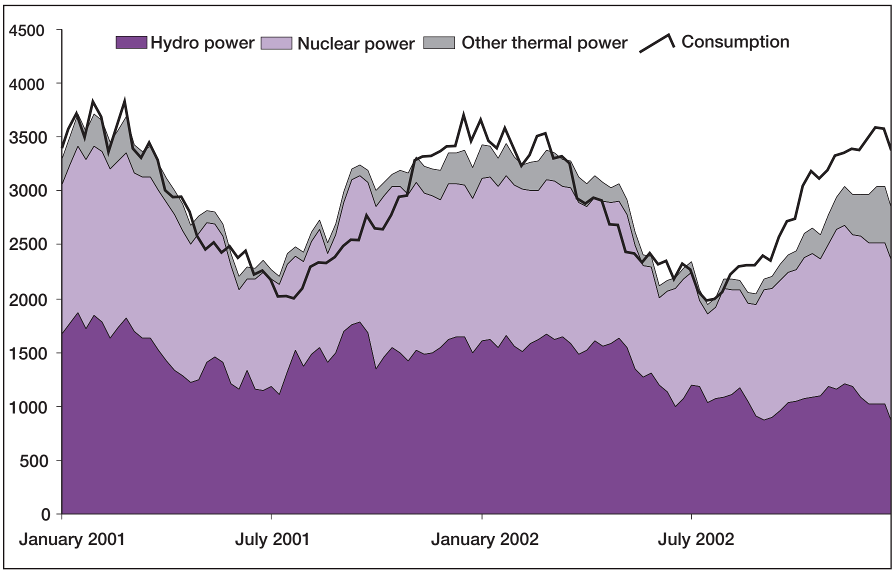
Danish power generation is based principally on coal-fired and natural gas-fired combined heat and power (CHP) stations and condensing power stations. A minor proportion of power generation is based on biofuels. In 2002, power generation in conventional thermal power stations accounted for more than 87% of the total electrical energy generated in Denmark. "Energi 21", which is the long-term plan

FACTS – POWER GENERATION

Thermal power – power stations in which heat is converted to electrical energy. This group includes condensing power, nuclear power, combined heat and power generation, and gas turbines. 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.
Steam turbine plant – in these power stations, the generator is driven by a steam turbine. Steam turbines are installed both in condensing power stations and in CHP stations.
Condensing power station – power stations that generate only electricity. The condensing power stations in Sweden are fuelled mainly with fuel oil and uranium. Condensing power is also generated in CHP stations with recoolers.
Hydro power stations – power stations that convert the kinetic energy of water into electrical energy.
Nuclear power stations – condensing power stations that use nuclear energy for generating electricity.
Wind power stations – power stations that convert the kinetic energy of wind into electrical energy.
Gas-fired combined cycle – a combined gas turbine and steam turbine plant.

FIGURE 6

Sweden's electricity balance, 2001–2002, GWh/week



Source: Energy in Sweden, Swedenergy

TABLE 13

Electrical energy generated in Sweden in 1990, 1996–2002 and forecast for 2010, TWh

	1990	1996	1997	1998	1999	2000	2001[4]	2002[4]	2010
Generation[1]	141.7	136.6	145.3	154.7	151.0	142.0	157.8	143.4	147.8
Hydro power	71.4	51.2	68.2	73.8	70.9	77.8	78.6	66.0	68.6
Wind power	0.0	0.0	0.2	0.3	0.4	0.5	0.5	0.6	3.9
Nuclear power	65.2	71.4	66.9	70.5	70.2	54.8	69.2	65.6	63.6
Conventional thermal power	5.1	14.0	10.0	10.1	9.4	8.9	9.6	11.2	11.8
- CHP in industry	2.6	4.0	4.2	4.0	3.9	4.2	3.8	4.7	4.9
- CHP in district heating networks	2.4	7.1	5.6	6.0	5.6	4.7	5.7	6.0	6.8
- Condensing, incl. gas turbines	0.0	2.8	0.2	0.1	0.0	0.0	0.0	0.5	0.1
Consumption[2]	**139.9**	**142.7**	**142.6**	**144.0**	**143.5**	**146.6**	**150.5**	**148.7**	**152.0**
Of which distribution losses	9.1	10.2	10.7	10.9	10.6	11.1	11.6	11.6	11.4
Imports-exports[3]	*-1.8*	*6.1*	*-2.7*	*-10.7*	*-7.5*	*4.7*	*-7.3*	*5.4*	*4.2*

[1] Net generation, excl. in-house energy consumption in power generation
[2] Due to rounding-off, the total sums do not always agree with the sums of the individual items
[3] For the year 1990, imports and exports also include a statistical carry-over
[4] The figures for 2001 and 2002 are based on preliminary statistics

Sources: For the years 1990 – 2000, Energy in Sweden 2002, Swedish Energy Agency. For 2001–2002, Statistics Sweden, EN20 SM. For 2010, "Updating of statistics ER 9:2003", Swedish Energy Agency.

TABLE14

Electrical energy generated in Finland, Denmark and Norway, TWh

	FINLAND				DENMARK				NORWAY			
	1990	1996	2001	2002	1990	1996	2001	2002	1990	1996	2001	2002
Energy generated	52	66	72	72	24	50	36	37	120	104	122	131
Hydro power	11	13	13	11	0	…	…	…	120	103	121	130
Wind power	0	..	..	..	1	1	4	5	0	…	…	…
Nuclear power	18	19	22	21	0	0	0	0	0	0	0	0
Conventional thermal power	23	36	36	40	24	49	32	32	1	1	1	1
- CHP in district heating networks	9	12	14	15	8	15	30[1]	30[1]				
- CHP in industry	8	10	11	12	0	2	2	2				
- Condensing power	7	14	11	13	15	32	2	2				
- Gas turbines	…	…	…	…								
Imports-exports	11	4	10	12	7	-15	-1	-2	-16	9	4	-10
Consumption	62	69	82	84	31	35	35	35	105	113	125	121

.... less than 0.1 TWh
[1] Including condensing power.
[2] For Denmark, condensing power generation and CHP generation in district heating networks are reported together from the year 2000 onwards.
Note: Due to rounding-off, the total sums do not always agree with the sums of the individual items.

Sources: Processed information from the Finnish Energia, Norwegian SSB, Danish Energy Administration, and Nordel.

TABLE 15

Installed generation capacity in the Nordic countries on 31 December 2002, MW

	Denmark	Finland	Norway	Sweden	Nordic countries[1]
Total installed capacity[2]	12 632	16 366	27 944	32 234	89 176
Hydro power	11	2 948	27 542	16 097[3]	46 598
Nuclear power		2 640		9 424	12 064
Other thermal power	9 733	10 735	305	6 374	27 147
- condensing power[4]		3 382	73	1 356[8]	4 811
- CHP in district heating	9 019[5,6]	3 655	12	2 462	15 148
- CHP in industry	444[7]	2 820	185	957	4 406
- gas turbines, etc.	270	878	35	1 599[8]	2 782
Wind power	2 888	43	97	339	3 367

[1] Excluding Iceland
[2] The power is the sum of the net outputs of 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 Linnvasselv River (25 MW).
[4] Including long-term mothballed power in Finland (about 230 MW)
[5] Including condensing power
[6] Including long-term reserve in Vendsysselvaerket power station (295 MW)
[7] Including industrial in-house generators (around 24 MW)
[8] Including output of stations comprised in the power reserve agreements in Sweden

Source: Processed statistics from Nordel

drawn up by the Danish Government for sustainable energy development in Denmark, is aimed at phasing out the use of coal in power generation and increasing the use of biofuels. This will take place by increased use of straw and wood chips, and by biofuel-fired thermal boiler stations being converted to combined heat and power stations. Denmark has also invested in substantial expansion of wind power and currently has the highest proportion of electricity generated by wind power among the Nordic countries. In 2002, Danish wind power plants accounted for 13% 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 2002, conventional thermal power accounted for 55% of the total energy generated, nuclear power for 30% and hydro power for 15%. 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 2002 amounted to about 12 TWh. To be able to meet the growing electricity consumption and reduce dependence on imports, the Finnish power generation system must be expanded. This has led to a discussion on expanding nuclear power. Another alternative discussed is to expand the natural gas-fired generation capacity. These two alternatives are given in the Finnish natural climate strategy from March 2001, and they are aimed at reducing coal consumption and thereby the emissions of carbon dioxide.

In the spring of 2002, the Finnish Government and Parliament decided in principle to build a fifth nuclear power reactor.

Power generation in Norway

Norwegian power generation is based principally on hydro power. In 2002, hydro power accounted for 99.4% of the total electrical energy 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 aim of the Norwegian energy policy is that generation should be based to a greater extent on renewable energy sources. Before the year 2010, the aim is to generate a further 4 TWh of water-borne heat from renewable energy sources, and to expand wind power so that the annual generation rate will increase to 3 TWh. An important part of the energy policy of the present government is to devote efforts to "carbon dioxide-free" gas-fired power stations.

Installed power in the Nordic countries

Table 15 shows the total net installed power in the Nordic countries at the end of 2002. Wind power has increased in all countries, but most of all in Denmark and Norway. In Denmark, the installed wind power has increased by 400 MW during 2002, and in Norway, it has increased by 80 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 page 41 and onwards. The installed CHP generation capacity in industry and district heating networks has also increased somewhat during the year.

Hydro power

In 2002, hydro power accounted for 54% of the electricity generated in the Nordic countries. The total installed power at the end of the year was 46 600 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 water inflow during 2002 was exceptionally low during the second half of the year, both in Norway and in Sweden, but the energy generated during the year was still above normal at a total of 207 TWh. This was because the hydro power generation rate in Norway was higher than normal.

Water inflow

2002 began as a normal year and the water inflow in Sweden during the spring was higher than normal. The pattern changed around week 20, the inflow dropped drastically and

TABLE 16

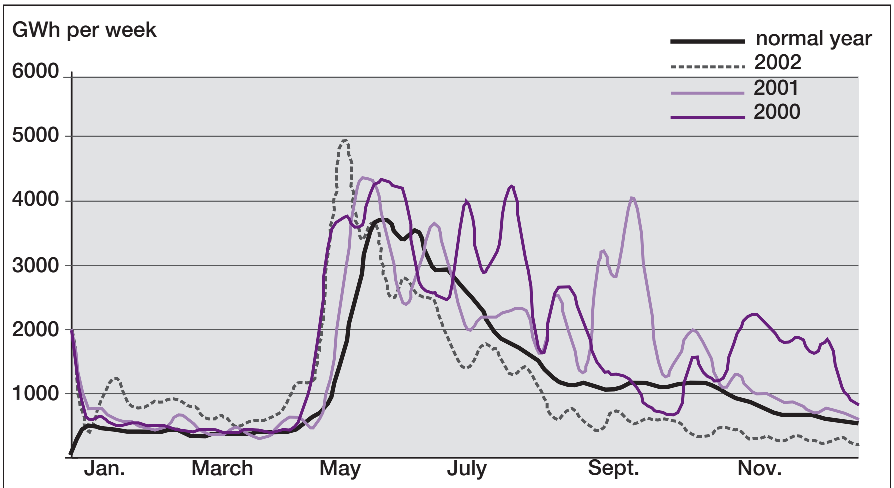
Electrical energy generated by hydro power in Norway, Finland and Denmark, TWh, and the installed capacity, MW in 2002

	Generation, TWh	Installed capacity, MW
Norway	130	27 542
Finland	11	2 948
Denmark	0.03	11

Source: Nordel

FIGURE 7

Water inflows in Sweden during a normal year and in 2000–2002, GWh/week



Source: Energy in Sweden, Swedenergy

was then low for the rest of the year. During the year, the total inflow in Sweden amounted to 57.8 TWh (not corrected for spillage). In a normal year, defined as the median for the 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 7.

Water reservoir contents

The reservoir contents in Sweden were normal at the beginning of 2002. Right up to week 30, the reservoir contents both in Sweden and in Norway were above normal level. The contents then dropped continuously in both countries right up to the end of the year, and were the lowest for 50 years during the last weeks of the year. The low contents of the Nordic water reservoirs have led to apprehension that there would be an energy shortage in the Nordic countries. The Norwegian NVE and Swedenergy therefore issued an electricity saving appeal in January 2003. The situation improved slightly in March 2003 because of the somewhat higher inflow, but the reservoir contents in Sweden were still very low compared to earlier years (12% compared to around 30% at the end of March under normal circumstances). The reservoir contents in recent years and in a normal year are shown in Figure 8.

