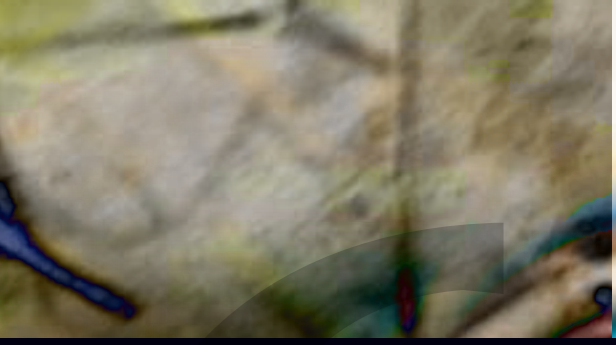
6: The transmission grid



6.1. Introduction

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

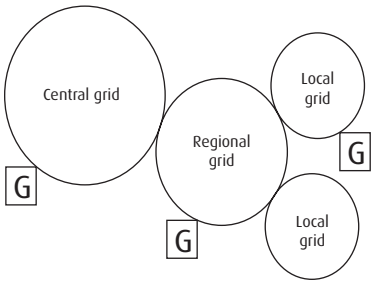
The transmission grid is divided into three levels, as shown in Figure 6.1. The central grid constitutes the 'motorway system' for power supply, linking producers with consumers in various parts of the country. It also embraces transmission lines to other countries, making it physically possible to export and import power as needed. The central grid has a high transmission capacity and usually carries a voltage of 300–420 kV. However certain parts of the country have lines carrying 132 kV.

At the level below the central grid are the regional grids. They also have a high transmission capacity, but cover only a particular region. 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 and to public and private sector enterprises. A distribution grid normally carries a voltage of up to 22 kV, but this is stepped down 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 economically inefficient for society 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 Section 4.3.



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

Figure 6.1 The power supply system

6.2. Regulation of monopoly operations

A consequence of grid companies' natural monopolies is that users are tied to their local distribution grid company. To prevent grid companies from exploiting their positions, the authorities have put in place regulation of their operations as monopolies. This regulation of monopoly operations is intended to

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)

safeguard user rights and ensure a well-functioning power market and efficient management and development of the grid.

The Energy Act, and regulations issued in pursuance thereof, set the legal framework for transmission operations. Regulation of monopoly operations includes provisions aimed at grid companies with regard to delivery quality and reliability, metering and settlement and the setting of grid tariffs. Furthermore, the Norwegian Water Resources and Energy Directorate (NVE) sets an annual upper limit on each grid company's income (income caps). See Section 6.2.1.

The NVE also monitors grid management and operations and is also empowered to issue administrative orders regarding compliance with regulations and licensing terms. Its decisions can be appealed against to the Ministry of Petroleum and Energy.

Grid services must be offered at non-discriminatory and objective point tariffs, ensuring all customers access to the power market. See Section 6.2.2.

Vertically-integrated companies are required to keep separate accounts for their monopoly operations. Thus, one aim of the regulation of monopoly operations is to ensure that costs related to generation and sale of electricity are not charged to grid management and operation (cross-subsidiation).

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 income cap for each company is based partly on the company's own costs, depreciation and grid capital in previous years and partly on the basis of information about how the particular company is performing compared with other grid companies (cost norm). The company's own costs are accorded 40 per cent weight, while the cost norm is accorded 60 per cent weight.

The data on which the determination of the income cap is based are updated annually, and accounting figures for one year are used in the efficiency analyses. The time lag for annual updates is two years. This is because cost figures and other information must be approved by an auditor and verified.

The cost norm is determined on the basis of comparative analyses of the grid companies. The NVE uses the DEA (data envelopment analysis) method, in which geographic and climatic differences (among others) between the companies is taken into account. An anal-

ysis is performed of the distribution grid and one of the regional and central grids.

The income cap is determined so that the industry's total income is equal to the industry's total costs and depreciation and yields an industry rate of return equal to a predefined reference interest rate. Efficiency analyses are a tool for sharing the industry's maximum permitted income among the companies based on efficiency.

The CENS scheme (Cost for Energy Not Supplied) introduces reliability of supply as a parameter that is included in determining the grid monopoly's total annual permitted income. By reducing grid companies' incomes in the event of delivery interruptions, the scheme gives the companies an incentive to take customer interruption costs into consideration when making operational or investment decisions. So far the scheme has included only long interruptions (duration over 3 minutes). Starting in 2009 the plan is also for short interruptions (duration under 3 minutes) to be covered.

In 2007 a scheme was introduced for direct payment to end users at all network levels in the event of interruptions of more than 12 hours for affected users who bring a claim within a reasonable time.

The NVE's regulation of 1 January 2005 concerning quality of delivery is also intended to ensure satisfactory delivery quality on the grid.

