6

The transmission grid

- Introduction
- Regulation of monopoly operations
- Environmental impact of electricity transmission

6.1 Introduction

Generation, transmission and sales are the three basic functions of the power supply system.

The transmission grid is often divided into three levels, as shown in Figure 6.1. The high-tension central grid constitutes the “motorway system” for power supply, linking generators with consumers in various parts of the country. It also embraces transmission lines to other countries. The central grid usually carries a voltage of 300–420 kV, but certain parts of the country have lines carrying 132 kV. Regional grids link the central and distribution grids. Most energy-intensive industries and generating companies are connected to the regional and central grids. Distribution grids are generally used to distribute power to end users – private households, services and industry. A distribution grid normally carries a voltage of up to 22 kV, but this is reduced to 220 V for supply to ordinary consumers. A number of small generating companies are connected to the local distribution grid. Power lines in the Norwegian grid, including overhead high- and low-voltage lines as well as underground and submarine cables, extend for roughly 300 000 km, or more than seven times the circumference of the Earth.

The construction of transmission grids is costly, but the average cost per kWh transmitted drops as the level of grid utilisation rises until capacity comes under pressure. This means it is socio-economically inefficient to build parallel transmission lines if the existing lines provide sufficient capacity. Parallel lines may also result in undesirable land use patterns and be unnecessarily intrusive. Grid management and operation have therefore been defined as a natural monopoly, and this sector has not been opened to competition.

The 1990 Energy Act with subsequent amendments provides the legal basis for regulating grid management and operation (regulation of monopoly operations). The Energy Act is discussed in more detail in Chapter 4.3.

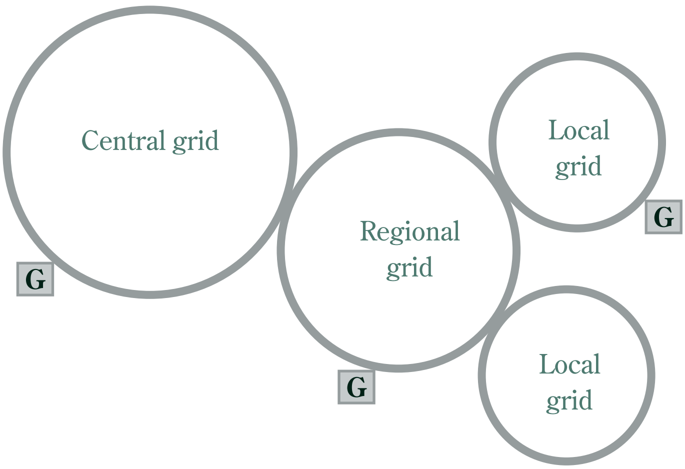

Figure 6.1. The power supply system

The grids are drawn as circles to indicate that they form a meshed network. This means that if one line is inoperative, power can be supplied to customers using other parts of the grids. G stands for generation.

6.2 Regulation of monopoly operations

Because the grid is a natural monopoly, consumers are obliged to buy grid services from the local grid company. Regulation is intended to safeguard consumer rights and ensure efficient management and development of the grid. The Energy Act and regulations issued by the Ministry of Petroleum and Energy and the Norwegian Water Resources and Energy Directorate (NVE) define the framework for transmission operations. The directorate is responsible for monitoring grid management and operations.

The NVE can issue instructions to ensure compliance with legislation and specify licensing terms for monopoly operations. Its decisions can be appealed to the Ministry of Petroleum and Energy.

Regulations currently in force:

- Regulations of 7 December 1990 concerning the generation, conversion, transmission, trading and distribution of energy etc, as subsequently amended (Ministry of Petroleum and Energy)
- Regulations of 11 March 1999 concerning financial and technical reporting, permitted income for network operations and transmission tariffs, as subsequently amended (NVE)
- Regulations of 11 March 1999 concerning metering, settlement and coordination of electricity trading and invoicing of network services, as subsequently amended (NVE)

The regulations require a grid owner to offer services to all customers who want them and to set non-discriminatory and objective point tariffs and terms. The point tariff system provides a basis for ensuring that all customers have access to the power market. See chapter 6.2.2.

Many companies in the power sector pursue both monopoly operations and activities subject to competition. They are required to keep separate accounts for monopoly operations. Such accounts play an important role in the regulatory system. One aim is to ensure that costs related to generation and sale of electricity are not charged to grid management and operation (cross-subsidisation).

Monopoly regulation otherwise involves two main activities. Firstly, the NVE sets income caps which specify the maximum permitted earnings for each grid company. This is intended to ensure efficient development of the grid and reasonable tariffs for customers. Secondly, the directorate determines the framework for setting point tariffs and for metering/billing.

6.2.1 Income caps

The NVE determines an income cap for each grid company. This reflects factors which influence costs in the area served, such as climate, topography and settlement patterns. The company's income, which derives mainly from transmission tariffs, must not be higher than the maximum permitted level determined by the directorate. This system is intended to ensure that grid companies do not make unreasonable monopoly profits and that cost reductions benefit their customers. The directorate has specified income caps for 2002–06 on the basis of costs reported by the grid companies for 1996–99 and the normal rate of return on capital at 31 December 1999. Income caps are intended to apply for the whole regulatory period. However, they are adjusted somewhat on an annual basis to take account of inflation, interest rates, the market price for electricity transmission losses, the cost of new investment and efficiency requirements.

To encourage new investment in the distribution grids, the NVE adjusts the income caps annually on the basis of an adjustment parameter which reflects the average increase in the amount of energy delivered in the country as a whole, combined with a factor for the amount of new construction in the area covered by each distribution grid company. New capital spending in the regional and central grids is dealt with on an individual basis as part of the directorate's consideration of each project licence.

The grid companies have their income cap adjusted on the basis of a general efficiency requirement of 1.5 per cent and an individual efficiency requirement ranging from zero and 5.2 per cent per annum. Individual efficiency requirements are determined on the basis of a comparative analyses of company costs carried out by the NVE. Grid companies which are already efficiently operated need only meet the general efficiency requirement, while less efficient companies must also meet individual requirements. The weighted overall average efficiency requirement is 2.1 per cent per annum. The efficiency requirement does not make it obligatory for companies to become more efficient, but their rate of return rises if they can reduce their costs. They are guaranteed a minimum average annual rate of return of two per cent for 2002–06, but are limited to a maximum return of 20 per cent.

Income caps do not change if grid companies merge. The income cap of the new company is calculated as the sum of the income caps of the merging enterprises. Any efficiency gains from the merger are thereby retained for the rest of the period.

The sum of the income caps for all grid companies in 2003 is about NOK 16 billion. Fourteen per cent of total revenues in grid management and operation accrues to the central grid, 21 per cent to the regional grids and 65 per cent to the distribution grids.

Each regulatory period must last at least five years. The first period in which the income cap system was applied ran for five years from 1997 to 2001, and 2002 is the first year of the period which runs to the end of 2006. The regulatory regime which will apply from 2007 is under development.

6.2.2 Point tariffs

All grid companies are required to use point tariffs when charging for transmission. Point tariffs mean that a grid customer pays the same transmission tariff regardless of whom they buy electricity from or sell to. An individual customer only pays a transmission tariff to the local grid company. Consumers pay one tariff to tap electricity from the grid (consumption tariff), and generating companies pay another tariff to feed electricity into the grid (input tariff). Point tariffs provide easy market access for customers and thus promote the establishment of a nationwide power market.

Point tariffs comprise several components, and must have at least two. One of these varies with the amount of electricity the customer feeds into (input) or taps (consumption) from the grid, and is called the energy component. In addition come one or two other components which do not vary with energy usage. Input and consumption tariffs are described in more detail in chapters 6.2.3 and 6.2.4.

The energy component, which varies with input or consumption, is intended as a general rule to reflect the cost of the change in power loss resulting from the transmission of an extra kWh (the marginal loss rate). Such losses increase with rising utilisation and can be substantial when grid capacity is almost fully utilised.

"Other components" is a collective term for all charges in the tariff other than the energy component. These are intended to ensure sufficient income in relation to the income cap. See Chapter 6.2.1.

All customers with a direct connection to the central grid are invoiced for the electricity they feed into or tap from the grid. Central grid costs form part of the basis used by the regional grid companies to calculate point tariffs for the regional grid. Customers connected to the regional grid accordingly bear a proportion of both central and regional grid costs. Everyone with a direct physical connection to a regional grid is invoiced for the electricity they feed into or tap from the grid. Regional grid costs form part of the basis for calculating point tariffs in the distribution grid. Customers connected to the distribution grid accordingly bear part of the costs of the distribution grid, the regional grid and the central grid, and therefore normally pay higher charges than customers connected to the regional grid.

Connection to higher grid levels is essential to ensure that electricity users receive stable, reliable power supplies, and to allow them to buy power in a national market.

6.2.3 Input tariffs

According to the regulations issued by the NVE, input tariffs for the central grid are to be used as guidelines for the other components of input tariffs for the regional and distribution grids.

The input tariff in 2004 is NOK 0.06 per kWh of a power station's mean output. More information about the central grid tariff is available from Statnett at www.statnett.no. The input tariff must also include an energy component which reflects grid losses. This is calculated on the basis of an individual percentage loss for the energy component at each input point, regardless of the grid level at which the input occurs. More information on the energy component in the central grid is provided in chapter 6.2.4

6.2.4 Point tariffs for electricity consumption

The consumption tariff for electricity can comprise several components:

- an energy component which depends on the amount of energy used by the customer
- fixed component payable per year
- power component which depends on the maximum consumption (in kW).

The percentage marginal loss in the central grid is calculated as a basis for the energy component at each connection point for input and consumption. These percentages are currently calculated every eighth week. The loss varies with the load on the system and thereby with the geographical location of each connection point for input or consumption in relation to other points. A power station can be favourably located in the grid so that increasing its output reduces the loss. In such cases, the loss rate – and thereby the energy component – will be negative. In areas with a large surplus output, the loss rate is high for input and negative for consumption. In cases where the same point in the central grid is used for both input and consumption, the loss rates lie symmetrically on either side of zero. The loss rate in the central grid varies between plus and minus 10 per cent. The value of the loss in the central grid is defined as equal to the price of the same amount of power on the spot market.

Loss rates are calculated for the energy component in the regional grids in the same way as for the central grid. In distribution grids, the average annual loss for the whole grid is calculated for consumption, and the regulations also permit the energy charge for consumption from a distribution grid to be higher than the real cost of the losses.