TABLE17

Energy generated by hydro power on various Swedish rivers, TWh, and the installed capacity on 31 December 2001, MW

	1990	1996	1997	1998	1999	2000	2001	2002	Installed capacity
Lule River	15.8	14.1	16.0	12.4	15.8	15.9	15.3	16.5	4 355
Skellefte River	4.8	3.4	4.4	4.7	5.2	5.2	5.5	4.5	1 023
Ume River	9.3	5.4	8.3	9.1	8.2	9.3	10.0	7.5	1 736
Ångerman River incl. Fax River	9.4	5.5	8.0	9.5	7.7	13.6	14.4	10.4	2 574
Indals River	9.7	7.5	10.2	10.4	10.0	11.7	10.9	9.6	2 101
Ljungan	1.9	1.6	2.1	3.4	2.4	3.1	2.5	1.8	606
Ljusnan	3.5	3.2	3.7	4.1	3.8	4.3	4.5	3.4	813
Dal River	4.7	3.1	4.4	5.5	4.7	5.6	5.8	4.7	1 107
Klar River	2.3	1.9	1.6	1.7	1.7	2.0	2.0	1.6	380
Göta River	1.4	0.9	1.4	1.6	2.2	2.0	2.1	1.6	301
Other rivers	3.9	1.6	4.0	7.1	4.9	5.1	5.5	4.4	1243
Total	**71.4**	**51.0**	**68.1**	**73.6**	**70.4**	**77.8**	**78.5**	**66.0**	**16 239**

Note: The totals for energy generated differ somewhat from the official statistics.

Source: Swedenergy

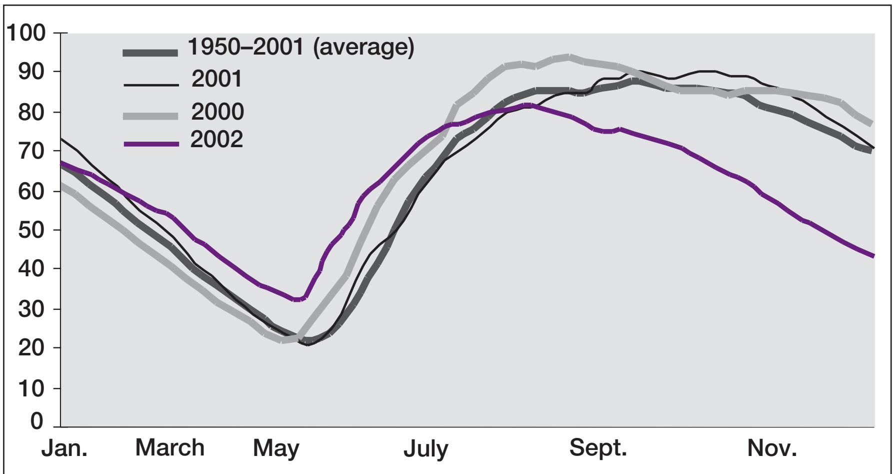
Hydro power in Sweden

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 energy generated by hydro power in Sweden (see Table 17).

During a year with normal water inflow, hydro power has the capacity to produce around 65 TWh of electrical energy, excluding losses, which represents about 45% of the total electrical energy 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 be as low as 51 TWh, whereas in wet years, it can amount to more 78 TWh. The highest annual electrical energy generated so far was recorded in 2001 at 78.5 TWh. The maximum water volume in long-term reservoirs corresponds to an energy of 33.6 TWh. Figure 9 shows the energy generated by hydro power during the past three years.

FIGURE 8

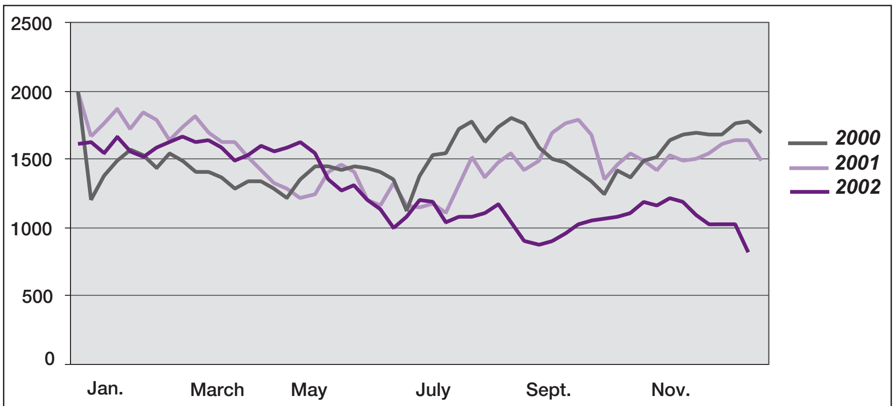
Reservoir contents in Sweden during an average year and in 2000–2002, %



Source: Energy in Sweden, Swedenergy

FIGURE 9

Hydro power generation in Sweden in 2000–2002, GWh/week



Source: Energy in Sweden, Swedenergy

Hydro power in Norway, Finland and Denmark

Virtually all of the electricity generated in Norway is based on hydro power. About 0.5 TWh of electrical energy comes from other generation sources. The energy generated during 2002 amounted to 130 TWh. In the same year, Finland generated 11 TWh of electrical energy in hydro power stations. The hydro power generated in Denmark is marginal. During the 1990s, it varied between 0.02 and 0.03 TWh, and was 0.03 TWh in 2002.

TABLE 18

Generation data for Swedish nuclear power reactors in 2002

REACTOR	NET OUTPUT, MW	ENERGY GENERATED, TWh				LOSSES, TWh	
		Max. available[1]	Actual[2]	Coast-down	Load reduction	Annual overhaul	Other losses[3]
Barsebäck 1	(600)	-	-				
Barsebäck 2	600	4.1	3.9	0.1	0.0	0.9	0.0
Forsmark 1	961	7.7	7.1	0.4	0.0	0.5	0.4
Forsmark 2	959	7.6	6.8	0.7	0.0	0.5	0.4
Forsmark 3	1155	9.6	9.1	0.4	0.0	0.3	0.3
Oskarshamn 1	445	0.0	0.0	0.0	0.0	4.1	0.0
Oskarshamn 2	602	4.8	4.5	0.1	0.1	0.4	0.2
Oskarshamn 3	1160	9.4	8.9	0.1	0.2	0.7	0.3
Ringhals 1	835	6.4	6.0	0.3	0.0	0.7	0.2
Ringhals 2	870	7.0	6.5	0.4	0.0	0.6	0.1
Ringhals 3	920	7.3	6.9	0.3	0.0	0.7	0.1
Ringhals 4	915	6.4	5.9	0.4	0.0	1.6	0.1
Total	**9422[4]**	**70.2**	**66.0**	**3.1**	**0.3**	**11.0**	**2.3**

[1] Net output . availability of the reactor . 8760 hours
[2] Net energy generated
[3] Other losses include the influence of cooling water temperature, external faults, periodic testing and faults
[4] Excluding Barsebäck 1 which was shut down on 3 November 1999.

Source: Compilation of information from Kärnkraftsäkerhet och Utbildning AB (nuclear power safety and training company).

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.

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 of the nuclear power stations, but this often involves modifications and additions 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.

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The annual generation potential of a reactor is obtained by multiplying the number of operating hours in the year by the maximum output of the plant. Since the power stations themselves use electricity, a distinction is made between gross and net output. In the Swedish reactors, the average net output is around 95% of the gross output.

There are two different ways of measuring the effectiveness of a nuclear power station – utilization and availability. Energy utilization gives the relationship between the actual generation and the theoretically attainable generation of electrical energy during a period of time. This is important for the valuation of the economics of the plant and thus its generation costs.

Energy availability specifies the time during which the reactor was connected to the grid, regardless of its output, during a certain period of time.

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 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 of the reactors declines over a period of a few weeks prior to every overhaul shut-down.

Nuclear power in Sweden

In 2002, the electrical energy generated by nuclear power in Sweden was 65.6 TWh, which is 5% lower than in 2001. One reason for the lower generation rate is that Oskarshamn 1 was shut down during the year.

The availability of Swedish reactors in 2002 varied between 77% and 95%, the average being 81%. This relatively low availability is due to Oskarshamn 1 being shut down. In an international perspective, the mean value

TABLE 19

Net electrical energy generated in Swedish nuclear reactors in 1990 and 1996–2002. TWh

Reactor	Commissioning year	1990	1996	1997	1998	1999	2000	2001	2002	Total energy generated from commissioning	Availability in 2002, %
Barsebäck 1	1975	4.3	4.1	3.7	4.3	2.6	-	-	-	92.7	-
Barsebäck 2	1977	4.2	3.8	3.9	4.0	3.5	2.9	4.4	3.9	98.8	77.2
Forsmark 1	1980	6.2	7.3	5.4	7.3	7.6	5.7	7.3	7.1	146.8	91.3
Forsmark 2	1981	6.4	7.3	7.3	7.2	7.3	5.4	7.4	6.8	142.2	90.1
Forsmark 3	1985	7.9	8.8	9.0	9.0	8.8	7.9	8.2	9.1	146.2	95.1
Oskarshamn 1	1972	2.5	2.4	2.9	1.3	3.3	3.1	3.1	0.0	72.1	0.0
Oskarshamn 2	1974	4.0	3.8	4.4	4.4	3.2	3.9	4.7	4.5	110.1	91.3
Oskarshamn 3	1985	7.6	8.5	9.0	8.0	8.5	7.2	9.1	8.9	144.2	92.2
Ringhals 1	1976	4.5	6.5	2.2	5.6	4.9	3.2	5.8	6.0	123.2	86.9
Ringhals 2	1975	5.2	5.7	6.2	6.1	6.4	5.1	6.3	6.5	134.4	92.3
Ringhals 3	1981	5.9	6.8	6.6	6.4	7.0	6.2	6.3	6.9	125.3	90.3
Ringhals 4	1983	6.5	6.3	6.4	6.8	7.0	4.1	6.6	5.9	120.0	80.2
Total		**65.2**	**71.3**	**67.0**	**70.4**	**70.1**	**54.8**	**69.2**	**66.0**	**1456**	**80.6**

Source: Compilation of information from Kärnkraftsäkerhet and Utbildning AB (nuclear safety and training company)

TABLE 20

Gross power output, MW, and energy generated, TWh, by the Finnish reactors in 2002

Reactor	Commissioning year	Gross output MW	Energy generated in 2002, TWh	Availability in 2002, %
Loviisa 1	1977	488	7.3	85.6
Loviisa 2	1981	488		
Olkiluota 1	1979	840	14.1	96.0
Olkiluota 2	1982	840		
Total		**2656**	**21.4**	**90.8**

Source: Finenergy

of availability for reactors of this type is just over 80%. The energy availability of seven of the Swedish reactors was in excess of 90% (see Table 19).

The availabilities of the various reactors are affected by the durations of the annual overhaul shut-downs. During 2002, the overhaul shut-downs of most of the reactors were on schedule. Extensive modernization of the Oskarshamn 1 reactor was begun on 7 December 2001, and the work continued up to January 2003. Modernization involved the introduction of a new safety concept in order to improve safety, introduction of a computerized control system, modernization of the control room and installation of a more efficient turbine.

Swedish operation permits

The operation permits for 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 Nuclear Power Phase-out Act must be invoked. This Act was adopted by Parliament in December 1997. According to Section 2 of this Act, the Government may decide, for each nuclear power reactor, that the right to operate it shall cease on a certain date.

Barsebäck 1 was shut down on 30 November 1999. The Government considers that Barsebäck 2 should be shut down no later than the end of 2003, provided that the loss of generation capacity can be compensated by reduced electricity consumption and new generation capacity. The opinion of the Government in March 2003 was that the conditions of Parliament for shutting down Barsebäck 2 before the end of 2003 have not been entirely met as regards power balance and the impact on the climate and the environment ("Certain electricity market matters", draft bill 2002/03:85). In the opinion of the Government, the issue of the future of Barsebäck should be dealt with together with negotiations concerning the other remaining reactors. In June 2002, the Government appointed a negotiator and entrusted him with the task of negotiating with the industry with the aim of preparing an agreement concerning a sustainable policy for continued decommissioning of nuclear power and adjustment of the energy system. However, the Government emphasises in the draft bill the importance of the opportunities available for shutting down Barsebäck 2 without undue delay.