The sum of income caps for all grid companies in 2007 was just under NOK 16 billion. The largest grid companies, Statnett SF and Hafslund Nett, have income caps of around NOK 3 billion and NOK 2 billion, respectively, per year. Of the total income from grid operations, approximately 14 per cent goes to the central grid, approximately 21 per cent to the regional grid and approximately 65 per cent to the distribution grid.

6.2.2 Tariffs

The grid companies' income is derived primarily from transmission 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 (grid rent) to the local grid company.

When consumers pay grid rent, it is the tariff for tapping electricity from a point on the grid, also called a consumption tariff. Generating companies also pay a 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, transmission tariff or grid rent is often used.

The tariffs are made up of 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 Section 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 Section 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 tariffs 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.

In 2008 the input tariff's fixed component is NOK 0.0056 per kWh of a power station's mean output. Starting on 1 January 2005 Statnett introduced a separate tariff for new power generation with good grid positioning, called a phase-in tariff. The phase-in tariff is set at NOK 0.001 per kWh for 15 years.

The input tariff must also include an energy component that 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 on the central grid is provided in Section 6.2.4.

More information on the central grid tariff may be found on Statnett's website, www.statnett.no.

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
- A power component which depends on the maximum consumption (in kW).

A marginal loss rate on the central grid is calculated for the energy component at each connection point for input or consumption. This rate is calculated weekly, with separate rates for day and night/weekends. 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 on 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 on the central grid varies between plus and minus 10 per cent. The value of the loss on 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 on the regional grids in the same way as for the central grid. On 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 load components are part of 'other components' as discussed in Section 6.2.2. Small consumers connected to the lowest grid voltages on the distribution grid normally pay a fixed charge, while larger consumers connected to higher grid voltages pay one or more load components. As fixed or load components 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 website, www.nve.no. Statnett SF provides information on central grid tariffs. See its website, 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. Rugged terrain and other natural obstacles as well as a dispersed settlement pattern can boost transmission costs. In addition, the efficiency of grid companies varies considerably. Private households are connected to the lowest voltage level in the distribution grids. The transmission tariff or grid rent 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 2007 including consumption tax (electricity tax) and VAT. When calculating

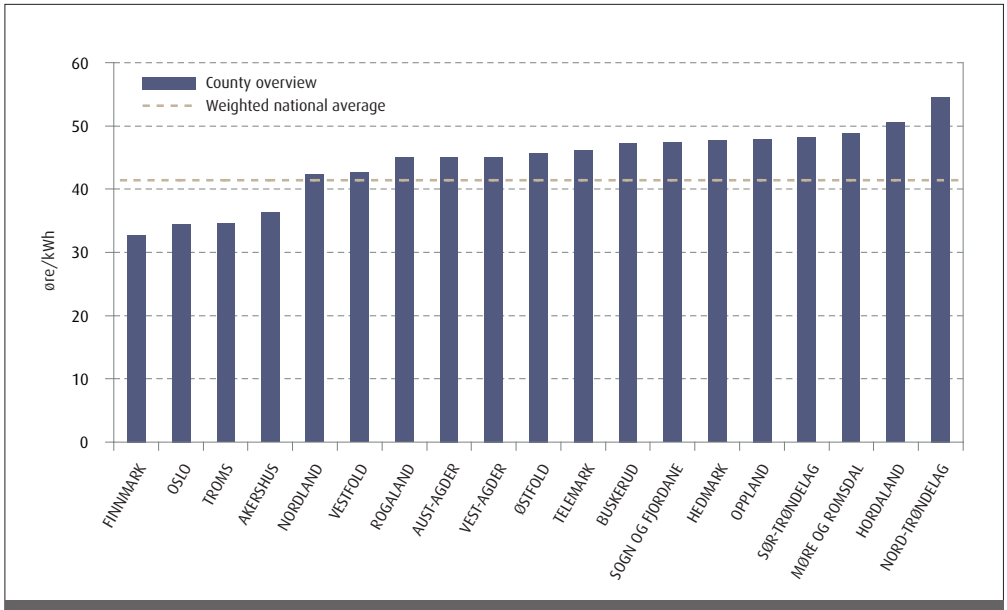


Figure 6.2 Average transmission tariffs for households in 2007.
Source: Norwegian Water Resources and Energy Directorate (NVE)

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 0.407 per kWh in 2007, including consumption tax and 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 2008, the Storting has appropriated NOK 30 million for the scheme. In 2008, 14 distribution companies are included in the scheme which covers around 60,000 grid users. For these distribution companies, the tariff is reduced by between NOK 0.011 and NOK 0.062 per 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 areas, the landscape and the natural environment in general. They have less effect on plant and animal life, 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 development. 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 environmental impacts. Administrative procedures pursuant to the Energy Act are described in more detail in Section 4.3.