Both fixed and power components are part of other components. See chapter 6.2.2. Small consumers connected to the lowest grid voltages normally pay a fixed charge, while larger consumers connected to higher grid voltages pay one or more power charges. The inclusion of a fixed or power charge means that the overall tariff measured in NOK per kWh falls as consumption rises. The NVE issues statistics on transmission tariffs for regional and distribution grids. See its web site at www.nve.no. Statnett SF also provides information on central grid tariffs. See its web site at www.statnett.no.

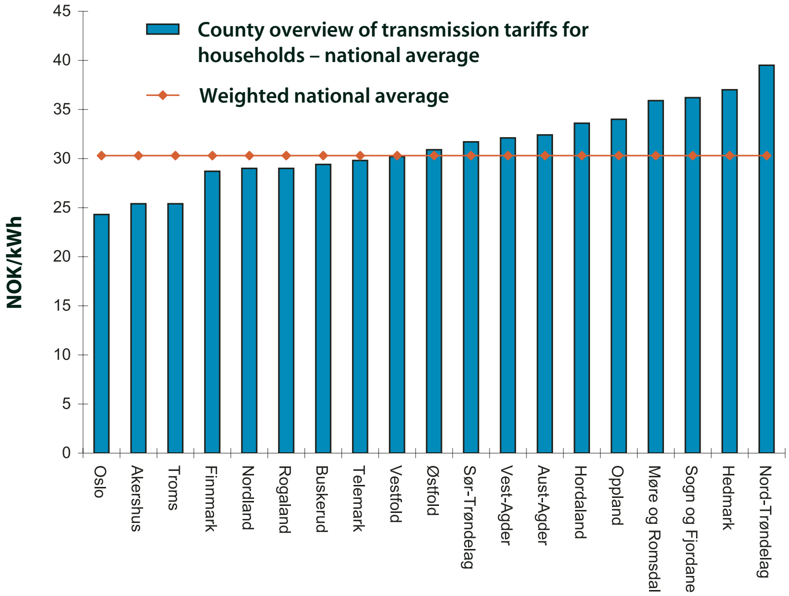

Figure 6.2 Transmission tariffs for private households at 1 June 2004, converted to a consumption of 20 000 kWh per year and shown in NOK per kWh.

Source: Norwegian Water Resources and Energy Directorate

Transmission tariffs for consumption vary from one grid company to another. This is because natural conditions and thus the cost of distributing electricity to the customer differ widely around the country. Both difficult natural conditions and a dispersed settlement pattern can boost transmission costs. In addition, the efficiency of grid companies varies considerably. Inefficient operation of the grid also contributes to high transmission costs and thereby to higher tariffs.

Private households are connected to the lowest voltage level in the distribution grids. The transmission tariff or charge they pay normally consists only of a fixed component and an energy component. Figure 6.2 shows average transmission tariffs for private households in each county at 1 June 2004, including VAT but excluding electricity tax. The figures are based on an average annual electricity consumption of 20 000 kWh. The average transmission tariff for a household consuming that amount per year was NOK 0.303 per kWh at 1 January 2004, including VAT.

With effect from 1 January 2004, the grid companies took over responsibility for collecting the electricity tax through grid charges. This job was previously discharged by the electricity suppliers via their invoicing. The electricity tax has been set at NOK 0.0967 per KWh for 2004, and comes to NOK 0.12 per kWh when VAT is added. The change has not increased the total cost to customers.

In order to reduce differences between transmission tariffs for end users in different parts of the country, a new grant system was introduced in 2000. It is intended to reduce transmission tariffs for end users connected to distribution grids in parts of the country with the highest transmission costs. Funds are transferred to the appropriate grid companies, which are then required to reduce their tariffs.

6.3 Environmental impact of electricity transmission

Electricity transmission affects land use and the environment. Power lines can have a negative aesthetic impact on residential areas, landscapes and the rest of the environment. They have less effect on the flora and fauna, although there may be a risk of birds colliding with overhead power lines. Power lines also occupy land which could be used in other ways, and can create difficulties for farming and reduce production in agricultural areas.

Aesthetic concerns and the visual impact of power lines on the landscape are taken into account when considering new developments. These concerns are given special weight in areas which remain relatively undisturbed. To limit the negative environmental impact of electricity transmission, the need for new transmission facilities and opportunities for dismantling surplus lines are always carefully considered. Careful planning of the routes for power lines, evaluating whether existing power line corridors can be used, and laying underground cables as an alternative to overhead power lines offer possible ways of mitigating the impact of new facilities. Licences granted pursuant to the Energy Act may include conditions designed to reduce the environmental impact. Administrative procedures pursuant to the Energy Act are described in more detail in Chapter 4.3.

7

The power market

– How the power market functions

– Power trading

– Price formation

– International power trading

– Norway´s imports and exports of power in 1970–2003

The power supply sector in Norway is regulated by the Energy Act. Market-based power trading is one of the principles incorporated in this statute. Similar legislation is found in Sweden, Denmark, Finland and the other EU countries. The Nordic countries today form a common power market, which also has links to Russia, Germany and Poland.

7.1 How the power market functions

All generating companies supply electricity to the transmission grid. Once delivery has been made, it is no longer possible to separate supplies from different generators. When a consumer turns on the electricity, it is impossible to say where the power was generated.

When electricity is transmitted, some energy is lost. This loss depends on such factors as consumption and transmission distance. At any given time, the amount of electricity supplied to the grid is equal to the amount tapped from it after allowing for transmission losses. Accounts are kept of how much each generator is delivering to the grid at any given time and how much each consumer takes out.

If a consumer changes supplier, this will not in itself affect the physical flow of electricity. The transmission tariff payable by the customer is therefore unchanged. See chapter 6. It makes no difference whether the customer buys electricity from a generator on the west coast or in the far north of Norway. They merely conclude a new contract which may specify different prices and terms.

The amount of electricity a generator sells at any time need not correspond to their output. To maximise income, generators manage the use of water in the reservoirs on the basis of the spot price at any given time and expectations about what it will be in future. See chapter 7.2 on power trading. To ensure that output corresponds to sales commitments, generators can buy and sell power in the market – Nord Pool, for instance, which is the Nordic power exchange.

The spot price varies to reflect changes in consumption, generation and transmission conditions in the Nordic power market. Variations in precipitation and temperature can result in large swings in the spot price. This means that the economic risk associated with electricity trading is high. To reduce this risk, generators, consumers and other players in the market can conclude long-term physical and financial contracts. Households can obtain fixed price contracts, for example.

7.2 Power trading

The power market is often divided into wholesale and end user segments. The latter is described in more detail in chapter 7.2.4.

The wholesale market embraces generators, suppliers, big industrial enterprises and other large undertakings. Electricity is traded bilaterally between different market players and in the markets organised by the Nord Pool Nordic power exchange. A number of companies broker standard bilateral contracts, but a growing proportion of contracts are traded in Nord Pool's markets. Bilateral contracts still have the largest market share.

Physical trade between the Nordic countries is based on Nord Pool Spot's electricity spot market. However, financial contracts may also be concluded bilaterally between players in the various countries.

7.2.1 Nord Pool – the Nordic power exchange

Trading in and clearing of physical and financial power contracts in the Nordic region are conducted by the Nord Pool group – the Nordic power exchange. About 350 players currently trade in one or more of Nord Pool's markets.

The Nord Pool group comprises the parent company, Nord Pool ASA, and its wholly-owned subsidiaries. These are Nord Pool Clearing ASA and Nord Pool Consulting AS. Nord Pool ASA is owned 50-50 by the system operators in Norway and Sweden – Statnett SF and Affärsverket Svenska Kraftnät respectively. With its head office in Oslo, the group has operations in Stockholm, Helsinki and the Danish city of Fredericia.

Nord Pool Spot AS also belongs to the Nord Pool group, and is owned by all the system operators in the Nordic region as well as 20 per cent by Nord Pool ASA. This company sets the electricity spot price on an hourly basis in the physical market for Norway, Sweden, Finland and Denmark to serve as a reference price for other power trading.

The Nord Pool group also has holdings in Germany's European Energy Exchange (EEX) and an operational collaboration over information technology systems with the French Powernext exchange.

Nord Pool has about 91 employees, and contracts worth NOK 405 billion were traded and cleared over the power exchange in 2003.

Nord Pool's products are divided into three principal categories: the physical market, the financial market and clearing.

The physical market

Electricity spot (Elspot) is a common Nordic market for trading physical power contracts hour by hour with delivery the following day. Prices are determined on the basis of the total quantity of electricity which the players announce they wish to buy or sell. The spot market price provides the basis for the system operators when balancing the flow of power between the Nordic countries.

The system price in Elspot serves as a reference for determining prices in Nordic financial power trading. This price reflects generating and consumption conditions in the region. In addition, area prices take account of possible bottlenecks in the Nordic transmission network. See chapter 7.2.2.

Apart from power generators and industrial companies, players in Nord Pool's spot market include distributors, electricity suppliers and power brokers.

Elbas is a physical balancing market for trading in Sweden and Finland, with hourly contracts which are traded continuously throughout the day. These contracts begin to be quoted when trading in Elspot for the following day has concluded, and they can be traded up to an hour before delivery begins. Elbas is administered by Nord Pool Finland.

The financial market

Nord Pool offers trading in forward contracts and settlement to exchange members in the financial market. These are financial power contracts used for price hedging and risk management in electricity trading. They can be traded for four years into the future, divided by days, weeks, months, quarters or years. Futures have a daily market settlement in both trading and delivery periods, while forwards accumulate the results of price changes during the trading period and have daily settlements during the delivery period.

Contracts for difference (CfD) provide opportunities for adjusting and hedging portfolios in terms of differentials between the system price and the various area prices in Elspot.

Nord Pool's options contracts are European options with forward contracts as the underlying product.

Clearing

Nord Pool Clearing acts as the middleman in financial power contracts. Providing daily security to cover future settlements reduces the financial risk for the contracting parties. Nord Pool automatically becomes a party to all contracts traded on the power exchange. In addition, Nord Pool Clearing offers clearing of standardised contracts traded off the exchange.

Nord Pool turnover in 2003

Activity was reduced in Nord Pool's markets during 2003, primarily as a result of the tightness of electricity supplies in the early part of that year.