Nuclear power in Finland

Finland has two nuclear power stations in operation, with a total of four reactors. These power stations account for around one third of the total electricity production in Finland. Table 20 shows the gross output, which includes the power demand of the plant itself. During 2002, the energy generated by Finnish nuclear power stations was 21.3 TWh.

In 2002, the Finnish Government and Parliament decided in principle that a fifth nuclear power reactor would be built in Finland. According to the planning application, the reactor rating will be 1000 - 1600 MW, and the reactor will be built either in Loviisa or Olkiluota nuclear power station. In view of the continued application permission procedure and the building process, the reactor will not be in operation until around 2010.

TABLE 21

Electrical energy generated in 2002 in conventional thermal power stations in the Nordic countries, TWh

	Denmark	Finland	Norway	Sweden
Conventional thermal power	32.5	40.0	0.8	11.2
CHP in district heating networks	30.2 [1]	14.6	0.0	6.0
CHP in industry	2.1	12.3	0.4	4.7
Condensing power	[2)]	12.9	0.2	0.5
Gas turbines	-	0.0	0.2	0.0

[1] Including condensing power generation

[2] Reported together with CHP generation in Denmark

Source: For Denmark, Norway and Finland: Nordel. For Sweden: Statistics Sweden.

TABLE 22

Electrical energy generated in 2002 in conventional thermal power stations in the Nordic countries, classified by fuel, TWh

	Denmark	Finland	Norway	Sweden
Biofuel, peat, etc.	1.9	15.5	0.0	3.8
Coal	17.3	12.4	0.0	2.3
Natural gas	9.5	9.4	0.2	1.2
Fuel oil	1.0	1.6	0.0	3.4
Others	2.6	0.9	0.6	0.5
Total	**32.3**	**39.8**	**0.8**	**11.2**

Source: Nordel

Conventional thermal power

In conventional thermal power stations, electricity is generated 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 (CHP) stations, condensing power stations and in gas turbine stations.

Both heat and electricity are generated in 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 electrical energy generated in district heating networks, for example, is largely dependent on the outdoor temperature. In industry, the obtainable electrical energy generated is dependent instead on the company's process heat demand. The amount of electricity generated is also determined by the price of electricity.

Conventional thermal power in Sweden

In 2002, the electrical energy generated in Sweden by conventional thermal power amounted to 11.2 TWh, which corresponds to around 8% of the total energy generated during the year. Tables 21 and 22 show the electrical energy generated and the share of different fuels in conventional thermal power plants in the Nordic countries in 2002.

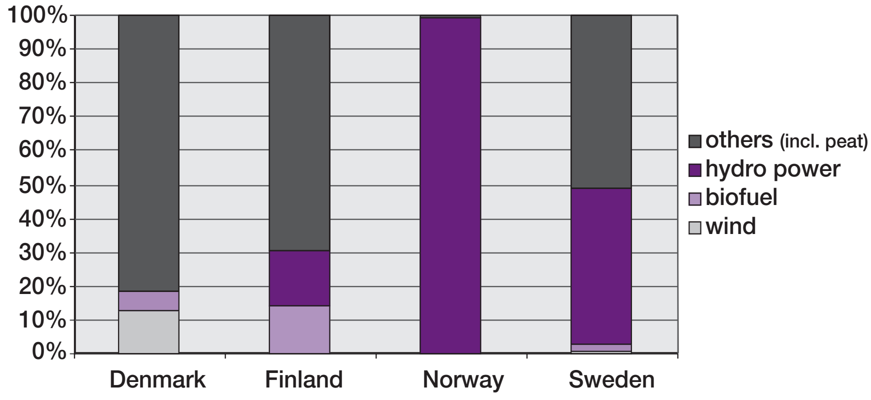
In district heating CHP stations, coal and blast furnace gas together accounted for 45% and fuel oil for 19% of the fuel supply for power generation in 2002. The proportion of oil has dropped since 1999. Natural gas and biofuels, peat, etc. accounted for 6% and 30% respectively. For taxation reasons, the proportion of fossil fuels in power generation is high. Biofuels and oil dominate in industrial CHP generation and accounted for 65% and 32% respectively of the fuel supply for power generation in 2002.

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 these power stations, since they were used only for peak-load generation and thus served as generation reserve. On the Nordic electricity market, power utilities instead import electricity from neighbouring countries. In 1996, there were seven major condensing power plants with a total rating of around 2820 MW. Today, only one of these plants with an output of around 340 MW is still available for generation.

In addition to this plant, a couple of additional plants have been procured by Svenska Kraftnät for safeguarding generation capacity in very cold weather. These plants serve as a power reserve. Further information on the procurement is given in the chapter entitled Power balance issues.

FIGURE 10

Percentages of electricity generated from renewable sources out of the total electricity generated in the Nordic countries in 2002



Source: Annual statistics from Nordel

Conventional thermal power in other Nordic countries

Out of the total electrical energy generated in Denmark in 2002, conventional thermal power accounted for just over 32 TWh, which corresponds to just over 87%. Out of the total, coal accounted for 54% and natural gas for 10%. Around 2% comes from biofuels. In Finland, the proportion of conventional thermal power in 2002 was 55%, which amounts to 40 TWh of electrical energy. Biofuels and peat accounted for 39% of the electrical energy generated, coal for 31% and natural gas for 24%. In Norway, conventional thermal power accounts for less than 1% of the total electrical energy generated.

Electricity from renewable energy sources

The concept of renewable energy source means that energy from the source can reproduce at the same rate as it is consumed. These energy sources include hydro power, wind power, bioenergy, solar energy and geothermal energy. Figure 10 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 2002, hydro power accounted for 66 TWh, which was 46% 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. In 2002, biofuels were used for generating about 3.8 TWh of electricity in CHP generation in district heating systems and in industrial back-pressure plants.

The number of wind power plants in Sweden has steadily increased. Contributory reasons for this are the falling costs, increased awareness of climatic issues, expected increased revenues from electricity sales, and also the State support system. In recent years, the sizes of wind turbines installed have increased. The median rating of the turbines taken into operation in 2002 was 850 kW, while it was 660 kW in 2000. The contribution of wind power to the electrical energy generated in 2002 was 0.57 TWh, which is an increase of 17% on 2001. Wind power accounted for 0.4% of the total electrical energy generated in Sweden in 2002. Almost 50 new wind power plants were built in Sweden, and there was a total of 620 wind power plants at the 2002/2003 turn of the year. The total rating of Swedish wind power at the end of 2002 was 339 MW, which is an increase of 16% on the previous year.

Denmark

Out of the 37 TWh of electricity generated in conventional thermal power plants in Denmark, biofuels accounted for only 1.9 TWh. The interest in wind power in Denmark has been greater than it is in Sweden, which is largely due to the Danish support system. At the end of 2002, the total installed power was 2888 MW. The total electrical energy generated by Danish wind power plants in 2002 was 4.9 TWh, which corresponds to 13% of the total electrical energy generated.

Norway

In Norway, hydro power produced 130 TWh of electrical energy, which corresponds to 99.3% of the total electrical energy generated in 2002. The installed wind power capacity is very low compared to Denmark and Sweden, but has increased during the year from 17 MW to 97 MW. Wind turbines produced a total of 0.04 TWh during 2002.

Finland

Hydro power accounted for 10.6 TWh of electrical energy or 15% of the total electrical energy generated in 2002. In Finland, about 9.5 TWh of the country's electrical energy is generated by means of biofuels and 6 TWh by means of peat in conventional thermal power stations. The electrical energy generated by wind power during the year amounted to 0.07 TWh, and the installed power at the end of 2002 was 43 MW.

Generation costs

Disregarding taxes and grants, the costs of electricity from the various energy sources are roughly the same in the Nordic countries. The generation costs shown in Figures 11 and 12 are based on Swedish power generation, but also show the approximate levels of power generation costs in all Nordic countries.

The calculations relate to costs, but exclude any grants. In Sweden, power generation is basically exempt from 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 Economic regulatory instruments.

Variable generation costs

The variable generation costs in the existing system consist of fuel costs and also operation and maintenance costs. The fuel prices in 2002 were used in the calculation.

For hydro power, the variable costs 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 the 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 liquor. The plants also use fossil fuels. The variable generation costs vary with the fuel costs, which are lower for biofuel and higher for fuel oil. The variable generation costs in 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 40 and 46 öre/kWh if heavy fuel oil is used. If light fuel oil is used, the costs are between 55 and 61 öre/kWh. Gas turbines fired with light fuel oil have the highest variable generation costs. Coal-fired condensing power stations have variable generation costs of between 21 and 25 öre/kWh.

New power generation plants

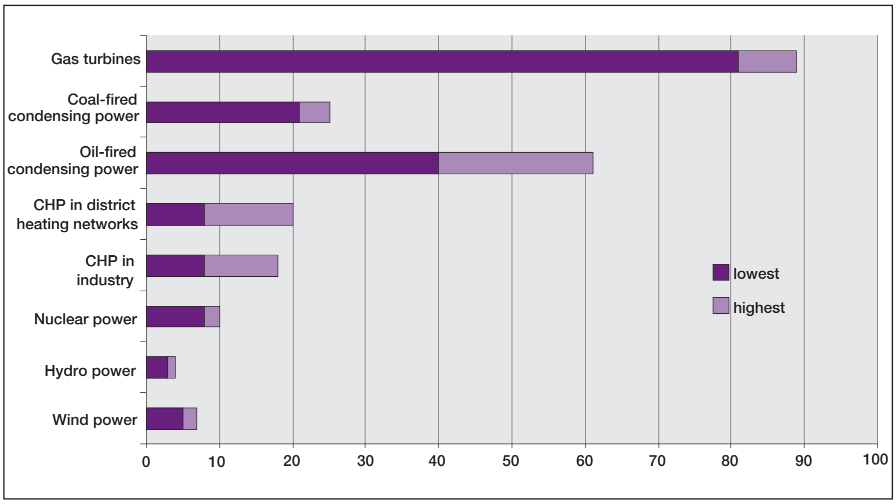
The total power generation costs in new generation plants consist of variable costs, capital costs and other fixed costs. The costs shown in Figure 12 should be used with caution, since every plant is unique and local conditions are of major importance to the total costs. This applies particularly to the costs in condensing plants, since no such new plants have been built in Sweden in the past 20 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 hydro power stations rated in excess of 10 MW, the upper cost limit is estimated to be around 37 öre/kWh.

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

FIGURE 11

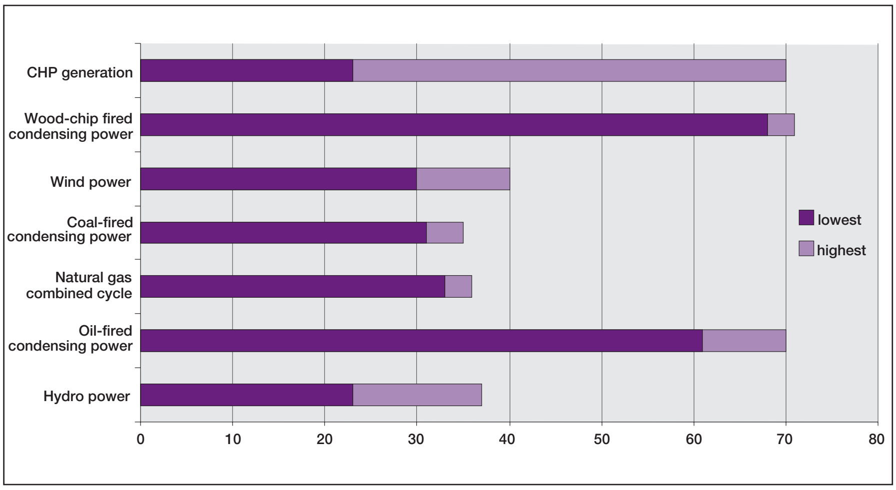
Variable generation costs in the existing power generation system, öre/kWh



Source: Energy in Sweden, Swedenergy

FIGURE 12

Total power generation costs in new plants, öre/kWh



The revenue from heat generation reduces the power generation costs in CHP 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 depends on the 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 13 shows the Nordic supply curve during a normal year. The generation costs shown are the variable costs. The figure gives a general picture of how the generation capacity is used with regard to costs.

