6

The transmission grid

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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 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 (the local grid) 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.

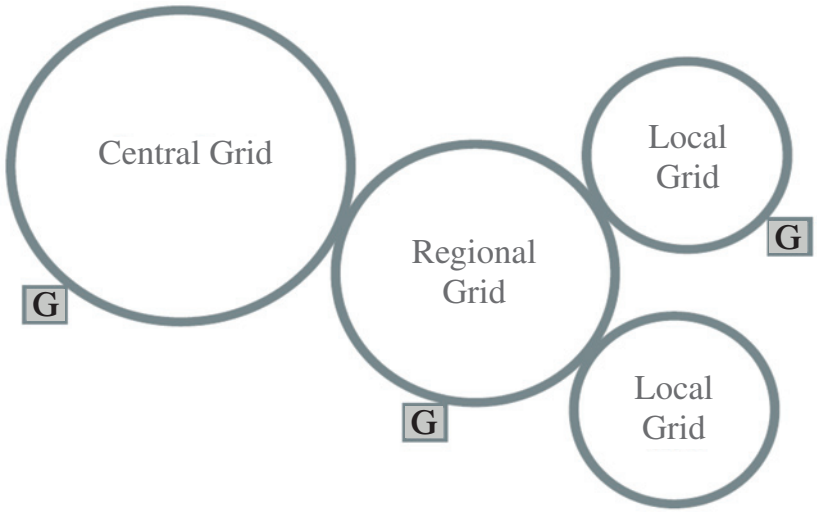

Figure 6.1 The power supply system

6.2 Regulation of monopoly operations

It would be expensive for society to have several parallel grids and competition within networks has therefore not been opened. The electricity grid is therefore a natural monopoly, where users are tied to their local distribution company. The authorities set an upper framework on the distribution companies permitted annual income and frameworks for transmission tariffs and metering/settlement. Regulation, which is described as monopoly regulation, is intended to safeguard consumer rights, a well functioning power market 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.

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).

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)

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 increase in 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 within the regulation period, but are limited to a maximum return of 20 per cent.

NVE introduced new regulations from 2001 which mean that the distribution companies' income is dependent on delivery reliability in the grid. Income framework regulation will in isolation give the distribution companies incentives to cut costs and through this reduce delivery quality and increase earnings. By giving distribution companies reduced income in the event of a cessation in delivery, provides companies with an incentive to ensure reliability is taken into consideration in their operation and investment decisions. The scheme was called compensation for non delivery of energy (KILE) and introduces supply reliability as a parameter that is included in determining the distribution monopoly's total annual permitted tariff income. The KILE scheme is a means for distribution companies to be confronted with customer interruption costs and take into consideration these costs when making decisions. In addition to the KILE scheme, NVE regulations on delivery quality (which came into effect on 1 January 2005) ensure a satisfactory delivery quality in the grid.

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 2005 is about NOK 14.3 billion. Of the total income in the distribution activity, around 14 per cent is the central grid, around 21 per cent is the regional grid and around 65 per cent the distribution grid.

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.

The regulation model recommended from 2007 is a development of the current income cap regulation. The data on which the income framework is based for the individual grid companies should now be updated annually (previously every 5 years) and the accounting figures for a year are included in the efficiency analysis. The income cap will continue to partly be based on the company's costs and partly on how the individual company performs compared with other distribution companies. The new model with annual updates will contribute to customers more quickly benefiting from the efficiencies that distribution companies achieve. It will be able to contribute to lower and more correct transmission tariffs for customers. It is however also important to ensure consumers receive a satisfactory delivery quality and to secure user's rights with respect to the distribution companies. The current KILE scheme, where distribution companies are financially penalised when power is interrupted, will therefore also be reinforced. In addition, it has been resolved to introduce a scheme for compensation for individual end users in the event of very long interruptions. The scheme involves a discretionary compensation for interruption of more than 12 hours to all affected end users who had notified a requirement within reasonable time.

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. Instead of the term point tariff, transfer tariff or transmission tariff is often used.

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 2006 is NOK 0.005 per kWh of a power station's mean output. From 1 January 2005 inclusive, Statnett introduced a separate tariff for new power production with good grid positioning. The input tariff for this type of production is set at NOK 0.001/ kWh for 15 years.

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. Statnett has in

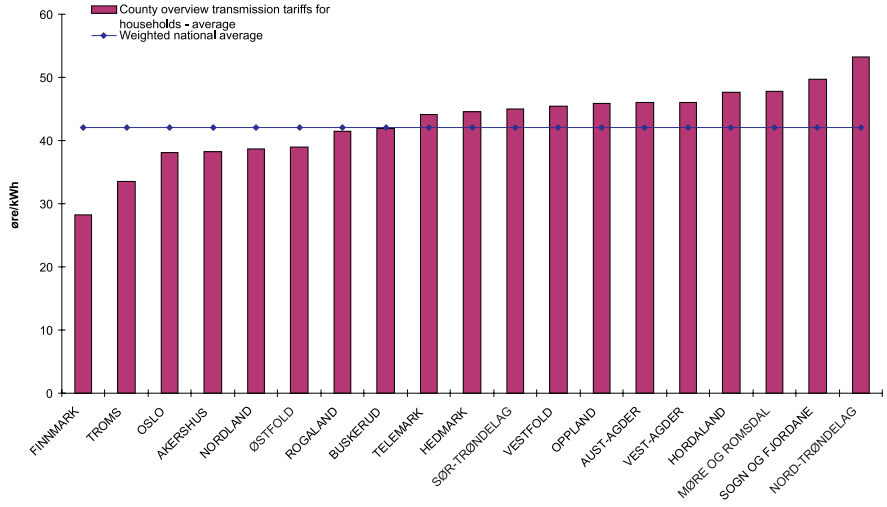

Figure 6.2 Average transmission tariffs for households in 2005
Source: Norwegian Water Resources and Energy Directorate

the course of 2004 and 2005 carried out a project relating to the energy component. As a consequence, a transition to weekly calculations of marginal loss rates is planned in the course of 2006. The loss varies with the load on the central grid and therefore how input and tap are geographically distributed in relation to other input and tap 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 tap. In cases where the same point in the central grid is used for both input and tap, 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, which in practice is the price used.

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 area for a year 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 capacity components are part of other components. See chapter 6.2.2. Small consumers connected to the lowest grid voltages in the distribution grid normally pay a fixed charge, while larger consumers connected to higher grid voltages pay one or more power charges. As fixed or power charges are independent of consumption, this 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.

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 of a fixed component and an energy component. Figure 6.2 shows the average transmission tariff for household customers for each county for 2005 including consumption tax (electricity tax) and VAT. When calculating the average tariff, an average annual consumption of 20,000 kWh is used as the basis. The average transmission tariff for a household consuming that amount per year was NOK 0.42 per kWh in 2005, including consumption tax and 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 change has not increased the total cost to customers. The electricity tax has been set at NOK 0.1005 per KWh for 2006, and comes to NOK 0.1256 per kWh including VAT.

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. For 2006, parliament has awarded NOK 30 million to the scheme. In 2006, 13 distribution companies are included in the scheme which covers 46,700 grid users. For these distribution companies, the tariff is reduced by NOK 0.0169 – 0.0671/kWh.

6.3 Environmental impact of electricity transmission

Electricity transmission affects land use and the environment. Power transmission lines have an environmental impact on residential environments, the landscape and the natural environment in general. 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.