The volume traded in the physical market declined by about five per cent from 2002 to 2003. Traded volumes for 2003 and 2002 were 119 and 124 TWh respectively. On the other hand, the value of traded volumes in the physical market rose by about 34 per cent over the same period to reach about NOK 36 billion in 2003. This value increase reflected higher spot prices throughout the year.

A decline of about 46 per cent in traded volume from 2002 to 2003 was registered by the financial market. Trade volumes totalled 545 and 1 019 TWh in 2003 and 2002 respectively. The value of this volume declined from NOK 180 billion in 2002 to NOK 139 billion in 2003.

Clearing of both bilateral trades and in the financial market has increased substantially over recent years, but declined by about 43 per cent in 2003 compared with the year before. It amounted to 1 764 and 3 108 TWh in 2003 and 2002 respectively, corresponding to NOK 369 billion and NOK 434 billion.

7.2.2 Managing bottlenecks in the grid

Nord Pool Spot sets a system price for each hour which takes no account of any transmission restrictions in the Nordic grid. However, such restrictions may arise between geographical areas.

Restrictions in the Nordic transmission grid, often termed bottlenecks, are managed by specifying price areas on either side of the bottleneck. Nord Pool determines such price areas in addition to the system

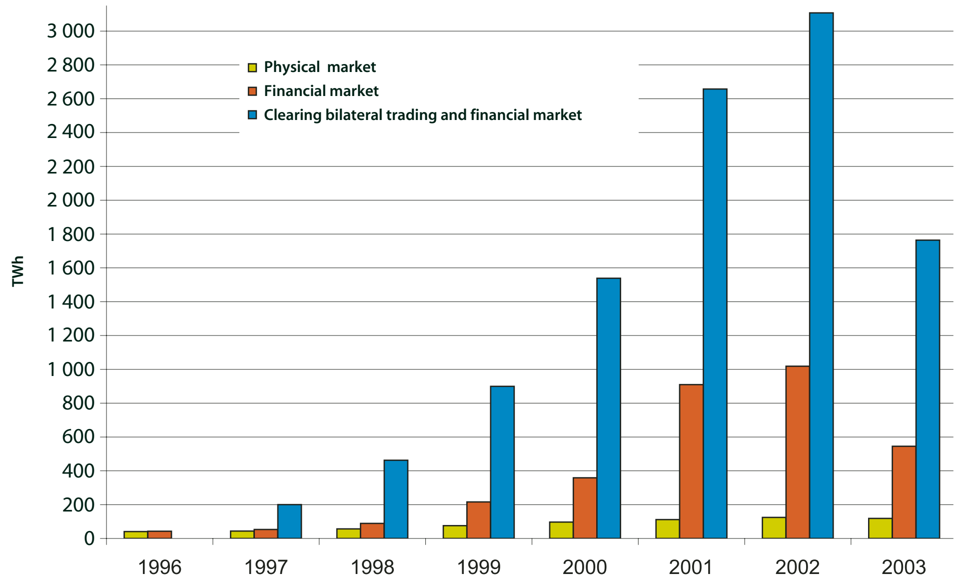

Figure 7.1 Developments in the physical and financial markets and in clearing since 1996.

Source: Nord Pool

price. Regions with a power surplus have an area price lower than the system price. The position is reversed in areas with a deficit. Area prices help to balance supply and demand within each area while taking account of the bottleneck.

Norway uses price areas as the main tool for dealing with bottlenecks within its borders and at the frontiers with Sweden, Denmark (Jutland) and Finland. As a general rule, Norway uses price areas to deal with major or long-lasting bottlenecks in the grid and counterpurchases when smaller adjustments are needed. Sweden and Finland only use price areas to deal with external bottlenecks and counterpurchases to deal with domestic ones. Counterpurchases involve the system operator paying generators to increase or reduce output in order to balance the market. Denmark is divided into two price areas, Jutland and Zealand.

The differential between area and system prices is called the capacity fee. Nordic system operators share the income from capacity fees arising in the Nordic power market.

7.2.3 The balancing market

The balancing (or regulatory) market is a tool which the Norwegian system operator, Statnett SF, uses to maintain a stable frequency and balance between generation and consumption in Norway. See chapter 5.4. The balancing market opens after prices and quantities have been determined in the electricity spot market. See chapter 7.2.1. Statnett receives quotes from major generators or consumers who are willing to alter their power output and/or consumption plans at short notice. In this way, Statnett ensures that it can adjust the amount of power in the grid either up or down right until the hour of delivery. This may be necessary, for example, in the event of the sudden failure of a power station or transmission line, or sudden unexpected changes in demand. In addition, Statnett exchanges power in the balancing market with other system operators in the Nordic countries. Elbas is also used for short-term regulation of the market in Sweden and Finland,.

Statnett also concludes contracts for power reserves with generators and major consumers in the balancing options market. These deals help to make sufficient reserves available in the balancing market so that the balance between generation and consumption can be maintained even when this comes under pressure. See appendix 2. The power reserve contracts specify how much capacity each player will make available to the balancing market, the period of time involved, and the price for keeping this capacity in reserve. The smallest volume which can be offered is 25 MW within the specified grid area and time period. See chapter 7.2.2. However, the contracts do not specify the price each bidder will receive for the specific volume of energy actually used. This is determined in accordance with the ordinary rules of the balancing market, and bidders are free to determine their own bid price in this market. When Statnett has determined which offers in the capacity options market to accept, all bidders which have made the same type of bid – in other words, within the same grid area and for the same period – receive the same price per MW. This price is equal to the highest price accepted for this type of bid. These contracts were first used in November 2000.

7.2.4 The end user market

Anyone who buys electricity for their own consumption is an end user. Small end users normally buy power from an electricity supply company. Larger end users, such as industrial enterprises, often buy directly in the wholesale market. All end users are free to choose which electricity supplier they wish to use.

An electricity invoice has several components: the electricity price, the transmission tariff, the electricity tax, VAT and a levy on the transmission tariff earmarked for the Energy Fund. See chapter 2.5.

All end users must pay a transmission tariff to the local grid company to which they are connected. See chapter 6.2.2. If transmission and electricity supply are handled by different companies which are not members of the same group, the end user will normally receive two invoices - one from the grid company and one from the electricity supplier. However, most end users buy their power from a company or a group which embraces both functions. They usually therefore receive only one invoice which specifies the transmission tariff and electricity price as separate items.

The electricity tax is charged on power regardless of whether the latter is generated domestically or imported, and stood at NOK 0.967 per kWh in 2004. See the presentation of taxes and fees in chapter 2.5.

Large customers normally have meters which measure electricity use by the hour, so that a precise settlement can be made. Smaller consumers receive invoices based on a predetermined load profile, but can opt to be metered by the hour.

Household customers can also choose between different types of contracts for purchasing electricity. The commonest kind is based on a variable price, which means that the supplier can change the price after notifying the customer. In the first quarter of 2004, 67.5 per cent of all households had such contracts. Elspot-based contracts, such as ones which charge the Elspot price plus a fixed mark-up, were held by 10.7 per cent. The remaining household customers had various types of fixed-price contracts. A fixed price, for example for one year, means that the supplier cannot alter the price during the contract period, even if market prices change. The percentage of households with such contracts has increased in recent years, largely as a result of electricity price developments in the winter of 2002–03, and stood at 28.1 per cent in the first quarter of 2004.

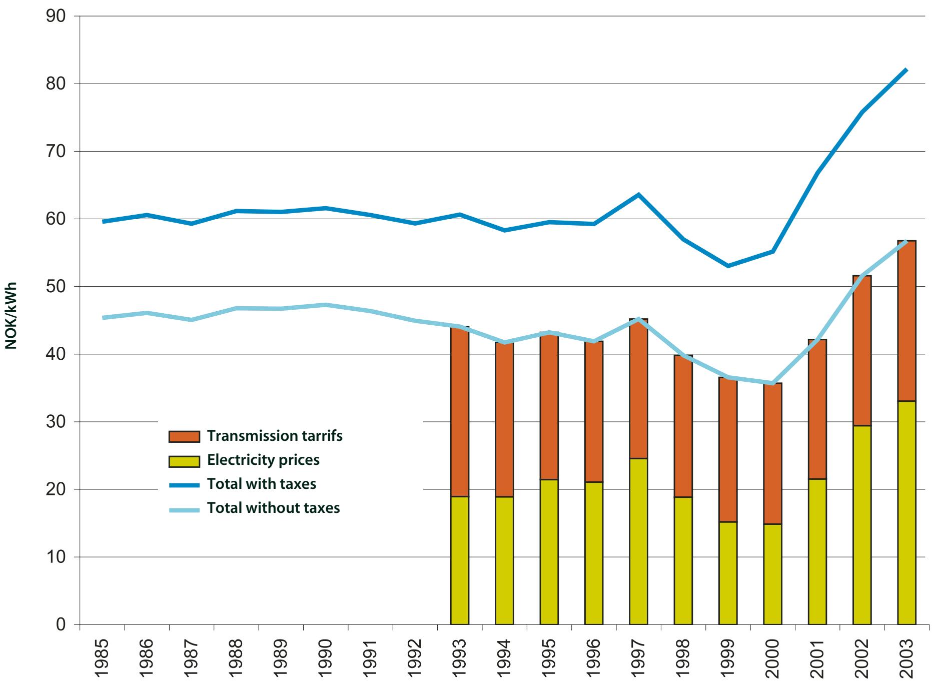

Figure 7.2 Electricity prices for households 1985–2003. NOK per kWh in fixed 2003 NOK

Source: Norwegian Water Resources and Energy Directorate

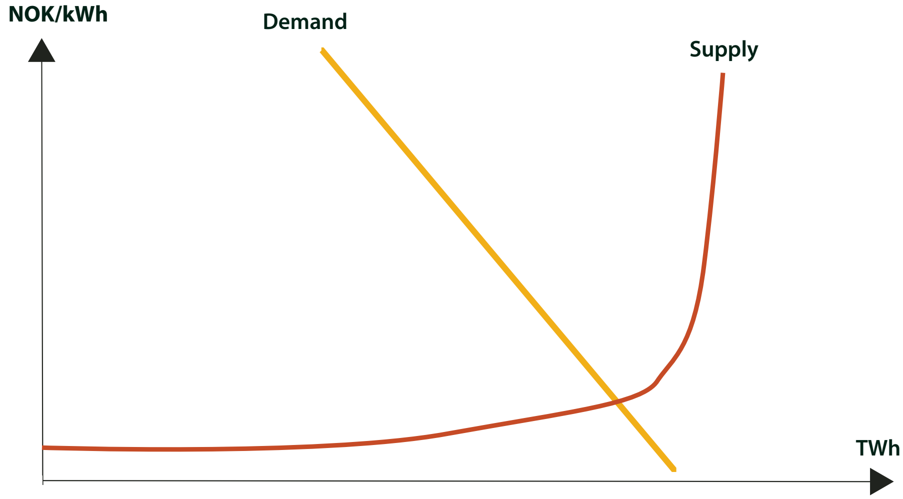

Figure 7.3 Principles for short-term variable costs of power generation in the Nordic region

Source: Ministry of Petroleum and Energy

Some 24 per cent of household customers, including cabins and holiday homes, had a different electricity supplier than the main one for their area in the fourth quarter of 2003.