FIGURE 13

Generation capacity from different energy sources in the Nordic countries in a normal year, and their variable generation costs in 2001/2002, öre/kWh.

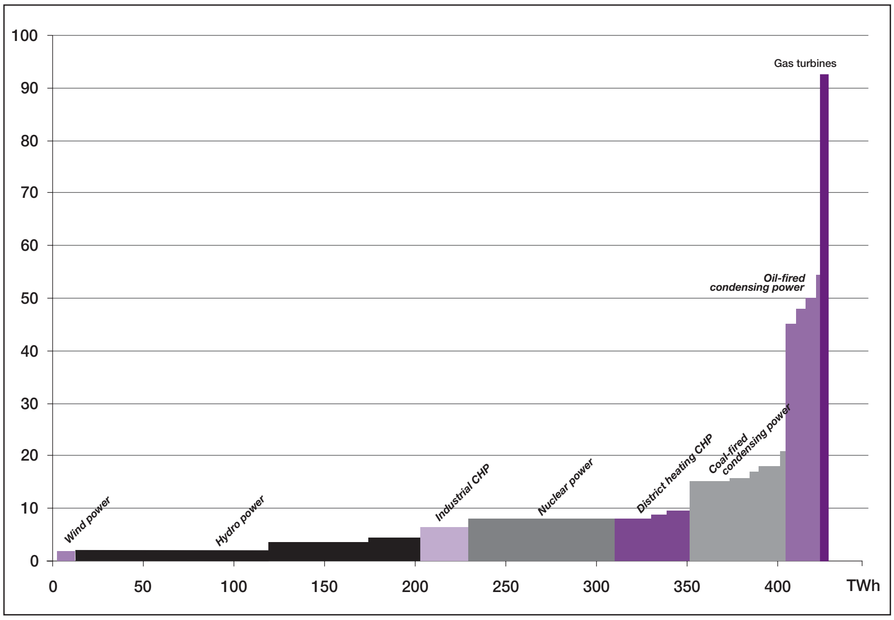


TABLE 23

Emissions of carbon dioxide, sulphur dioxide and nitrogen oxides in Sweden in 1990 and 1996–2001

	1990	1996	1997	1998	1999	2000	2001
Carbon dioxide, million tonnes							
Power generation	1.4	5.1	4.0	3.9	2.9	1.5	1.8
Total in Sweden	56.1	62.1	57.1	58.1	56.5	55.9	55.3
Nitrogen oxides, thousand tonnes							
Power generation	2.8	6.0	5.4	5.1	3.2	1.3	2.0
Total in Sweden	349	309	291	277	267	247	251
Sulphur dioxide, thousand tonnes							
Power generation	3.2	8.0	7.0	6.3	3.8	1.2	2.0
Total in Sweden	**111**	**74**	**66**	**63**	**54**	**58**	**60**

Note: The emissions of carbon dioxide do not include those from biofuels, sinks or bunkering. The statistics have been revised compared to the earlier issue.

Source: Statistic Sweden, National Environmental Protection Agency

Environmental impact

Due to the high proportion of hydro power and nuclear power in the Nordic countries as a whole, power generation accounts for only a small proportion of the environmentally harmful emissions. Hydro power and nuclear power are not entirely devoid of environmental impact, but they are virtually emission-free during normal operation. However, the emission pattern varies in the individual countries. In Norway, there is basically no emission from power generation, since hydro power generation accounts for more than 99% of the total power generation. On the other hand, power generation in Denmark is largely based on the combustion of fossil fuels, and power generation therefore accounts for almost 40% of the country's carbon dioxide emissions.

Emissions from power generation in Sweden

In the year 2001, the carbon dioxide emissions from power generation amounted to 1.8 million tonnes, which represents 3% of Sweden's total carbon dioxide emissions. Power generation is exempt from carbon dioxide tax, which has led to a high proportion of fossil fuels in power generation.

Sulphur dioxide emissions from power generation varied between 3000 and 7000 tonnes annually in the past ten years, with the exception of the dry year 1996 and years 2000 and 2001. Annual nitrogen oxide emissions during the same period varied between 3000 and 6000 tonnes. Since 1996 was a dry year, the electricity generated in hydro power stations was low and generation in fuel-fired plants increased, which led to increased emissions of sulphur dioxide, nitrogen oxides and carbon dioxide. During the wet years 2000 and 2001, the situation was reversed, and the emissions were therefore much lower than in previous years.

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 south 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 air 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 23 shows Sweden's total carbon dioxide, sulphur dioxide and nitrogen oxide emissions between 1990 and 2001. Table 24 shows the emissions per kWh during the same period.

Regulations on nitrogen oxide and sulphur dioxide emissions

Swedish Parliament has set guidelines for nitrogen oxide emissions from combustion plants. Guideline or limit values are specified for each individual plant in conjunction with environmental appraisal.

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 have now been set for sulphur dioxide and, from 1 January 2005, standards will also be in force for particulates and, from 1 January 2006, also for nitrogen dioxide and nitrogen oxides. In addition to these, there are also standards for lead (only an annual mean value).

The municipalities are entrusted with the 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. The ordinance also specifies limit values for sulphur for certain coal-fired plants. A sulphur tax is levied on fuels that contain sulphur. Biofuels are exempt from sulphur tax.

Emissions from power generation in 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 the Nordic countries in terms of both total emissions and emissions per kWh of electricity generated. 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 power generation based on fossil fuels. The picture is the same for carbon dioxide emissions. Table 24 shows the emissions per kWh of SO_2, NO_2 and CO_2 in Denmark, Finland and Sweden between 1990 and 2000. All emissions have dropped since 1990. This is due mainly to improved combustion efficiency and, in the case of Denmark, the decommissioning of old coal-fired power stations and heavy investments in wind power.

TABLE 24

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

	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	310	20	415	170	11
1999	574	280	13	793	320	19	377	170	11
2000	240	280	13	725	310	18	361	170	12

Source: Annual statistics from Nordel

Transmission

Electricity is transmitted from power stations to consumers by a network of power lines. The network is classified into three levels, i.e. national grid, regional networks and local networks. 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 the local networks and sometimes to electricity users with high consumption, such as major industrial plants. From the local networks, normally at a maximum of 20 kV, electricity is transformed in the distribution area to the normal domestic voltage of 400/230 volt.

The consumption and generation of electricity must be in balance at all times. Every country has a system operator whose task it is to maintain this balance and be responsible for the national grid. In Sweden, the Svenska Kraftnät utility is the system operator. There are 13 regional networks that are owned by Sydkraft, Fortum, Vattenfall, Graninge and Jämtkraft. The 200 or so local networks are owned by private, State and municipal companies or cooperative associations.

National grid

In Sweden, the national grid consists of 15 050 km of 220 kV and 400 kV lines. Around 150 transformer and switching stations are provided for linking the network together. Owners of power stations or regional networks can connect their systems to the national grid and use the grid for transmitting electricity. At the end of 2002, 29 corporate bodies, some of which were sometimes in the same company, were connected to the national grid at a total of 141 connection points. A quarter of these are connections to adjacent networks and the others are connections to power stations. The national grid is owned and operated by Svenska Kraftnät.

Charges on the national grid

Svenska Kraftnät applies a spot tariff on the national grid. The tariff was changed in 2002 in order to harmonize the national grid tariffs in the Nordic countries. The basic principle for the spot tariff is that a player pays for the right to feed in or take out electricity at just one point. This gives the player access to the entire grid system and enables him to trade with any of the other players in the grid system. The Electricity Act specifies that spot tariffs shall also be applied on the regional and local networks. This is an important condition for the deregulated electricity market. The spot tariff is divided into an annual power charge and an hourly charge for the energy transmitted. The cost of transmitting electricity on the national grid is an average of 1.4 öre/kWh.

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 northern Sweden to central and southern Sweden, where the electricity consumption is high. Transmission over large distances gives rise to losses on the grid. To make the grid charge fair, it differs in magnitude depending 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 infeed increases the load on the national grid, whereas the outtake charges are low. The converse applies in southern Sweden.

Balancing service

The system responsibility of Svenska Kraftnät includes obligation for planning and coordinating the balance between the generation and consumption of electricity in the country. Balance in the grid means that the frequency does not deviate from 50 Hz (within ±0.1 Hz). This is managed by the balance service.

There are three levels of responsibility for maintaining the balance. The first is the balancing service at Svenska Kraftnät that has access to consumption forecasts and automatic or quickly controllable generation plants. This enables the balancing service to maintain balance in the grid minute by minute. The balancing service also has access to a disturbance reserve of more than 1300 MW. This consists of quick-starting generation plants that are in a state of preparedness to manage unexpected disturbances in the power system. The reserve consists mainly of gas turbines.

The next level of responsibility consists of balance provider companies. These companies have concluded balancing responsibility agreements with Svenska Kraftnät. They are responsible for submitting consumption forecasts and generation plans to the balancing service of Svenska Kraftnät. The forecasts are needed to allow Svenska Kraftnät to plan for the next 24-hour operating period. The companies must also undertake tasks such as reporting trading values, including trading with Nord Pool and foreign trade. The balance provider companies take economic responsibility for the Swedish electrical system being supplied every hour with as much electricity as that consumed by the electricity consumers for which they have balance responsibility. Certain balance provider companies have their own generation capacity that they offer to the balancing service for use in control. At the 2002/2003 turn of the year, Svenska Kraftnät had balance provision agreements with 33 companies in Sweden.

The electricity suppliers have the third level of responsibility. They deliver electricity to the end users or are end users themselves, and are responsible for concluding an agreement with the balance provider company to manage the balance for them. There are 158 electricity suppliers in the country.

Balance control

The unbalance that may 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 during the actual operating hour, and this is known as balance control. Financial settlement is made after the event, as described below under the heading Balance settlement.

Balance control takes place in the Svenska Kraftnät central control room that is manned around the clock and is located in Råcksta, outside Stockholm. 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 power generated being increased or reduced. A Nordic agreement specifies the regulation power that every country must have available for primary regulation.

Secondary regulation is a manual procedure for raising or lowering a regulating object, and takes place in the form of power transactions with the balance providers who have access to generation plants and who have concluded agreements with Svenska Kraftnät concerning this 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). The Svenska Kraftnät balance engineer then places orders against the bids in price order, as necessary.

Balance settlement

The energy for the Svenska Kraftnät trade in balancing power and regulating power is priced and settled with the relevant balance provider. The purpose of balance settlement is to:

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

Svenska Kraftnät levies a settlement charge for trade in contracted power[1] between the balance provider companies in Sweden and between balance providers and players abroad, outside the spot market of the electricity exchange.

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 the electricity generated by hydro power from the surplus areas in the north to the shortfall areas in the south. The transmission network from north to south has certain limiting bottlenecks known as “constraints”. The most important constraint in Sweden today is constraint 2 between northern and central Sweden on a level with the town of Söderhamn. The constraint limits the power that can be transmitted to between 6700 and 7000 MW. After strengthening, the transmission capacity between central and southern Sweden at constraint 4 on a level with the town of Växjö has been raised to between 4000 and 4500 MW.

Bottlenecks usually lead to different price areas occurring. This results in limitation of the market.

The counter-trade method can be used for avoiding different price areas. This takes place in Sweden and is managed by Svenska Kraftnät. All parts of Sweden therefore belong to the same price area. Counter-trade involves Svenska Kraftnät purchasing more expensive generation capacity on the consumption side of the strained link and cancelling generation capacity on the other side. This reduces the physical energy flow on the link without the trade of customers being affected. The cost of this is borne by Svenska Kraftnät and provides signals that grid strengthening is needed.

Other Nordic countries

Figure 14 shows the national grids in northern Europe. The national grid in Norway is owned mainly by Statnett, which has system responsi-

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

bility. Around 15% 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 that 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 monitor and plan operation in the national grid. Every party on the Finnish electricity market is responsible for balance between electricity generation and 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. In the event of unbalance during the operating hour, Fingrid uses balance control.

Denmark has two national grid companies with system responsibility, namely *Eltra* that is responsible for the national grid in Jutland and Funen, and Elkraft that 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 currently not interconnected with one another, but a link is being planned.

TABLE 25

Links with foreign countries in Northern Europe

	TRADING CAPACITY, MW	
Sweden-Norway	**To Sweden**	**From Sweden**
Northern Norway	1400–1550	900–1550
Central Norway	450–680	450–680
Southern Norway	1850	1850
Sweden-Finland	**To Sweden**	**From Sweden**
Northern Finland	1100–1300	1500
Southern Finland	550	500
Sweden-Denmark	**To Sweden**	**From Sweden**
Jutland	610	580
Zealand	1650	1350
Denmark-Norway	**To Denmark**	**From Denmark**
Jutland-southern Norway	1000	1000
Norway-Finland	**To Norway**	**From Norway**
Northern Finland	100	70
Links 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	1050	60
Denmark-Germany	1800	1800

Note. The table shows the approximate trading capacity for the cable, i.e. that part of the trading capacity that is available to the market. A certain proportion of the capacity is retained for players with system responsibility.

Source: Nordel Balancing group

Trade connections in northern Europe

In the Nordic electricity exchange area of Norway, Sweden, Finland and Denmark, there are a large number of transmission links between the countries. In addition, there are links with the neighbouring countries of Russia, Germany and Poland. The links for trading in electricity in northern Europe are shown in Table 25.

The transmission capacity shown in Table 25 is the approximate trading capacity for the cable, i.e. the capacity available for the players on the market. In addition, capacity is reserved for the system operators. The power that can be transmitted at a given time is dependent on a number of factors. In some situations, the transmission capacity can be substantially restricted. Restrictions may be due to limitations in the network capacity and/or the supply situation in the respective area. At a high load in the Oslo area, the capacity for transmission from southern Norway to Sweden is greatly reduced. For the time being, Sweden's links with Germany and Poland cannot be fully utilized due to limitations in the two countries. The transmission capacity from Sweden to Zealand has been reduced as a result of the shut-down of Barsebäck 1.

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. The trading capacity may differ widely between high-load and low-load periods. Certain limitations may be particularly serious just when 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 being planned across the Great Belt, with the aim of joining the network systems in eastern and western Denmark. The planned capacity is around 300 MW.

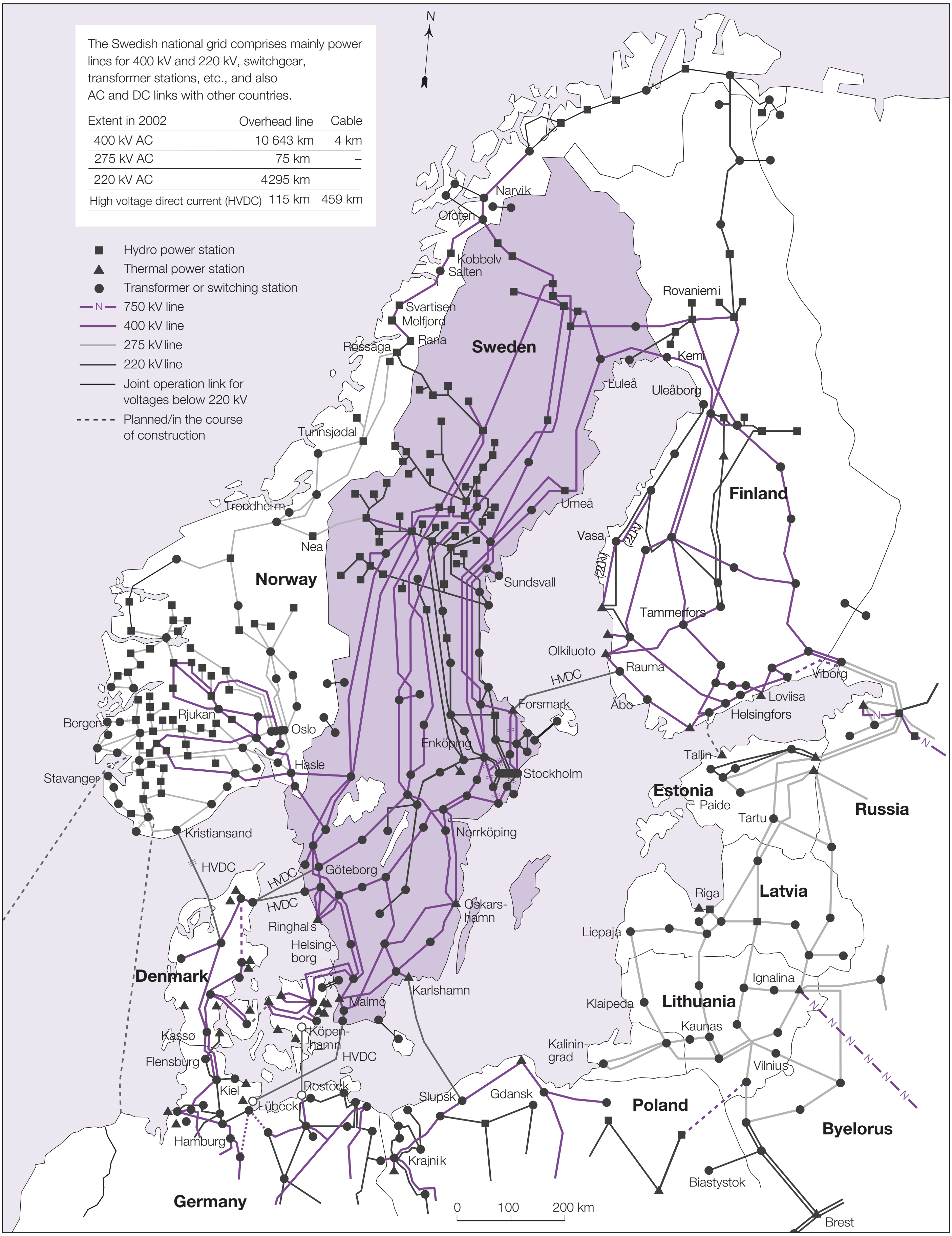
In the past, there were ambitious plans for cable links between Norway and the Conti-

FIGURE 14

Power network in northern Europe

The Swedish national grid comprises mainly power lines for 400 kV and 220 kV, switchgear, transformer stations, etc., and also AC and DC links with other countries.

Extent in 2002	Overhead line	Cable
400 kV AC	10 643 km	4 km
275 kV AC	75 km	–
220 kV AC	4295 km	
High voltage direct current (HVDC)	115 km	459 km



nent, but these have been severely restricted. The Viking Cable project between Norway and the Continent has been abandoned. A 600 MW cable between Norway and Denmark and/or the Netherlands is still being discussed. A concession application has been made for a DC North Sea Interconnector cable between Norway and Great Britain.

Power balance issues

In recent years, the instantaneous electricity consumption – the power demand – has reached new peaks as shown in Table 26. However, the highest power demands occur only during a few hours a day in very cold weather.

Before the electricity market reform, the high-load generation capacity needed was determined by certain reliability of supply criteria. These were abandoned in conjunction with the deregulation. Since then, the generators have decommissioned most of the oil-fired condensing plants and gas turbines that had previously served as peak-load capacity for cold winter days, for instance. These plants were needed extremely rarely and did not justify their costs. In addition to the decommissioning of the fossil-fired plants, Barsebäck 1 was also shut down.

In total, significant capacity has been taken out of service in southern and central Sweden. At the same time, electricity consumption has continued to rise. As a result, the power balance in Sweden has weakened and the risk of power shortfall has increased.

In the past, southern Sweden was particularly weak from the power balance viewpoint. However, statistics from Svenska Kraftnät show that the transmission links through constraint 2 have never been the limiting factor at the power peaks that have occurred so far. The transmission capacity at constraint 4 has been strengthened in order to prepare for the decommissioning of both Barsebäck reactors. The power balance in the country is also dependent on imports, a large proportion of which are connected to southern Sweden. Against this background, no separate power balance is drawn up for southern Sweden, and the balance prepared is for the whole country.

If power is insufficient, Svenska Kraftnät will be obliged to temporarily disconnect the power supply from parts of the country.

Power reserves

In Sweden, a distinction is made between reserves in the form of high-load capacity and disturbance reserves. High-load capacity refers to the resources in generation and consumption that are in readiness only for meeting the highest power demands that seldom occur. Disturbance reserve is the power in the form of quick-starting gas turbines and similar plants to which Svenska Kraftnät has access in order to manage unexpected disturbances in the power system. This may occur if a major transmission link should break down or if a nuclear power reactor is taken out of service.

During the period between 1996 and 1999, high-load capacity of 2500 MW, which corresponds to 10% of the maximum load during a normal winter, was taken out of operation because the cost of maintaining these plants in a state preparedness could not be justified. Most of these plants consisted of oil-fired condensing power stations. When Barsebäck 1 was shut down, the power capacity was reduced by a further 600 MW.

Before the 2000/2001 winter, Svenska Kraftnät considered that the power balance in Sweden was worryingly weak and procured, for the first time, 1000 MW of high-load capacity and created a power reserve consisting of plants that had earlier been taken out of operation. The fixed cost of keeping this reserve in a state of readiness was paid by the balance providers in accordance with an addendum to the balance agreement. Before the 2001/2002 winter, the Government instructed Svenska Kraftnät to increase the power reserve. This additional procurement also included a reduction in the consumption of some major industrial plants. The cost of this additional procurement was to the account of Svenska Kraftnät.

In November 2001, Svenska Kraftnät was instructed to draw up a system, in consultation with the Swedish Energy Agency and in cooperation with representatives of the industry, aimed at securing power balance in both the short term and the long term. The system was to contain clear incentives for increased flexibility on the user side.

The report on the assignment was submitted on 1 October 2002. In its proposal for action, the report states that the availability of power should be achieved through market economic mechanisms. Harmonization of the conditions, above all at Nordic level, would be required for this. As an interim measure, Svenska Kraftnät will continue to purchase power reserve. The reserve is restricted to a maximum of 2000 MW and is financed by the balance provider companies. The terms for utilizing the power reserve shall be adjusted so that market economic management of the power issue will be promoted. The expanded responsibility of Svenska Kraftnät will be regulated in a law of limited duration. The transition period extends up to 1 March 2008. The work that had been started on promoting and developing businesslike forms of limiting, when necessary, the power demand in industry and other electricity users will be intensified. A study will be undertaken to clarify how power assurance products, i.e. in the form of options, can be designed and traded with in a trading place. An R&D project will be started in order to clarify the character and price sensitivity of power consumption in very cold winter weather. The Svenska Kraftnät proposal for long-term handling of the power issue was dealt with in draft bill 2002/03:85. This also includes a proposal for a power reserve law in accordance with the above.

The assignment from the Government was preceded by a study arranged by Svenska Kraftnät during 2001, which served as a base for the work. This study found that, in power shortage situations, the pricing on the electricity market for physical trading, principally on the 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 shortage of sell bids. The effectiveness of measures on the consumption side must be assessed in relation to the costs of maintaining capacity on the generation side. Most of the generation side is not exposed to the spot price. A large proportion of the power problem consists of the lack of flexibility on the consumer side. The possibility of handling parts of the power peaks by action on the consumer side is the subject of discussion. However, in the foreseeable future, most of the power peaks will have to be handled by reserve generation capacity and/or by imports.

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 usually occurs during the morning hours of a winter day, is of the order of three times higher than the lowest hourly value. The latter usually occurs on a summer night. Temperatures are the most important reason for the variations.

For various reasons, the electrical system is temperature sensitive. This is largely due to Sweden having a large proportion of electrically heated houses. Sales of heat pumps have also increased. If heat pumps are used to replace electric heating, the power consumption will drop. If the heat pump replaces an oil-fired boiler, the power demand will increase. At normal outdoor temperatures, heat pumps are very energy-efficient. However, they are usually rated for only 50 – 60% of the maximum power demand of the house, and a heat pump is supplemented with an electric heater element when the weather turns cold. As a result, heat pumps have a great influence on the power peaks. In recent years, underfloor heating has become popular in households, in addition to electric heating and heat pumps. This increases the electricity consumption for heating. The district heating networks also include large electric boilers that contribute to the power demand, although some of these can be disconnected when the price of electricity is high.