Figure 7.2 shows trends in average prices for households from 1985 to 2003. The electricity price and transmission tariff were separated in 1993. The figure also shows the total end user price, including VAT and electricity tax. Prices for private households were relatively stable from 1986 to 2001. However, the cold winter in 1995-1996, combined with low inflow in 1996, resulted in a sharp rise in wholesale prices which led in turn to an increase in prices charged to households. These accordingly rose from 1996 to 1997. Precipitation was above normal for every year in the 1997-2000 period, with relatively high hydropower output. This was reflected in a general decline in prices over the whole period. Inflow to the reservoirs declined substantially in the winter of 2002-03. This led to a considerable rise in household prices for many consumers. See appendix 2 on the 2002–03 dry year.

7.3 Price formation

Norwegian electricity prices are determined by supply and demand in the Nordic power market and to some extent by the market balance in countries outside this region. Figure 7.3 provides a simplified outline of how electricity generating costs in the Nordic region influence electricity prices. The rising curve shows the availability of power capacity in the Nordic region as short-term generating costs rise. The falling curve shows the demand for power in the Nordic region. Generating costs are lowest for hydropower and nuclear energy. Precipitation and inflow to reservoirs determine how much hydropower can be generated, and are therefore also important for the overall output potential and for prices. Generating costs are higher at thermal power facilities, such as coal- and gas-fired stations. Given the current level of demand, coal-based facilities often serve as the swing generator to balance the market, and therefore determine the price. In a year with average hydropower output, electricity prices will therefore be largely determined by the

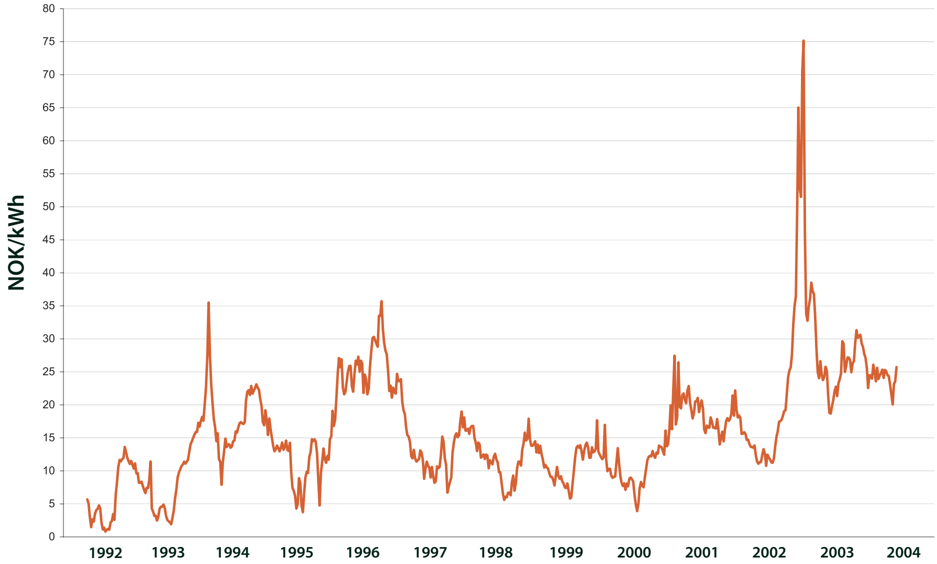

Figure 7.4 Prices in Nord Pool's spot market 1992–2004

Source: Nord Pool

cost of generating electricity from coal. In periods of increased demand, power stations with higher generating costs – such as oil condensate or pure gas turbine units – will determine the price. These peak-load stations are used only to generate electricity for short periods at a time. In Figure 7.3, they would lie on the steeply rising part of the supply curve. Temperature and general economic activity are among the factors which help to determine demand.

Figure 7.4 shows variations in the nominal Elspot price for 1992–04.

7.4 International power trading

Norway was traditionally a net exporter of power. But it has been a net importer since the late 1990s because consumption continues to rise while hydropower development has been limited in recent times. In certain years, however, high precipitation and inflow to reservoirs mean that the hydropower utilities can help exports to exceed imports. Net Norwegian power exports in 2002 totalled 9.7 TWh, for instance, while net imports came to 7.8 TWh in the following year. Figure 7.5 shows imports and exports of power by Norway from 1970 to 2003.

International power trading is determined by generating and consumption patterns in each country, in addition to the capacity of the transmission grid linking countries and the conditions for its use. One basis for power trading is the opportunities it offers countries to derive mutual benefit from differences in national generating systems.

Exchanging power in this way is important for Norway because it reduces the country's vulnerability to variations in precipitation and inflow and makes use of the regulatory capacity of hydropower. Good opportunities for power exchange moderate the need to maintain a large domestic reserve capacity as an insurance against dry years.

Most of the countries with connections to Norway base their power output largely on thermal sources – coal, oil, gas and

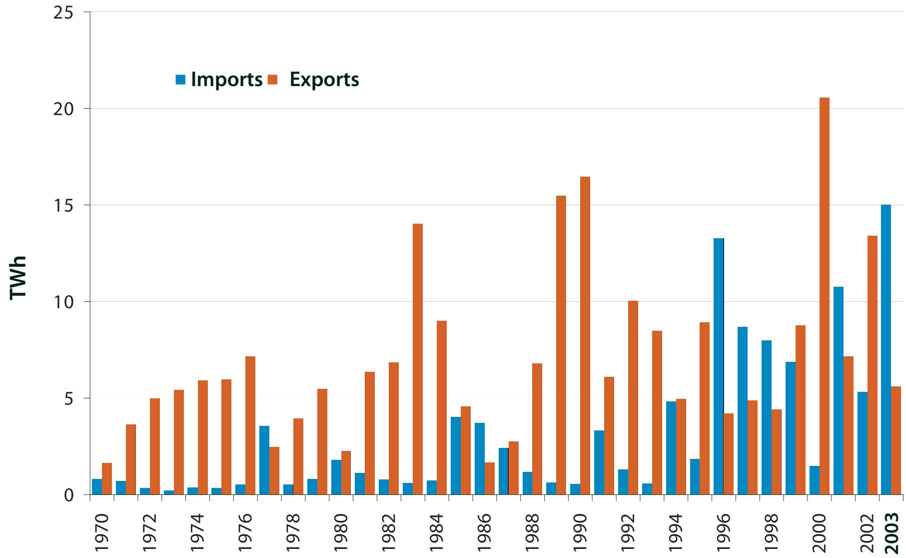

Figure 7.5 Norway's imports and exports of power in 1970–2003

Source: Ministry of Petroleum and Energy

nuclear. This normally ensures stable energy supplies. The opportunity to import electricity in dry years provides a reserve for the Norwegian system. In years when water inflow is good, the transmission grids make it possible to export power from Norway. In this way, opportunities for power exchange will damp down price fluctuations in the Norwegian energy supply system. In a closed Norwegian system, electricity prices would be much more sensitive to variations in climate.

Power exchange between Norway and other countries exploits the advantages of interconnecting hydro and thermal power systems. In countries based on thermal sources, power station capacity determines how much electricity can be generated, while the limiting factor in Norway today is the amount of energy available in the form of water in reservoirs. The energy sources used in thermal power countries – oil, coal, natural gas and uranium – can generally be acquired in whatever quantities are needed and accordingly impose no restrictions on output.

Building new thermal capacity to meet short-term peaks in demand in countries with thermal-based systems is expensive, and adjusting output up and down in existing generating facilities is both time-consuming and costly. But thermal power stations can deliver relatively inexpensive electricity outside peak consumption periods – in other words, at night and on weekends.

Capacity in Norway's hydropower stations exceeds the level normally required to meet domestic daytime consumption. Output from such facilities can be adjusted up and down rapidly and at low cost to meet fluctuations in consumption or unexpected short-term changes in power supplies.

Interconnecting a hydropower-based system with ones based on thermal power also makes it possible to reduce the need for new power stations and multi-annual reservoirs in Norway. When the Norwegian electricity price rises sufficiently above the marginal cost of thermal power output, it becomes profitable for neighbouring countries to export to Norway. Conversely, it is profitable for Norway to export power when the price at home is lower than in neighbouring countries.

Norway has transmission connections with Sweden, Denmark, Finland and Russia, as shown on the map in Appendix 3. Transmission capacity to Finland and Russia is small, and the connection with Russia is used only for imports to Norway. Transmission capacity is largest between Norway and Sweden, at about 3 600 MW, while capacity in the other direction is rather smaller. Capacity between Norway and Denmark is about 1 000 MW. The specified transmission capacity is what the various system operators consider to be realistic for large parts of the year. However, estimates indicate that, were this capacity to be fully utilised, it would be theoretically possible to exchange almost 20 TWh per year between Norway and neighbouring countries. In practice, operating and market conditions limit the amount which can be transmitted at any time.

Transmission capacity from Sweden to Denmark is normally assumed to be about 2 000 MW, while capacity from Denmark to Sweden is generally about 400 MW higher. The figure from Sweden to Finland is just little over 2 000 MW, and about 1 500 MW in the opposite direction. Transmission capacity in and out of a country differs because of internal factors related to electricity generation, transmission and consumption in each country.

The map also shows transmission capacity out of the Nordel area – in other words, capacity between the Nordic region and neighbouring countries. Transmission capacity is available to Germany, Poland and Russia.