When the weather is very cold, further electricity consumption arises, such as for fan heaters and extra electric radiators. It is also conceivable that households that normally use wood-fired heating also back it up with electric heaters or entirely switch over to them. The composition of the power peaks must be studied further.

Figure 16 shows the power demand in the second week of January and the second week of July 2000. Figure 15 shows the average power demand and the monthly energy demand by sector in the year 2000. The figure also shows that the curves for the energy demand of dwellings, and commercial and services premises, and for the power demand follow one another. This can be attributed to factors such as electric space heating and the increased demand for lighting in the winter.

The highest power demand in the 2002/2003 winter was between 0800 and 0900 hours on Friday 31 January 2003 and amounted to 26 400 MW.

TABLE 26

Consumption peaks in Sweden

Date	Consumption, MW
7 Feb. 1996	26 300
29 Jan. 1999	25 800
24 Jan. 2000	26 000
5 Feb. 2001	27 000
2 Jan. 2002	25 800
31 Jan. 2003	26 400

Source: Svenska kraftnät

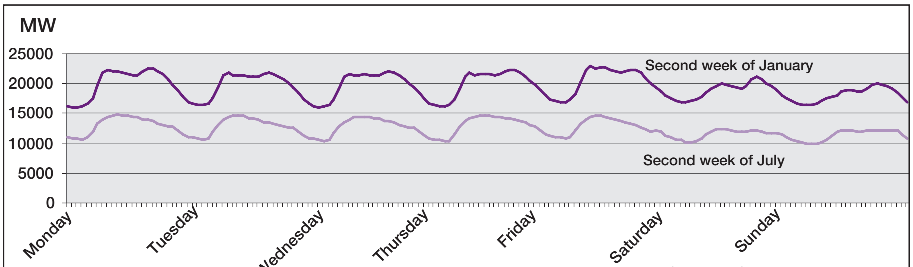
The highest ever consumption so far was recorded between 0800 and 0900 hours on Monday 5 February 2001 and amounted to 27 000 MW.

Various Nordic solutions

The Nordic countries have so far solved the power problems in different ways. Balance providers in Norway and Denmark have been given greater responsibility for power balance than the balance providers in Sweden and Finland. The solution chosen by Norway differs from that employed in the other Nordic countries. Before last winter, Statnett has procured reserve power in the form of hydro power and load reductions in industry. The reserve power includes both that defined in Sweden as high-load capacity and that defined as disturbance reserve. The experience gained is favourable and the concept will be gradually developed. Finland and Denmark have chosen solutions that are similar to that in Sweden. Work is in progress at Nordel aimed at harmonizing and coordinating the conditions and methods for handling the power problem. ■

FIGURE 15

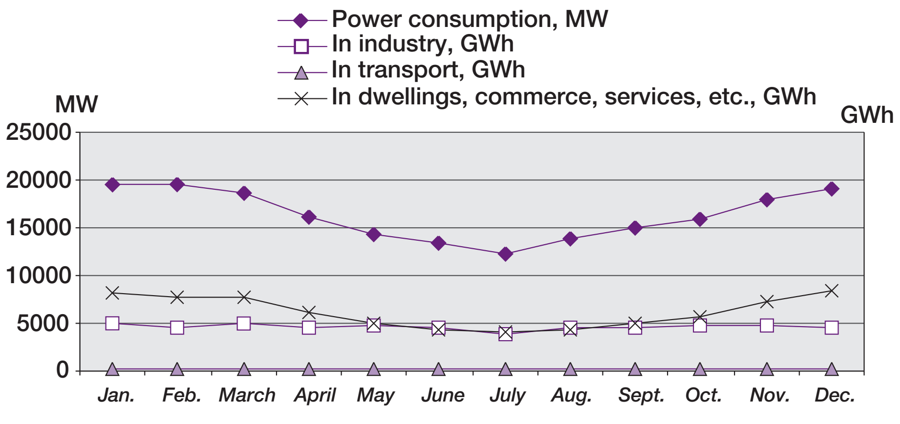
Power demand in a summer week and a winter week in 2000, MW



Source: Svenska Kraftnät

FIGURE 16

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



Source: Svenska Kraftnät

Energy and environmental policies

The energy system in Sweden is in the course of development in order to meet the demands for efficiency, reliability of supply and low environmental impact. The work in the EU on matters such as creating an internal market with increased competition for energy affects developments in Sweden. This chapter describes the current situation in the area of energy and environmental policies in Sweden and the EU.

Sweden

Wide-ranging amendments were made to the Swedish electricity legislation in 1996, which enabled the electricity market in Sweden to be opened to competition. 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.

Secure, efficient and environment-friendly energy supply

In March 2002, the Swedish Government tabled a new energy draft bill "Samverkan för en trygg, effektiv och miljövänlig energiförsörjning" (draft bill 2001/02:143) (Cooperation for secure, efficient and environment-friendly energy supply). The draft bill was passed by Parliament in June 2002. According to the decision of Parliament, the guidelines specified in the 1997 energy policy decision still apply. The objective of the energy policy in both the short term and the long term is to secure the availability of electricity and to increase the use of energy from renewable energy sources.

The energy policy is intended to create the conditions for efficient energy utilization and costs-effective Swedish energy supply. At the same time, the effect on health, the environment and the climate must be low, and the change to an ecologically appropriate society should be facilitated. Moreover, the energy policy must contribute towards creating stable conditions for competitive industry and for renewal and development of Swedish industry. Electricity supply in Sweden must be secured by an energy system that is based on sustainable, preferably domestic and renewable energy sources and efficient energy utilization. Nuclear power should be replaced by improving the efficiency of electricity utilization, by converting to renewable energy sources and to an environmentally acceptable power generation technology. To an increasing extent, energy supply should be based on renewable sources, while the use of fossil fuels should be maintained at a low level.

Since the short-term measures taken to compensate for the loss of the nuclear power reactors in Barsebäck ceased at the end of 2002, the regulatory mechanisms that affect the short-term situation will change as from 2003. The objective is to promote a new and more long-term orientation both for encouraging power generation from renewable sources and for more efficient energy utilization. As part of the work of increasing the proportion of renewable energy, Parliament has adopted the target that the use of electricity from renewable sources should increase by 10 TWh by the year 2010. In order to stimulate power generation from renewable sources, a system of trading in electricity certificates has been introduced. The system is described in more detail in the chapter dealing with economic regulatory instruments. A draft bill on a proposed law for electricity certificates was tabled in January 2003 and was basically approved by Parliament in April 2003. The system was introduced in May 2003. In order to ensure more efficient use of energy, information and training will be given at local and regional levels. Support for technology procurement will continue. Due to these amendments, the Swedish Energy Agency has been given a number of new tasks, including those within the framework of the new system for trade in electricity certificates. The Energy Agency has also been given the role of expert authority for improving the performance of the electricity market.

In addition, the Government proposes in its draft bill that the taxation of CHP generation in district heating networks should be changed, so that the rules are made the same as those applicable to industrial back pressure. The draft bill has now been submitted for approval to the European Commission.

In the draft bill, the Government also states that it will study whether an agreement similar to that concluded in Germany for a controlled and responsible settlement regarding nuclear power could also offer benefits in Sweden. In June 2002, the Government appointed a negotiator and entrusted him with the task of entering into negotiations with the industry on behalf of the State, with the aim of preparing the ground for an agreement on a sustainable long-term policy for continued decommissioning of nuclear power and adaptation of the energy system.

Appraisal of Barsebäck 2

In the energy policy agreement of 1997, it was decided that Barsebäck 2 would be shut down no later than in 2001. However, a number of conditions were set for shutting down. According to the decision, the shut-down of Barsebäck 2 must not cause significant negative impact on the power balance, the availability of electricity to industry, the price of electricity or the climate and the environment. In March 2003, the Government appraised for the third time the issue of whether the conditions decided by Parliament for shutting down Barsebäck 2 have been met. The assessment is described in draft bill "Vissa elmarknadsfrågor" (draft bill 2002/03:85) (Certain electricity market matters). The Government considered that Barsebäck 2 could not be shut down in 2003, principally due to the effects on the power balance, but also due to the impact on the climate and the environment. The Government considers that the matter of the future of Barsebäck 2 should be dealt with together with negotiations concerning the other remaining reactors and the issue of energy adaptation as a whole. The Government emphasises the importance of reviewing the opportunities available for shutting back Barsebäck 2 without delay and proposes a number of measures, including that of improving the efficiency of electricity utilization.

In the draft bill, the Government also proposes two new laws – one on power reserve, and the other on origin guarantees. The Government also presents the guidelines for monthly reading of electricity meters and proposes that the limit for hourly metering of electricity consumption should be lowered as from 2006 from today's 200 ampere or 135 kW to 63 ampere. According to the law on power reserve, Svenska Kraftnät will have responsibility for a power reserve being kept available in the Swedish electrical system. Svenska Kraftnät shall do this by concluding agreements with electricity generators concerning increased generation, and with major electricity users concerning reduced electricity consumption. According to the proposal, the law is to come into force on 1 July 2003 and will remain in force until the end of February 2008, when a market solution will have been developed. The draft bill was passed by Parliament in the spring of 2003.

Swedish climate strategy

The draft bill on climate strategy (draft bill 2001/02:55) tabled by the Government was approved by Parliament in March 2002. According to this decision, the objective is that Sweden's emissions shall be at least 4% lower than they were in 1990 as a mean value for the period 2008 - 2012. This target is more ambitious than Sweden's undertaking of +4% set in the EU burden distribution of the undertaking in accordance with the Kyoto Protocol. According to the Government, the Swedish objective will be reached without compensation for its absorption in carbon sinks or by employing more flexible mechanisms.

Joint implementation and the mechanism for clean development represent the so-called project-based mechanisms. Trading in emission rights enables one country that has reduced its emissions more than it has undertaken to sell emission rights to a country that finds it difficult to meet its target.

Project-based mechanisms mean that projects are implemented that generate emission reductions and that the investing country may credit itself with a certain proportion of the emission reduction in order to meet the Kyoto Protocol undertakings. Joint implementation is cooperation between countries that both have quantitative undertakings, whereas projects within the mechanism for clean development are undertaken in countries without quantitative undertakings in accordance with the Kyoto Protocol. The projects should contribute to sustainable development and to meeting the targets of the climate convention.

Detailed regulations are needed for ensuring that the projects are additional, i.e. that they result in emission reductions beyond what would otherwise have taken place. According to the energy policy draft bill "Samverkan för en trygg, effektiv och miljövänlig energiförsörjning" (draft bill 2001/02:143) (Cooperation for a secure, efficient and environment-friendly energy supply) adopted in June, Sweden will continue to work on measures in international cooperation, such as joint implementation for gaining experience and contributing to the development of flexible mechanisms as instruments. Sweden will also cooperate in the system for trading in emission rights that the EU intends to introduce from 2005.

Climate work and the national targets will be continually followed up. If the emissions do not diminish in accordance with the target, the Government can propose further measures or, if necessary, re-appraise the target. Consideration will be given to the competitiveness of Swedish industry. Checkpoints are proposed for 2004 and 2008. At the 2004 checkpoint, the Government intends, as a supplement, to consider a target that comprises the flexible mechanisms.

Proposal for modified energy taxation

For several years, the energy taxation system has been in the course of being reviewed. The aim is to make the system more transparent and to raise its environmental relationship. As an element aimed at raising the environmental relationship, Parliament decided in 2000 to launch a green fiscal reform in 2001. The reform means that the tax on environmentally harmful activities is raised, while tax on work is lowered. The reform will comprise a total of SEK 30 billion and will continue for a period of ten years. In addition, a parliamentary committee was appointed to study the makeup of the rules for lowering the tax on energy in sectors that are exposed to competition. This was aimed at ensuring that the current Swedish reduction rules are not considered to be compatible with EC state support rules. The committee presented its proposal in April 2003. According to the proposal, only environment-related taxes (carbon dioxide tax and sulphur tax) may be imposed on industry in the future, but not fiscal taxes (energy tax), with the exception of the EU minimum tax on electricity. In addition, the earlier demarcation of the sectors entitled to reduction will be discontinued, which means that all of industry is covered by the same energy taxation. This means that the energy tax on fuels in the energy conversion sector will also be discontinued, and the introduction of a consumption tax on district heating should be introduced instead. It is proposed that the carbon dioxide tax level imposed on industry should be 19 öre/kg of carbon dioxide (25% of the level for households and public authorities). According to the proposal, a general limitation rule shall apply to energy-intensive companies, which limits the carbon dioxide tax levied to a maximum of 0.7% of the company's sales. However, the EC minimum tax level must apply to all fuels, provided that no other undertakings are made. According to the proposal of the committee, the new model can come into force on 1 July 2004. The proposal was circulated for comments in the spring of 2003.

Other work now in progress

A special investigator was given the assignment in March 2002 to study the electricity and natural gas markets. The study will follow the current work in the EU on the internal market for energy and will submit proposals no later than 31 October 2003 for the changes necessary in Swedish legislation for implementing the revised EU Electricity and Natural Gas Directives. The study will also analyze whether improvements can be made on the electricity and natural gas markets as regards competition and customer influence and, if necessary, propose changes for improving the situation. A study of the competition on the heating market is also in progress and is scheduled to be completed on 30 June 2004.

As regards climate policy, a delegation with a parliamentary composition was appointed with the aim of drawing up a proposal for a Swedish system and regulations for the flexible mechanisms of the Kyoto Protocol. An interim report was submitted to the Government in May 2003 and contained proposals for the principles for drawing up a national allocation plan in accordance with the EU proposal for trading in emission rights. A final report on the study will be submitted in December 2003.

In addition, a special investigator has been entrusted with the task of examining and evaluating the work done in the 1997 long-term energy policy programme. The task also includes analyzing the need for changes, submitting proposals for guidelines for the long-term energy policy programme, and reporting on the work needed that would lead to sustainable energy supply. The assignment will be completed no later than 1 September 2003.

Norway

Norway opened its electricity market to competition back in 1991. Profile settlement was introduced in 1995, which enabled all electricity users to change their electricity suppliers free of charge.

The 1999 energy strategy of the Norwegian Government specifies that energy generation shall be based to a greater extent on renewable energy sources. The aim is to use a further 4 TWh of water-borne heat generated from renewable energy sources, and to expand wind power so that the annual energy generated will increase to 3 TWh before 2010. Another target is to restrict 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 are largely financed by funds from the State energy fund.

A focal part of the present Government's energy policy is an investment in "carbon dioxide-free" gas-fired power stations (Parliamentary decree 9 2002/2003 on the use of gas in Norway). The aim for the Government is to set up a framework that enables such technology to be developed in Norway. The Government has therefore proposed that it shall be possible to grant state technical and product development support for concrete project proposals, and that investment support for gas-fired power stations with carbon dioxide management should be introduced by 2006. In addition, a State innovation association will be formed and the role of the State in the development of infrastructure for carbon dioxide management will be studied.

However, it was decided in 2002 to postpone the investment decisions for the three gas-fired power stations that have received construction concession in Norway, which means that the plants will not be commissioned until 2006 – 2007 at the earliest.

The Government has also declared that a national hydrogen programme will be established in order to promote the use of hydrogen in Norway. Moreover, the Government considers it important to undertake rebuilding and expansion of small hydro power generation plants, and has therefore decided to simplify the permit process for smaller hydro power stations.

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 proposes that a national system for trading in emission rights should be established from 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 profile settlement was introduced for low-consumption electricity customers.

The objectives for the Finnish energy policy were decided in the energy policy strategy from 1997. The main objective was to use economic regulatory instruments and market economy mechanisms to create the conditions in which access to energy at competitive prices is secured and the environmental emissions that occur correspond to Finland's international obligations. Important interim objectives are to reduce coal consumption, promote efficient energy utilization and energy saving, and ensure that adequate versatile and advantageous energy generation capacity is available.

The Finnish climate strategy from 2001 is based on national measures. In the national climate strategy, it was decided that the use of coal must be reduced either by expanding nuclear power generation capacity or by increasing the use of natural gas. In addition, Finland's need for importing electricity must be reduced. One of the most important measures in the climate strategy is to promote technical development as regards both energy saving and the use of renewable energy sources.

During the spring of 2002, the Finnish Government and Parliament approved the construction of a fifth nuclear power station in Finland. The nuclear power station may be ready for commissioning in 2010 at the earliest.

Within the work of implementing the climate strategy, a new energy saving programme was presented in December 2002. The long-term objective was to arrest a continued increase in energy consumption. Technical development is needed to achieve this target. An important element in the work is to conclude energy saving agreements and draw up energy saving programmes. Agreements have already been concluded with large parts of the energy-intensive industry. In the new programme, it is suggested that agreements should also be concluded with small and medium-sized industrial plants. In the programme, it is also proposed that increased support should be given to the repair of buildings and to the dissemination of information concerning energy savings. In addition, it is proposed that the energy taxation system should be developed, taking into account the coming emissions trading system within the EU.

Moreover, a proposal for a new plan of action for renewable energy sources was presented in December 2002. The objectives from earlier plans of action remain, i.e. the use of renewable energy should increase by more than 30% or around 28 TWh. The plan of action suggests that taxation should be developed in order to benefit renewable energy sources further, that investment support should be increased and that new financing models should be studied. The working committee also suggested that the energy saving agreements should also contain measures aimed at increasing the use of renewable energy.

In addition, a commission has been appointed in order to draw up proposals for measures aimed at reducing the use of coal in electricity and heat generation, and a report will be submitted at the end of 2003.

Denmark

The electricity market in Denmark was opened to all electricity customers as from 2003. The first step was taken in 1999 when the market was opened to electricity customers with a consumption in excess of 100 GWh annually and, as from 1 January 2001, to all users with an electricity consumption of more than 1 GWh.

The energy policy is focused on reducing the environmental impact of power generation. The most important means for reducing the environmental impact is to develop renewable energy, improve energy efficiency and adapt the energy sector to a reformed energy market. A political ambition is to phase coal out of Danish power generation by 2028 by means such as support for changing over from coal to biofuel.

After the change of Government in Denmark in November 2001, energy issues were transferred from the Ministry of the Environment and Energy to the Ministry of Economic and Business Affairs. The views on energy policy consequently changed. One of the results was the introduction of a review of the support system in the field of energy, with increased focus on cost effectiveness. An agreement was reached in June 2002 whereby the earlier plans for introducing trading in electricity certificates for supporting electricity from renewable energy sources were postponed and replaced by a fixed price and a price surcharge. As from 2003, the support for new wind power plants will be reduced to correspond to the carbon dioxide charge (12 öre) when the plant has achieved a certain number of full-load hours. The support will be reduced to the same levels also for existing wind power plants that are older than 10 years.

In 2001, Denmark introduced a national system of trading in emission rights that covers only power generation plants. For 2001, a carbon dioxide emission ceiling was set in 2001 at 22 million tonnes, and the ceiling was then lowered by 1 million tonnes annually to 20 million tonnes for 2003. The ceilings can be compared with the 20.7 million tonnes of emissions from power generation in 2001. A carbon dioxide charge of DKK 40 per tonne of carbon dioxide is levied for emissions above the quota. No political decision has yet been taken concerning the emissions for 2004, but the system will be included by 2005 in the EU emission trading system.

Another example of changes in energy policy is the new climate policy strategy presented in February 2003. In the strategy, the Government stated that Denmark is far from the target of reducing the emissions by 21% by 2010, and that meeting the targets would therefore involve high economic costs. It is therefore obvious that the most cost-effective measures must be selected and that it may be much less expensive to implement the measures in other countries than it is in Denmark. In the past, the importance of national measures was emphasized. The Government considers that the EU emission trading system will account for a large proportion of the future climate investments. It will be up to the Danish trading-system participants themselves to determine the measures that should be taken.

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 and the Natural Gas Directive in 1998. The aim of the Directives is to create common rules for the production, transmission and distribution of electricity and natural gas. According to the Directives, the markets for electricity and natural gas will gradually be opened to competition. The rate of opening has been discussed for a number of years, but the countries were not agreed in the matter. However, the EU Ministers for Energy reached agreement in November 2002 that the gas and electricity markets will be opened fully to all industrial customers during 2004 and to all domestic customers in 2007.

In its White Paper on renewable energy sources, the European Commission sets the target that the proportion of renewable energy sources out of the total energy consumption should increase from 6% to 12%. A separate Directive (Support for electricity from renewable energy sources in the internal electricity market) states that the proportion of power generation from renewable energy sources should increase to 22% by the year 2010. The target is indicative, i.e. is 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.

Security of supply is another issue that has gained growing importance in recent years. In November 2000, the European Commission presented the Green Paper "Towards a European strategy for secure 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 coming 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 Paper, 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 stocks and plan for new import routes.

With the aim of improving the security of supply, the Commission has submitted two proposals for directives in September 2002, one of which concerns the security of supply of oil products and one that concerns the same issues for natural gas. The proposals include ensuring that all countries have a public authority that is responsible for the country's oil stocks, that the volumes of oil stocks should be increased from 90 days' consumption to 120 days' consumption, and that common rules should be established for crisis situations. The member countries should define a general policy for the supply of natural gas and should specify the distribution of responsibilities. As a minimum yardstick for the gas stocks, the supply to non-disconnectable consumers should be assured for 60 days.

The European Commission also submitted in July 2002 a proposal for a directive that promotes combined heat and power (CHP) generation. One of the objectives of the directive is to improve the reliability of supply, since CHP generating plants generally broaden the diversity of the fuel mix and the plants are often fairly small and can be installed in regions that are dependent on energy imports. Another reason for promoting CHP generation is that it leads to improved energy efficiency and reduces the environmental impact of energy generation. The directive proposes that CHP generation plants will be able to request and will be granted a guarantee of origin, i.e. a certificate confirming that a certain amount of electricity is generated in a certain plant, with particulars of the plant efficiency, fuels used, etc. In addition, it is proposed that it should be mandatory to determine national potentials for CHP generation, to assure CHP generators access to the grid, and for the member countries to evaluate the current legislation, with the aim of reducing the barriers for CHP generation.

In addition, the European Commission has launched the European Climate Change Programme (ECCP). The programme contains two parts, one of which is a list of prioritized measures, and the other is a plan of action for an emission rights trading system that will become operative in 2005. In November 2002, the EC Ministers for the Environment agreed that a system for trading in emission rights will be introduced in the EU by 2005. The matter was discussed by Parliament in July 2003. According to the proposal, the trading system will comprise 46% of the estimated EU emissions. Power stations and CHP stations with a power input of more than 20 MW will be included. In addition, it is proposed that all member states should issue, free of charge, emission rights to the participating plants during the period between 2005 and 2007. No later than June 2006, the Commission will study the experience gained in order to decide what type of harmonized allocation method is best suited in the future. ■

An international perspective

The conditions on the Nordic electricity market differ in several respects from the conditions prevailing in the remainder of Europe and in the world. As an example, the per-capita electricity consumption in Sweden, Norway and Finland is twice as high as that in many European countries. Viewed in the international perspective, Sweden and Norway also have an exceptionally large proportion of renewable power generation. In international comparisons, it is very important 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. In this chapter, comparisons are made between various countries as regards per-capita electricity consumption, distribution between different power sources, the proportion of electricity from renewable sources, and electricity prices. In addition, the chapter describes EU cooperation in the areas of electricity, natural gas and power generation from renewable sources.

Electricity consumption

The per-capita electricity consumption in Sweden is relatively high compared to other countries. In 2000, Sweden was in fourth place in the world after Norway, Iceland and Canada. In some of the major European industrialized countries, e.g. Germany, France and Great Britain, the per-capita electricity consumption was less than half that in Sweden. Compared to the average among OECD countries, Swedish electricity consumption is about twice as high and is more than twice as high as the average in the EU.

Between 1990 and 2000, electricity consumption in the EU member countries increased by more than 20%. The highest increases were in Iceland, Ireland and Portugal. During the same period, consumption in Sweden increased by 2%, while that in the Nordic countries increased by less than 13%.

A common feature of many of the countries that have high per-capita electricity consumption is that they have access to inexpensive hydro power and have a high demand for space heating due to a cold climate. 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 about 20% lower. Canada, Norway and Finland also have high proportions of electricity-intensive industries. All of these countries contribute to the international distribution of labour, since a large proportion of the electricity-intensive products is exported.