7.5 Electricity output in the Nordic countries

Electricity output in the Nordic countries totalled about 370 TWh in 2003. From 1990 to 2002, output in these countries rose by 44 TWh, or about 14 per cent. The decline in inflow to the Nordic hydropower stations reduced electricity output in 2003 by 19 TWh compared with the year before. Under more normal precipitation conditions, output will return to the 2002 level. Norway and Sweden are the largest power generators among the Nordic countries.

Hydropower and nuclear energy are the two most important energy sources for Swedish electricity generation, and together account for about 90 per cent of total output. Most of the remainder comes from power stations based on bioenergy, gas and coal. Electricity output totalled just over 133 TWh in 2003, while gross consumption was roughly 145 TWh. Almost all available Swedish generating capacity based on oil condensate has been closed down in recent years. The Swedish government has decided to shut down nuclear power stations, including capacity at Barsebäck. However, new generating capacity is also planned. This includes two new gas-fired power stations in Gothenburg and Malmö respectively.

Danish power output is based mainly on fossil fuels, particularly coal as well as some gas. Total output in 2003 was 33 TWh, with total consumption almost 35 TWh. Denmark's electricity output in 2003 was about 10 TWh higher than normal because of the tight power supply position in the Nordic region. Cogeneration stations, which generate both electricity and heat, account for about 85 per cent of Danish power output. Wind power accounted for roughly 12 per cent of electricity generated in 2003. Electricity prices to consumers are relatively high in Denmark at present compared with the other Nordic countries, partly because of heavy taxes on consumption.

Finland's system includes hydropower, nuclear energy and cogeneration. The country generated almost 80 TWh in 2003. Thermal power accounted for 60 per cent of this output, with nuclear and hydropower providing 27 and 12 per cent respectively. Total Finnish consumption in 2003 was 85 TWh. The bulk of Finland's power imports come from Russia, with the rest mainly supplied by Sweden – the only Nordic country with significant transmission capacity to Finland.

8

Research and development

- Research and development
- Research programmes
- International research and development

8.1 Research and development

The Research Council of Norway is responsible for administering most of the public funding available for energy research. From 2004, such research is organised in the Renergi programme on the clean energy for the future. This embraces basic research as well as work focused on commercial applications and social science aspects.

Part of Norway's research effort in the energy sector is the responsibility of the Norwegian Water Resources and Energy Directorate (NVE). This primarily concerns activities relating to energy and watercourse administration.

The Ministry of Petroleum and Energy has appropriated about NOK 179 million for research in the energy field during 2004. NOK 150 million of this total is allocated to the Research Council of Norway and NOK 18.5 million to the NVE. Roughly NOK 9.5 million goes to meeting Norway's commitments in international collaboration on energy research.

Strategic research is intended to lay the basis for more market-related projects in cooperation with industry and other users. Other parts of the research effort are user-managed to ensure that the results can be adopted if they are technically successful. Users also contribute the bulk of project financing.

8.2 Research programmes

More information on the energy research programmes pursued by the Research Council of Norway and the NVE can be found on their respective web sites at www.forskningsradet.no and www.nve.no.

8.2.1 Renergi – clean energy for the future

All Norwegian energy research has been organised from 2004 in a single programme called Renergi – clean energy for the future. It had a 2004 budget of NOK 150 million from the Ministry of Petroleum and Energy.

This programme covers a wide range, from basic research and expertise development focused on institutions and universities, through applied research and technological development with the main focus on industry, to social science research as a basis for policy formulation. It is thereby intended to facilitate research both for the long term – a 30-year perspective – and in the short term – over the next five to 10 years.

The main aim of Renergi is to develop knowledge and solutions as the basis for environment-friendly, economically rational and safe administration of Norway's energy resources, and internationally-competitive industrial development relating to the energy sector. Emphasis is placed on building up competent and robust R&D institutions which can serve industry and the authorities in a satisfactory way.

With limited available resources, both financial and in terms of researcher capacity, priorities must be set for the research effort. In light of a steady trend towards more joint international research, four areas in particular will attract a special focus and commitment for government-funded research in Norway. These are where:

- Norwegian research institutions have a special expertise and position
- Norwegian industry and other user groups have special expertise with adopting research results in terms of Norwegian value creation in the broad sense
- Norwegian energy resources put the country in a special position over the long term
- Norway has special research requirements.

In light of this, the following issues will provide the basis for setting priorities in Renergi:

- renewable energy production: hydropower and new renewable sources
- natural gas: gas-fired power with CO_2 capture
- hydrogen

– the energy system, including infrastructure, planning and security of supply
– the energy market
– energy use
– energy policy and international agreements, including policy instruments and the environment.

Renewable energy production
Norwegian energy companies, energy industry suppliers and research institutions are strongly placed in the hydropower sector. Expertise in this area should be further enhanced with a view to future operation and development of the system. At the same time, research should support export opportunities available to Norwegian industry.

Norway is also plentifully endowed with renewable energy resources, such as wind, solar, biological, and marine sources – including waves, salt gradients and tides. These resources are substantial, so the challenges will primarily be technological and commercial – the ability to produce at competitive costs.

Possible priority areas could be:
– optimised and environment-friendly hydropower developments
– utilisation of solar energy in buildings
– production and use of biofuels derived from wood and waste
– offshore wind power and other utilisation of wind energy adapted for Norwegian conditions
– salt gradients and other areas where Norway is strongly placed.

Natural gas – gas-fired power with CO_2 capture
Natural gas is an energy resource which puts Norway in a special position internationally through production solutions and exports. Very little domestic use is made of natural gas. Renergi will focus on new opportunities for energy production and industrial development relating to a growing use of natural gas.

Generating electricity from natural gas with minimum CO_2 emissions is one area where Norwegian research institutions have acquired an international position over several years. A number of avenues are being explored, but commercially-attractive solutions remain a long way off. The programme will focus on capture, transport and storage of CO_2.

Possible priority areas could be:
– electricity generation systems incorporating CO_2 capture
– technology and expertise in handling CO_2 from production to storage
– new technologies for direct use of natural gas, including fuel cells
– decentralised cogeneration (combined heat and power) systems.

Hydrogen
Great attention has been focused internationally in recent years on developing hydrogen as an energy carrier. This subject has also attracted increased attention in Norway. See chapter 3.6.

The visions described for hydrogen involve a very lengthy perspective. Consequently, the commitment in Renergi will be long term and place great emphasis on building up basic expertise.

Initially, the programme will give priority to projects which build on existing Norwegian knowledge. One important consideration will be to prioritise areas where research in Norway can contribute to broader international collaboration.

Possible priority areas could be:
– production of hydrogen from natural gas or electrolysis of water
– hydrogen storage
– developing fuel cell components and systems for use with hydrogen
– hydrogen-relevant materials research
– system integration for hydrogen, including safety issues and social considerations
– using hydrogen in the transport sector.

Energy systems, including infrastructure, planning and security of supply
Further development and integration of

power system planning to embrace the energy system as a whole will be important. This includes better interaction between technical and economic planning models, and the inclusion of heat. Further progress also needs to be made on the interaction between energy planning and other physical and public planning at local authority and national level.

Possible priority areas could be:
- system analysis
- improving efficiency, security of supply/contingency planning and environmental aspects
- local and regional energy planning
- system integration of distributed power generation
- LNG technology, with the emphasis on small-scale solutions
- power transfer within Norway and with its neighbouring countries
- small-scale district heating systems.

The energy market

Ensuring that the signals sent by the power market are sufficient to provoke long-term decisions on constructing new generating capacity is important. So is ensuring that the market stimulates efficient energy use.

Participation in research on shaping an efficient international gas sales system is important for Norway as a major gas exporter – also with a view to facilitating domestic sales.

Norwegian specialists and institutions have a strong position in the energy market and in its development. Further improvements in knowledge and analysis of experience in this area will allow that position to be retained.

Possible priority areas could be:
- market integration, both geographically and between energy carriers
- competition and system regulation, and harmonisation of regulatory measures
- market regulation in terms of capacity and security of supply
- market arrangements for environmental regulation and valuation of environmental considerations
- technological changes and the introduction of new technologies
- innovation and industrial development
- government instruments and the effect of applying such tools.

Efficient energy use

An increased focus on end use and on cutting energy use is important in reducing environmental impacts and ensuring an acceptable security of energy supply. The goal for developing new technologies is that they must be competitive in the market. Research will be directed on the one hand at possible suppliers of such products and services. On the other hand, both the authorities and the public at large will need to possess good expertise on framing efficient instrument and on their own investments.

A considerable gap still exists between the technical-economic potential for efficiency gains and the improvements actually made. Increased knowledge is needed about behaviour at the individual and collective levels, market mechanisms, legislation and the effect of information in order to release a larger proportion of this potential. Information and communication technology (ICT) will facilitate many new opportunities in the future, not least through two-way communication, and will form an element in many projects.

Possible priority areas could be:
- energy use in buildings: heating, ventilation, air conditioning, lighting, local energy production and so forth
- energy use in industry
- physical planning and energy use in transport
- government instruments, including legislation, information and grants, and their impact
- improved energy management and administration through outsourcing of services, ICT and so forth.

Energy policy and international agreements
Extensive energy policy changes have occurred in most countries over the past decade. The growing attention being paid to such issues as environmental problems – primarily climate change – competitive conditions and a focus on the market have stimulated international agreements and directives designed to identify suitable tools for regulating such conditions.

Environmental and other international agreements have significantly altered the framework conditions for developing energy systems. Experience suggests that scientific expertise and vigorous political debate are important for identifying good long-term political measures.

Developing the regimes established by international pacts creates a big demand for multidisciplinary expertise in such areas as framing agreements and determining their impact. A continuing need will exist to renew and supplement knowledge about negotiating and implementing international compacts, and about the way such agreements influence framework conditions in Norway.

Possible priority areas could be:
- government instruments
- the effect of policy instruments
- negotiating processes
- knowledge of developments affecting international energy markets
- enforcement of agreements.

8.2.2 Administration-related energy and watercourse research

Research relating to the administration of energy and watercourses is conducted on behalf of the NVE, with a 2004 budget of NOK 18.5 million from the Ministry of Petroleum and Energy. These activities are intended to support the directorate's work and help it to develop and disseminate knowledge which improves the basis for its regulatory activities. The work supplements programmes pursued by the Research Council of Norway, and is coordinated with the latter. In addition, the NVE collaborates closely with the Norwegian Electricity Industry Association (EBL), the Directorate for Nature Management (DN) and Enova SF.

The commitment to micro, mini and small power stations will occupy a central place in watercourse research, along with upgrading and expansion projects. Work will also be pursued on the environmental and safety rehabilitation of watercourse installations. A special programme on environmentally-based water supplies is running from 2001–05 and a number of activities are related to the flood issue. These include modelling, flood zone mapping, flood risk, information transfer techniques and area planning.

Hydrological research concentrates principally on the impact of climate change, modelling and metering methodology. All these R&D tasks are long-term in nature. Other research activities include snow studies and glaciology.

Energy research relating to administration includes continued work on efficiency analyses of the power system, delivery reliability to selected end users, extending projects on new and renewable energy technologies and analysing the impact of the EU's water directive on existing hydropower facilities. The effect of wind power turbines on birds is another research topic, with the wind farm at Smøla providing an appropriate location for observation.

8.3 International research and development

Participation in international R&D collaboration in the energy field has a high priority and represents an important supplement to national research. Collaboration across national boundaries is crucial not only for maintaining a high scientific standard at Norwegian research institutions but also for strategic reasons in establishing contacts and alliances with other countries. Participating in international projects builds expertise and provides both scientific and economic assistance for solving key research tasks. International cooperation also helps to showcase Norwegian technology and knowledge suppliers. Norway collaborates in the energy area primarily in the EU system, with the International Energy Agency (IEA) and at Nordic level.

Through the European Economic Area (EEA) agreement, Norway participates as a full member in the EU's sixth framework programme for research, technological development and demonstration (FP6, 2002–06). This programme has an overall budget of EUR 17.5 billion. One of its priority subjects is sustainable energy systems, which has a financial framework over the programme's lifetime of EUR 810 million. The energy programme can deploy a variety of instruments, which range from support for thematic networks and coordinatory activities to support for R&D and demonstration projects. The Research Council of Norway is coordinator for the Norwegian activities.

The FP6 energy programme is divided into two sections:
short to medium term activities – renewable energy sources, energy saving/efficiency and alternative motor fuels
medium to long term activities – fuel cells, hydrogen, new renewable energy sources, CO_2 management and socio-economic conditions.

A number of research programmes relating to various energy topics have been established by the IEA through implementing agreements. Norway belongs to 21 of these, including ones in the fields of end-user technologies, renewable energy technologies and dissemination of information. Norwegian participants are drawn from industry, research institutions or the authorities, depending on the activities covered by a programme. The Research Council of Norway is coordinator for the Norwegian activities.

Nordic Energy Research (NEFP) is an institution under the Nordic Council of Ministers which aims to promote and extend regional cooperation in the field of energy research. It is intended to strengthen national energy research programmes and institutions in the Nordic area and to contribute to a joint strategy for research and development in those parts of the energy sector which are of common Nordic interest. The institution also pursues strategy work and provides advice on projects under the Nordic Council of Ministers. Its annual budget of NOK 27.5 million is contributed jointly by the Nordic countries in accordance with a specified formula.

The NEFP is due to become more flexible in its 2003-06 programme period, partly by introducing more possible instruments for supporting energy research. Its scientific research activities are intended to support core areas identified by the energy ministers as priority commitments for Nordic energy collaboration. These cover Nordic electricity cooperation, climate issues and regional cooperation. On this basis, five scientific programmes have been defined:
- energy market integration
- renewable energy sources
- energy efficiency
- the hydrogen society
- consequences of climate change in the energy sector.

Norway also participates in a number of other international research initiatives in the energy area, such as:
- the International Partnership for a Hydrogen Economy (IPHE), which aims to help organise, coordinate and initiate international R&D and demonstration projects relating to hydrogen as an energy carrier and to fuel cells
- the Carbon Sequestration Leadership Forum (CSLF), which helps to promote cooperation over research and further development of technologies relating to the separation, storage, transport and/or use of CO_2, and which aims to facilitate profitable exploitation of this substance
- bilateral research agreements with such countries as the USA and Japan in various energy areas.

9

International cooperation

- The EEA agreement
- Participation in EU energy programmes
- Nordic cooperation
- Baltic cooperation
- Economic Commission for Europe (ECE)
- European Energy Charter
- Cooperation with Russia
- The International Energy Agency (IEA)
- Development cooperation and assistance in the field of public administration

9.1 The EEA agreement

The European Economic Area (EEA) agreement came into force on 1 January 1994. Its object is to create a homogeneous economic area based on common rules and equal competitive conditions. Under the agreement, the European Free Trade Area (Efta) countries participate in the European Union's single market and in cooperation relating to associated fields. The agreement was extended on 1 May 2004 to include the 10 new members of the EU.

To ensure a balanced development of regulations in the EEA, Norway has undertaken to incorporate relevant new EU legislation in the agreement. For its part, the EU is committed to contacting the Efta countries during its decision-making process. The information and consultation phase covers the period after the European Commission has presented its proposals and the issue has been submitted to the Council of Ministers. However, the EEA agreement does not confer the right to participate in negotiations over a directive within the Council.

Formalised contacts under the EEA agreement take place in the EEA joint committee, and between the Efta working group on energy matters and the EC Commission's directorate general on transport and energy (DG TREN).

9.1.1 Regulations for the single market

A number of regulations and directives adopted by the EU have been included in the EEA agreement. These include provisions on the electricity and gas markets, electricity from renewable sources, energy labelling of products and the energy efficiency of certain products.

Work on opening up EU electricity markets to competition has been under way for several years. For some time, Council directive 96/92/EC on common rules for the single market in electricity was particularly important in this context. But the Commission and the member countries recognised that this original electricity directive was inadequate for achieving the objective of creating an integrated single market for electricity. Important issues in this connection were harmonised rules for cross-border trade and managing bottlenecks (transmission capacity shortages). The Commission initiated an informal process – the Florence process – in 1998, in which these issues were discussed by representatives of such bodies as regulatory authorities in the member countries, transmission system operators and industry organisations. Norway was also represented in the Florence discussions.

The Commission presented a set of measures – known as the energy market package – in March 2001. These included proposals for amending the existing electricity and gas market directives, and a draft regulation which specified terms for access to cross-border electricity trading. The latter included many of the proposals discussed in the Florence process.

This energy market package was approved by the EU on 26 June 2003. The new electricity directive (Commission and Council directive 2003/54/EC) forces the pace of opening the market, with full freedom to choose an electricity supplier being extended to industrial customers on 1 January 2004 and households on 1 July 2007. A minimum requirement is that transmission functions and activities which can be subject to competition must be legally separated (unbundled). In addition come certain requirements for separate management of grid companies and activities subject to competition. Nevertheless, member countries can opt to exempt companies with less than 100 000 customers from the requirements for legal and functional unbundling. The directive does not require separate ownership of grid operators and companies involved in activities subject to competition.

Market access is organised on the basis of regulated third-party access. This means that the method used to determine grid tariffs must be published and approved by the national regulators before these changes come into force. At the same time, the member countries have been given the power to impose stricter terms on power companies with regard to their public service obligations. Minimum standards have also been specified for protecting consumer rights, including requirements to take account of vulnerable customer groups and to specify on the customer's bill which energy sources have been used for electricity generation.

The regulation on access to cross-border electricity trading – (EC) 1229/2003 – introduces a mechanism for settlements between system operators in the EU over such transactions. It also provides a basis for harmonising the principles applied in determining tariffs and the principles for access to cross-border transmission links. Detailed guidelines on these aspects will be drawn up by the Commission in cooperation with a committee appointed by the member countries. The regulation comes into effect for the EU on 1 July 2004.

A directive to promote power generated from renewable energy sources in the single electricity market was adopted on 27 September 2001. Its object is to increase the proportion of total electricity consumed in the EU which derives from renewable sources. The target set by the directive is that renewables should account for 22 per cent of electricity output in 2010, as against 13.9 per cent in 1997 (EU-15). Achieving this goal is regarded as important for the ability of the EU as a whole to meet its environmental commitments through a mix of different measures. Provisions in the directive specify that electricity generators using renewable energy sources can receive a guarantee of origin for the power they generate. Together with the other Efta members, Norway is engaged in a dialogue with the Commission on incorporating this directive into the EEA agreement.

Council directive 92/75 EEC is a framework ordinance on specifying the energy and resources used by household appliances with the aid of labelling and standardised product information. More detailed provisions for each type of appliance are specified in implementing directives. Norway has adopted a number of the latter, so that the energy labelling scheme currently covers refrigerators, freezers, combined fridge-freezers, washing machines, tumble dryers and combined washing machines/dryers, ovens, dishwashers and fluorescent tubes. Work is also under way to incorporate implementing directives for air conditioning systems, as well as an amending directive on labelling fridges, freezers and combined fridge-freezers.

Directive 96/57/EC of the European Parliament and the Council deals with energy efficiency requirements for household electric refrigerators, freezers and combined fridge-freezers. It must be viewed in conjunction with the energy labelling directives, but goes a step further by specifying upper limits for permissible electricity consumption (energy efficiency). Appliances may only be marketed if their electricity consumption is below or equal to the maximum allowable level for their category of product.

Directive 2000/55 of the European Parliament and the Council deals with energy efficiency requirements for ballasts in fluorescent lighting. These units are divided into several classes, with the least energy-efficient to be removed from the market 18 months after the directive comes into force. It has also been implemented in Norwegian law through regulations.

The Commission presented a set of proposals on 10 December 2003 relating to the energy infrastructure and security of supply. This package includes a draft directive on security of supply and infrastructure investment for electricity, another on energy services and energy efficiency for end users and a draft regulation on access to gas transmission systems. These proposals are currently under consideration by the European Parliament and the Council, with parallel consideration of the directives in the EEA.

9.1.2 The EU's water policy directive

The EU framework directive on water, which came into force on 22 December 2000, will provide guidelines for and determine water resource management throughout Europe. It will help to maintain, protect and improve water quality and the aquatic environment, and ensure sustainable water use. The directive gives great weight to a unified consideration of the various factors which affect river basins and ground water. Water resource management will therefore be based on catchment areas.

The minimum environmental goal to be attained, designated "good water status", is to be achieved no later than 15 years after the directive comes into force. The ecological and chemical status of water and its quantity will be defined, classified and monitored. Management plans and action programmes must be drawn up.