Power generation

The total electricity generated in the EU countries is less than 30% of the electricity generated in the OECD countries, whereas generation in the USA is 40%. The electricity generated in Sweden is 2% of that generated in the OECD countries and about 6% of the total power generation in the EU. The total electricity generated in the EU countries increased by more than 20% between 1990 and 2000. In the same period, Swedish power generation has not increased.

In the EU member countries, half the electricity is generated from fossil fuels, one third from nuclear power and 14% from hydro power. Biomass accounts for 2%. Power generation in Denmark is based predominantly on fossil fuels, while the generation mix in Finland in 2000 consisted of one third fossil fuels, one third nuclear power, 20% hydro power and 13% from biomass. In the international perspective, Sweden had a low proportion of power generation from fossil fuels at just over 4% in 2000, and a high proportion of hydro power and nuclear power in the 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, since almost 100% of the total electricity generated originates from hydro power.

In the EU, hydro power accounts for a predominant part, i.e. 80%, of the total electricity generated from renewable energy sources. Solar, wind, biomass, waste and geothermal power generation account for only 2% of the total electricity generated in the EU. The use of biomass is highest in Finland at 13% of the total electricity generated in 2000. In Sweden, about 3% of the power generation is based on biomass.

According to statistics, geothermal heat is used only in Iceland and Italy. Above all in Belgium and the Netherlands, but also in Denmark and Germany, waste accounts for a relatively high proportion of the electricity generated. In Denmark, wind power dominates at 70% of the total renewable power generation in the country. The proportion of solar energy is very low in all countries. According to statistics, electricity from tidal power is generated only in France and Canada.

TABLE 27

Gross electrical energy generated in 2000, 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 inhabitant [2]
Belgium	2	48	33	1	84	4	8 605
Denmark	4	0	30	2	36	1	6 891
Finland	15	22	24	9	70	12	15 809
France	73	415	50	3	541	-70	7 797
Greece	5	0	49	0	54	0	5 098
Ireland	1	0	23	0	24	0	6 359
Italy	57	0	218	2	277	44	5 559
Luxembourg	1	0	0	0	1	6	15 909
The Netherlands	1	4	80	4	90	19	6 817
Portugal	12	0	30	2	44	1	4 466
Spain	37	62	124	3	225	5	5 750
Great Britain	9	85	277	4	375	14	6 511
Sweden	79	57	5	4	146	5	16 979
Germany	36	170	356	10	571	3	6 990
Austria	44	0	17	2	62	-1	7 501
USA	296	800	2 865	69	4 030	31	14 744
Japan	100	322	653	17	1 092	0	8 600
Canada	359	73	166	7	605	-36	18 522
Norway	142	0	0	0	143	-19	27 612
Switzerland	38	26	1	2	67	-7	8 381
Iceland	8	0	0	0	8	0	27 500
Nordic countries	248	80	59	15	403	-2	16 596
EU total	**374**	**864**	**1 315**	**46**	**2 599**	**42**	**6 980**
OECD total	**1 451**	**2 246**	**5 857**	**145**	**9 700**	**0**	**8 643**

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

[2] Electricity consumption includes here the electricity consumed in industry, transport, residential and services sectors, and also distribution losses and in-house consumption in the electricity sector.

Source: Electricity Information , IEA, OECD 2002

Electricity prices

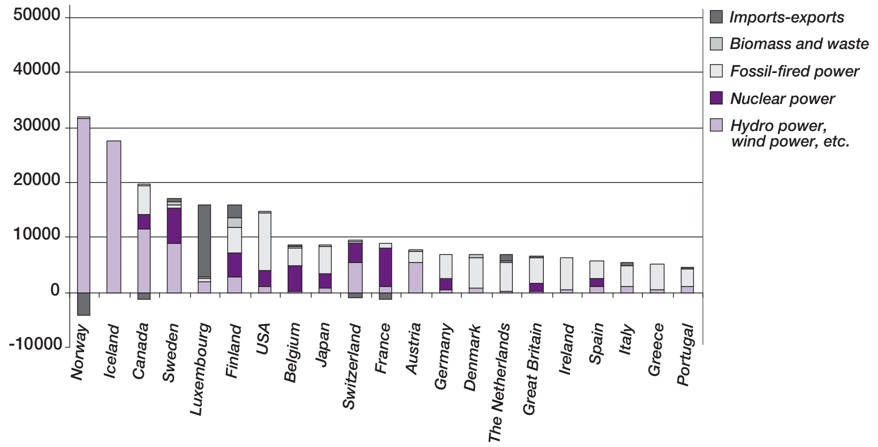
Electricity prices vary between different countries and also between different customer categories. Electricity customers with high consumption (industry) generally pay lower electricity prices than customers with low consumption (domestic customers). In most countries, domestic customers pay energy, environmental and/or value added taxes, and a turnover tax, while industrial customers are exempt from such taxes in most of the countries listed in Table 28.

In the European Commission report from October 2002 concerning the implementation of the internal market for gas and electricity, a study is made of the development of electricity prices. Since 1996, the electricity prices payable by domestic customers, excluding taxes, have dropped in all countries except four. In Denmark and Ireland, the prices excluding tax have instead risen by more than 30% and 20% respectively. In Sweden and Luxembourg, the prices have also increased somewhat, while the prices in Spain during the same period have dropped by 20%.

The prices payable by industrial customers, excluding taxes, have dropped by 20% in most countries, including Sweden and Germany. However, the prices of electricity in Italy and Ireland have increased by 37% and 30% respectively.

FIGURE 17

Per-capita electricity consumption, with relative distribution per source of power, kWh per inhabitant



Source: Electricity Information IEA, OECD 2002

TABLE 28

Electricity prices to domestic and industrial customers, including taxes and VAT, on 1 January 2002, öre/kWh

	Small industrial plant[1]	Medium-sized industrial plant[2]	Large industrial plant[3]	Domestic customer 3500 kWH	Domestic customer 20000 kWh
Australia, Sydney	50	39	31	54	32
Belgium	81	65	42	129	82
Denmark	65	-	-	203	176
Estonia	48	37	-	50	42
Finland	45	41	30	86	54
France, Paris	61	52	-	109	88
Greece, Athens	59	54	38	58	50
Ireland, Dublin	88	68	53	92	58
Italy	98	88	67	175	-
Japan, Tokyo	139	-	-	139	89
Canada, Montreal	58	38	26	67	46
Latvia	48	45	39	63	55
Luxembourg	77	42	35	119	74
The Netherlands		-	-	152	90
Norway	46	35	26	120	78
Poland	87	55	50	93	87
Portugal	67	61	43	119	77
Spain, Madrid	55	47	43	97	63
Great Britain	66	52	42	100	60
Sweden	32	26	24	105	87
Germany, Hamburg	92	70	48	158	92
Austria	-	-	-	124	98

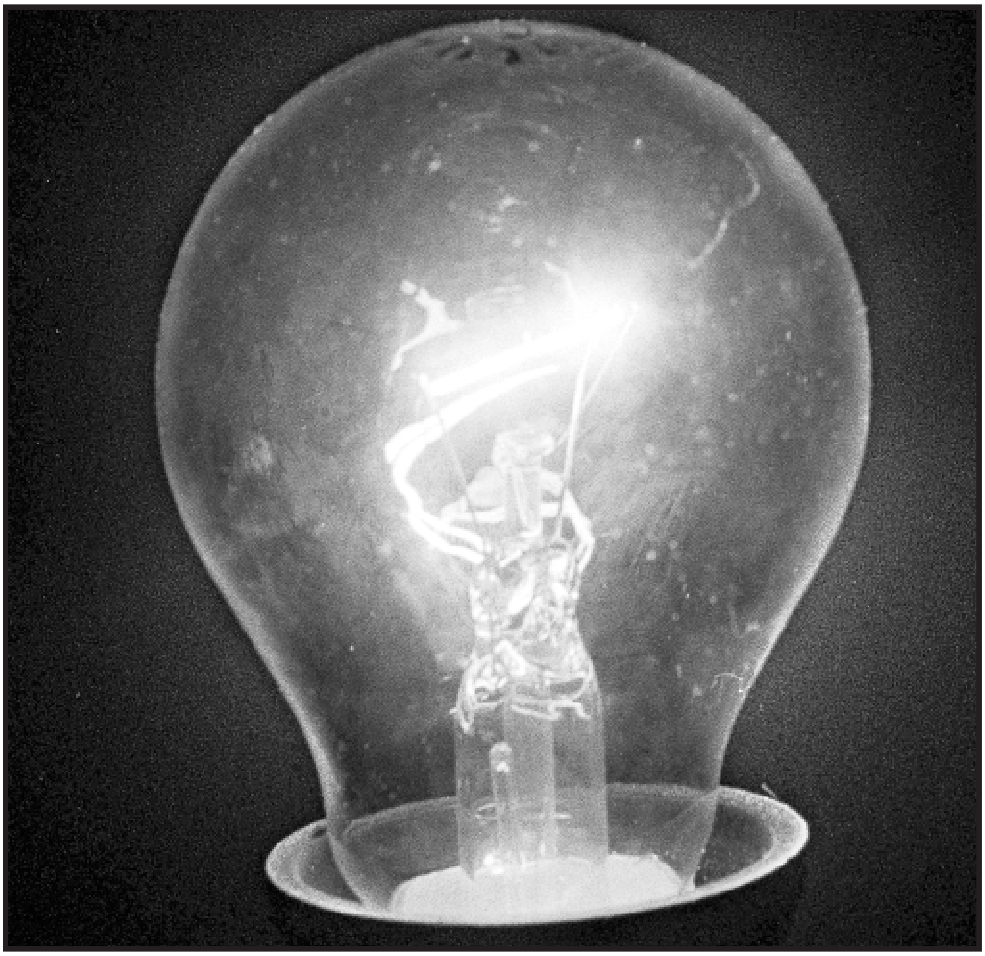
[1] 1.25 GWh annually, 0.5 MW, 2500 hours
[2] 10 GWh annually, 2.5 MW, 4000 hours
[3] 70 GWh annually, 10 MW, 7000 hours
[4] For industrial customers, the prices are quoted excluding VAT, whereas for domestic customers, including VAT.
Note: The foreign exchange rates are mid-rates for January 2002. Source: Statistics in Focus, Theme 8-4 and 5/2002, Eurostat, Electricity Tariffs as of 1 January 2002, Eurelectric April 2002.

TABLE 29

Electrical energy generated from renewable sources and waste in 2000, GWh

	Hydro power excl. pumped storage	Biomass	Biogas	Waste	Wind	Solar/ tidal	Geo- thermal	Total power generation	Proportion of total generated, %
Belgium	459	182	90	947	15			1 693	2
Denmark	29	409	207	1 238	4 441			6 324	18
Finland	14 660	8 476	22	383	78			23 619	34
France	66 938	949	346	1 995	77	573	0	70 878	13
Greece	3 693		1	163	451			4 308	8
Ireland	846		95		244			1 185	5
Italy	44 205	221	566	1 120	563	6	4 705	51 386	19
Luxembourg	120		4	52	27			203	47
The Netherlands	142	378	283	3 509	829	8		5 149	6
Portugal	11 323	1 037	2	514	168		81	13 125	30
Spain	28 372	1 360	380	1 033	4 724	22		35 891	16
Great Britain	5 110	700	2 556	1 104	946	1		10 417	3
Sweden	78 951	3 670	22	240	447			83 330	57
Germany	21 732	804	1 683	7 634	9 352	60		41 265	7
Austria	41 995	1 483	65	167	67	3		43 780	73
USA	248 358	41 616	4 984	22 205	5 645	883	14 678	338 369	9
Japan	87 253	11 309	0	5 209	109		3 348	107 228	10
Canada	358 302	7 379			203	35		365 919	61
Norway	141 597	226		129	30			141 982	100
Switzerland	36 834	14	155	1 434	3	11		38 451	58
Iceland	6 356						1 323	7 679	100
Nordic countries	241 593	12 781	251	1 990	4 996	0	1 323	262 934	62
EU total	**318 575**	**19 699**	**6 322**	**20 099**	**22 429**	**674**	**4 785**	**392 583**	**15**

Source: Energy balances of OECD countries, 1999 - 2002, IEA, OECD



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