This directive will provide important guidelines for future water resource management. Its requirements are likely to affect management in relation to several statutes and must be taken into account by various government agencies and users of water resources. The directive must be implemented in each country's legislation within three years of coming into force. It is currently under consideration for a decision by the EEA joint committee.

9.2 Participation in EU energy programmes

Norway has participated since 1996 in the EU's Save and Altener programmes on energy efficiency and renewable energy sources. On 26 June 2003, the EU resolved to established a new overarching energy programme for 2003-06 called Intelligent Energy Europe. This extends Save and Altener and introduces Steer, a programme aimed at the transport sector, and the Coopener programme on cooperation with developing countries over energy issues. Intelligent Energy Europe was incorporated in the EEA agreement during November 2003. Coopener has been excluded for the time being, but could also be incorporated.

Norway contributes funding to the programmes, and Norwegian interests can apply for project support from these programmes. Such applications must be made jointly with one or more partners from within the EU.

9.3 Nordic cooperation

The Nordic countries have a long tradition of cooperation in the energy field. At government level, collaboration has been established under the Nordic Council of Ministers. Extensive cooperation is also pursued between the system operators in each country. See Chapter 5.4.

The Nordic energy ministers meet once a year. Between these meetings, energy collaboration is headed by a committee of senior civil servants. Cooperation concentrates on three core areas: electricity, climate policy and regional cooperation.

For further information, see the Nordic Council of Ministers web site at www.norden.org.

9.4 Baltic cooperation

The Bergen declaration on a sustainable energy supply around the Baltic was issued by the Nordic prime ministers in 1997. It forms the basis for energy cooperation in this region, and has been followed up subsequently by the energy ministers.

Following the energy minister meetings in Stavanger in 1998 and Helsinki in 1999, a more permanent regional energy collaboration was established as the Baltic Sea Region Energy Cooperation (Basrec). This forms part of the collaboration pursued through the Council of the Baltic Sea States, which embraces 11 countries – Russia, Germany, Poland, Estonia, Latvia, Lithuania, Sweden, Finland, Denmark, Iceland and Norway – and the European Commission. Estonia chairs the Council until 1 July 2002, when Poland will take over.

Basrec has established ad hoc groups in the areas of climate change, energy efficiency, gas markets and electricity markets, with work headed by a group of senior energy officials (GSEO). The mandate for today's activities was adopted by the energy minister meeting in Vilnius in 2002, and runs to the end of 2005.

For further information, see Basrec's web site at www.cbss.st/basrec/.

The power companies in the Baltic region have established their own collaboration, known as Baltrel, to help create a single market for the area. Baltrel cooperates with Baltic Gas, a similar organisation for the gas companies.

9.5 Economic Commission for Europe (ECE)

The Economic Commission for Europe is one of the UN's five regional commissions. It was established in 1947, and has a committee for sustainable energy in which Norway participates. This committee provides a meeting place for 55 nations, including the USA, Canada and European countries, including most of the former Soviet republics (the Commonwealth of Independent States). It has working groups for energy efficiency, gas and coal. In addition to discussing key energy policy issues of mutual interest, these groups focus on information dissemination and knowledge transfer between the member countries, with a particular emphasis on measures for energy efficiency in central Europe.

For further information, see the Commission's web site at www.unece.org.

9.6 European Energy Charter

The European Energy Charter forms the political framework for pan-European energy cooperation, including former Soviet Union republics and east European nations as well as Japan and Australia.

Signed in December 1991, its objective is to promote long-term energy cooperation based on the principles of the market economy and non-discrimination.

The European Energy Charter treaty was signed in Lisbon in 1994. Fifty-one countries have signed both the treaty and a protocol on energy efficiency. After 30 countries had ratified both the treaty and the energy efficiency protocol, these two agreements came into force in the spring of 1998. Norway has signed the concluding document of the conference and signed the treaty in 1995, but has yet to ratify it.

For further information, see the web site at www.encharter.org.

9.7 Cooperation with Russia

Norway signed an energy efficiency agreement with Russia in 1996, and this was renewed for a further three years in 1999. The object of the agreement is to facilitate projects on energy efficiency and utilisation of new renewable energy sources in north-western Russia. Four energy efficiency centres have been established under this agreement in the Russian part of the Barents region. Collaboration between the two countries in this area has continued after the agreement expired in 2002. A fifth centre was opened in 2003. Expertise transfer, demonstration projects, development of funding models and information dissemination are important elements in this bilateral collaboration.

The Barents Euro-Arctic Council adopted an action plan in 1998 for improving energy supply in the Russian part of the Barents region. It also decided to appoint an energy working group (EWG) to pursue the objectives of the plan. The EWG includes representatives from various sectors and regions in Norway, Finland, Sweden and Russia. Denmark and Iceland participate sporadically, and the EU has observer status.

Work in the EWG has concentrated on establishing networks and disseminating information. Particular attention has focused on energy efficiency and the use of renewable energy sources. The energy efficiency centres backed by Norway in northwestern Russia have gained official status through the EWG as Barents energy focal points. A special group of experts on bioenergy was appointed in 2002 and submitted its final report in the spring of 2004. Norway provided the chair, and also chaired the EWG in 2001–04.

For further information, see the web site at www.barentsenergy.org.

9.8 The International Energy Agency (IEA)

The International Energy Agency embraces 26 of the 30 members of the Organisation for Economic Cooperation and Development (OECD). The EU Commission also participates in its work. The IEA was established in response to the 1973-74 oil crisis as an independent organisation associated with the OECD, and has subsequently developed into an important element in the political and scientific cooperation on energy pursued between the OECD countries. Norway is associated with the IEA through a separate agreement which provides that Norway cannot be made subject to the same obligations as other members in the event of an oil supply crisis. The country otherwise participates on equal terms with other countries in this collaboration, on its board and in its sub-committees.

Issues relating to electricity generation and supply, energy use and energy efficiency are mainly discussed in the committee for long-term cooperation (SLT). Analyses are also carried out of output/production and demand for various energy carriers, such as electricity, gas, coal and nuclear power. The IEA's activities also embrace energy research and development. See section 8.3.

Environmental issues have gained a more prominent place in the IEA's energy policy agenda, and the agency has become an important contributor to various international fora.

For further information, see the web site at www.iea.org.

9.9 Development cooperation and assistance in the field of public administration

Lack of access to modern energy services is one of the greatest barriers to economic progress and improved living standards in developing countries. Existing energy use is often based on unsustainable methods which result, for instance, in deforestation or pollution from burning poor-quality coal. Electricity distribution is another major problem which calls for both knowledge and capital.

In order to create properly functioning electricity sectors and good management regimes for water resources, many developing countries need help to develop satisfactory legal and administrative systems. Good water management is important, since this resource is often more valuable for irrigation than for power generation. Some countries frequently suffer damaging floods which also claim human lives. This makes efficient flood control a major challenge.

Most of the practical activities relating to development cooperation in these areas are pursued by the Norwegian Water Resources and Energy Directorate (NVE). This work is governed by a special cooperation agreement between the directorate and the Norwegian Agency for Development Cooperation (Norad). Tasks include advising Norad and direct assistance to developing countries in framing legislation and creating administrative structures for water resource management and the energy sector. The NVE also offers help in the fields of hydrology, dam safety and computing. Advisory services provided in southern Africa include the establishment of national regulators for the electricity sector.

In recent years, the NVE has provided assistance on developing legislation and institutional structures to such countries as Angola, Mozambique, Namibia, Uganda, Vietnam and Bhutan. The latest addition to this list is Timor-Leste (East Timor). This work helps the countries involved to establish modern legislative systems and appropriate administrative bodies, and is based on Norwegian experience with energy and water resource legislation. Extensive use is also made of experience from other development countries which have been in a similar position. This provides a basis for more efficient administration which can safeguard the interests of the recipient countries in utilising energy resources while also stimulating investment and sustainable development.

The institutional contracts also open the way to substantial assignments for Norwegian industry, including both consultants and equipment suppliers. Such contracts are usually placed through tendering processes in Norway or internationally. A number of Norwegian consultancy companies have recently become involved in studies for hydropower projects in both Africa and Asia.

10

Water resource management

– Introduction

– Administrative responsibilities for water resource management

– Legal framework

– The Water Resources Act

– Ground water

10.1 Introduction

River systems and their associated lakes and wetlands are complex systems, with a flora and fauna characterised by great diversity and numbers of species. Ecological conditions in a river system change from the mountains to the sea. River systems support a rich algal flora and many types of bottom-dwellers (benthic species). In addition to fish and other species which live in the water, river systems are very important to a number of birds and mammals.

Norway has a great many rivers and waterfalls. These are of very important both to commercial interests and for community purposes such as outdoor recreation. A number of local communities have grown up around the commercial utilisation of rivers.

Many interests collide over the exploitation of river systems. Water supply is the oldest known form of utilisation, and remains the most important. Otherwise, fishing, timber floating, transport, irrigation, water-driven flour and saw mills and, more recently, hydropower generation are the best-known and most widespread uses. Electricity generation is the most important economic application of Norwegian river systems today. See chapter 2. The importance of the various uses varies from one river to another, and user interests have also changed over time.

A watercourse belongs to the owner of the land it runs through. However, the interests of neighbouring properties and more general considerations of public interest impose important restrictions on a landowner's rights to a watercourse.

Agriculture occupies a special position for the use of river systems. Important applications include irrigation and drinking water, property boundaries and natural barriers for livestock. Landowners can abstract water from a river system on their property without a licence for household and livestock use. These applications also take priority in the event of water shortages. Bathing, boating and angling are important recreational activities in river systems, and also represent nature experiences of great importance for tourism in Norway.

Watercourses have been subject to a number of changes and measures which influence their condition. Human intervention can have both positive and negative effects in this context.

10.2 Administrative responsibilities for water resource management

Hydrology deals with the distribution, movement and effects of water in the environment. The hydrology department at the Norwegian Water Resources and Energy Directorate (NVE) studies the hydrological cycle, and its work provides the basic knowledge required for water resource management.

Flood forecasting, measures to prevent erosion, construction of flood protection works and clearing watercourses are important management tasks. Another important job relates to measures for adjusting biotopes, or habitat restoration, which are often required after earlier developments. The NVE also conducts extensive research and development in disciplines within its sphere of responsibility.

Norway has many reservoirs used to store water for such purposes as electricity generation and water supply. The water authorities are responsible for safety and inspection of such facilities and associated installations. The safety department of the NVE carries out inspections and provides advice and training on dam safety.

One of the most important jobs of the water resource authorities (the NVE and the Ministry of Petroleum and Energy) is processing licence applications for measures subject to the legislation on water resources.

10.3 Legal framework

10.3.1 Water resources legislation

Legislation relating to water resources has roots which extend back to Norway's 12th-century provincial laws. These were based on the principle of private ownership, but also imposed clear restrictions on what owners could do, particularly in relation to fisheries. Most of these rules were retained in the Norwegian Law adopted by Christian V in 1687. The pace of technological innovation and economic change during the 19th century prompted the appointment of a commission to review the legislation, which laid the groundwork for the 1887 Watercourses Act. The first statute which can be called a direct precursor of today's legal framework for water resources, it was replaced by the 1940 Watercourses Act. In 1990, a commission was appointed to draw up proposals for a new Act. The Act Relating to River Systems and Ground Water (the Water Resources Act) took effect on 1 January 2001, and is the general statute governing Norway's fresh water resources. See the more detailed discussion in section 10.4 below.

10.3.2 The licensing system pursuant to the Water Resources Act

The special licensing systems for works in watercourses date from the beginning of the 20th century. Advance public control through the requirement to secure a licence ensures an individual assessment of the legality and impact of each project. The Water Resources Act is the general statute governing water resource management. The requirement to obtain a licence pursuant to this Act applies to all types of works which might cause significant damage or nuisance to community interests.

Previously, licences were generally only needed for hydropower development. This requirement has been interpreted more widely in recent years, so that other works which could involve damage or nuisance – such as major water supply or drainage projects and the abstraction of water for fish farms – have also become subject to the licensing process.

The Water Resources Act includes more detailed provisions on administrative procedures for licence applications. These specify the information to be included in an application and provide the legal authority to establish more detailed regulations. During the processing of an application, the applicant may be required to pay for investigations and studies needed to identify the advantages or drawbacks of the project.

An application is a public document and must be publicly notified at the applicant's expense in accordance with the provisions of the Planning and Building Act. The application is subjected to a process of public consultation before the NVE draws up its recommendation. A consultation process involving affected local authorities, county councils and any other relevant ministries also takes place during consideration by the Ministry.

The NVE has drawn up guidelines for considering many types of works in watercourses, such as aquaculture facilities, small power stations, upgrading and expanding existing power stations, construction in or across watercourses, gravel extraction, measures to lower water levels, construction of embankments, and flood prevention schemes. These guidelines lay great emphasis on distinguishing between large- and small-scale projects in terms of the level of consideration required.

At national level, the competent authorities pursuant to the Water Resources Act are as a general rule the King, the Ministry of Petroleum and Energy and the NVE. At regional and local level, the competent authorities are the NVE, the county governor, the local authority or any other body specified by the Ministry. Decisions made by the NVE can be appealed to the Ministry as the superior authority. Decision made by the Ministry can be appealed to the King in Council.

10.3.3 Other administrative authorities and legislation

In addition to the Water Resources Act, the Watercourse Regulation Act and the Industrial Concession Act, a number of other acts are of importance for water resource management. These are administered by other authorities than the Ministry of Petroleum and Energy and the NVE. The Planning and Building Act governs land use generally, and also applies to river systems and ground water. The Act includes provisions relating to land use planning, environmental impact assessment and procedures for dealing with building applications. The highest administrative authority for the Act is the Ministry of the Environment.

The Neighbouring Properties Act governs the legal relationship between neighbours, and not only between neighbouring properties. This Act is applicable unless otherwise specified by special legislation. This had been interpreted to mean that the Watercourses Act took precedence over the provisions of the Neighbouring Properties Act in matters concerning watercourses. Under the Water Resources Act, however, the Neighbouring Properties Act also applies to watercourse-related issues.

Pollution is regulated by the Pollution Control Act. The Ministry of the Environment also is the highest administrative authority for the Pollution Control Act, and the Norwegian Pollution Control Authority is the subordinate agency. The Water Resources Act defines the key concept of "works in watercourses" in a way which excludes pollution. This will ensure that pollution of river systems continues to be governed by the Pollution Control Act, whereas other impacts are regulated by the Water Resources Act.

Many of the provisions of the Cultural Heritage Act are important for works in watercourses. Licences pursuant to the water resources legislation currently include conditions relating to steps to safeguard cultural monuments automatically protected pursuant to the Cultural Heritage Act. Cultural heritage conservation is also taken into account in several other ways in the Water Resources Act. Such considerations may result in a requirement to obtain a licence, a refusal to grant a licence, or the inclusion of terms requiring the developer to safeguard cultural monuments. The Ministry of the Environment is the highest administrative authority pursuant to the Cultural Heritage Act, but some powers have also been delegated to the county authorities.

The Outdoor Recreation Act governs the public right of access to and passage across other people's property. The actual right to roam on lakes and rivers is governed by the Water Resources Act, while other activities (bathing, landing and mooring boats) are governed by the Outdoor Recreation Act. The Ministry of the Environment is the highest administrative authority for this Act as well, and the Directorate for Nature Management is the subordinate agency.

In addition, the Nature Conservation Act, the Wildlife Act, the Act relating to salmonids and fresh-water fish, and the Aquaculture Act may all be applicable to works in watercourses.

10.4 The Water Resources Act

10.4.1 General principles

The form and substance of the 1940 Watercourses Act gradually became outdated, and this statute was intended by and large to solve other problems than those faced today. The scope of an act dealing with water resources needed to be more clearly delimited, and better coordination with other legislation in this field was also necessary. Act no 82 of 24 November 2000 relating to river systems and ground water (the Water Resources Act) came into force on 1 January 2001.

This statute is intended to ensure that river systems and ground water are used and managed in accordance with the interests of society. It takes a balanced view of natural resources and users, and is more resource-oriented than its predecessor.

Water resources themselves are renewable, but parts of the ecological system along and within watercourses are not. Nature conservation has an important place in the Water Resources Act. General provisions cover conduct in watercourses, and general requirements and restrictions are set out for watercourse use and for planning and implementation of works in them. Most of the requirements follow from the general provisions, and seek to take account of prevailing conditions in a watercourse.

The main objectives of the Water Resources Act are to promote sustainable development and to maintain biological diversity and natural processes in river systems. The intrinsic value of river systems, both as landscape elements and as habitats for plants and animals, is of central importance.

Several the provisions of the statute reflect the principle of sustainable development. These include the rules on conservation of waterside vegetation and on the minimum permitted rate of flow in watercourses. Both of these provisions are intended to provide good conditions for biological production and diversity in watercourses. In the long term, the amount of ground water abstracted may not exceed the inflow.

Sanctions have been substantially strengthened by comparison with earlier legislation. More severe penalties, for instance, have been introduced to deal with environmental crime in watercourses.

10.4.2 The licensing system

As a general rule, nobody can initiate works in watercourses which may cause any significant damage or inconvenience to public interests there or in the sea without first obtaining a licence. This provision reflects the important position assigned to public interests in the Act. The expression "public interests" is intended to be interpreted widely, and may include nature conservation, outdoor recreation, the landscape, fish stocks, economic activity and local communities.

The decision was taken not to transfer authority for large-scale hydropower projects, so that the competent authorities remained the same as before the Water Resources Act came into force. However, authority to issue licences for projects of more regional or local interest could be delegated to the county governor or local authority. The possibility of local authorities acting as the licensing authority for certain smaller projects can also be considered. This must be done gradually to allow these bodies to develop the necessary competence. The expertise of the Geological Survey of Norway is being applied to the management of ground water resources.

10.4.3 Special provisions relating to works in protected watercourses

The purpose of including watercourses in the protection plans for water resources has been to prevent any reduction of their conservation value through hydropower developments. Even if a watercourse is protected against hydropower development, however, other types of developments may reduce its conservation value. To prevent this from happening, the Water Resources Act includes several special provisions relating to the management of protected watercourses. The most important of these is the statutory principle that whenever a decision of importance to protected watercourses is made pursuant to the Water Resources Act, considerable weight must be given to the conservation value of the watercourse. This will result, for example, in stricter treatment of licence applications for protected watercourses than for others.

10.5 Ground water

Before the Water Resources Act entered into force, there were no provisions on the abstraction of ground water. This natural resource will become increasingly important in the future. It must be protected against pollution and excessive use and, if resources are scarce, they must be distributed in accordance with the interests of society. Since the Pollution Control Act deals mainly with the qualitative aspects of environmental pressures, the Water Resources Act focuses primarily on quantitative issues.

The Act has retained the general rule which gives the landowner rights to watercourses, and has introduced provisions conferring similar rights to ground water. These provisions form part of the ordinary rights of ownership. Nevertheless, certain general restrictions on the right to utilise ground water have been imposed. The watercourse authorities are bound by these statutory constraints when processing licence applications.

One principle of the Watercourses Act which has not been retained in the Water Resources Act is that the first person to establish facilities for abstracting ground water is protected against all subsequent facilities which could reduce the amount of water available to them. Provisions relating to priorities for use and empowering the watercourse authorities to make further decisions on the distribution of water in the event of shortages both apply to ground as well as surface water. Abstraction of ground water must not contravene the provision on the minimum permitted rate of flow. A licence has been made mandatory for abstracting ground water or for activities with an impact on ground water. There was no similar provision in earlier legislation.

10.6 Preserving installations in watercourses as part of the cultural heritage

A varied cultural heritage is associated with the utilisation of water resources. This is often to be found in the immediate vicinity of watercourses, such as installations used for timber-floating, watermills, hydropower installations and canals.

The Ministry of Petroleum and Energy discharges its responsibility for the industry's cultural heritage through a permanent museum scheme administered by the NVE. This project aims to preserve, systematise and disseminate the history of Norway's water resource and energy administration and to conserve cultural artefacts which reflect that past. As part of this work, the NVE has established a partnership with the Norwegian Hydropower and Industry Museum at Tyssedal and the Norwegian Museum of Forestry in Elverum. A network for disseminating information has also been created in collaboration with a number of other museums. The museum project's mission is to establish a nationwide network to preserve and disseminate the history of Norwegian water resources and energy. By conveying knowledge, the project will help to enhance awareness of and the importance of this sector.