3

Energy use and heat production

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3.1 Energy use

3.1.1 Factors influencing energy use trends

A country's energy use and material living conditions are normally closely related. Generally speaking, energy use rises with economic growth because the need for energy increases as more goods and services are produced. Increased value added means increased income for both the private and public sector. The increase in income is partly used on increased consumption, including energy.

The effect of economic growth on energy use will depend on which sectors of the Norwegian economy are in growth. Energy usage varies widely from one sector to another in terms of both energy mix and energy intensity in production.

The use of electrical equipment has increased significantly both in households and in industry, as electricity has become widely available. Falling product prices combined with rising disposable incomes have made new products available to everyone.

Demographic factors such as population size, age structure, settlement patterns and the number and size of households have an impact on energy demand. Population growth leads to an increase in energy use because more houses, schools and commercial buildings are built, and these need heating and lighting. Population growth also results in higher consumption of goods and services produced with the aid of energy.

Energy use will be higher for a given number of people living in many small households rather than large households. In Norway, the trend in recent years has been towards more households of fewer people.

Energy use also depends on energy prices. Higher energy prices boost production costs for industry as well as the cost to households of using electricity and other energy carriers. This usually constrains energy use.

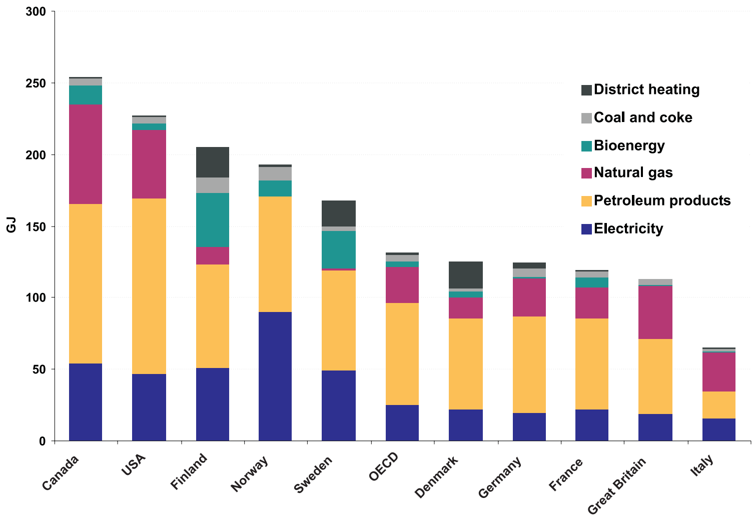

Figure 3.1 Per capita energy consumption in OECD countries, 2002
Source: Energy Balances of OECD Countries, IEA/OECD Paris

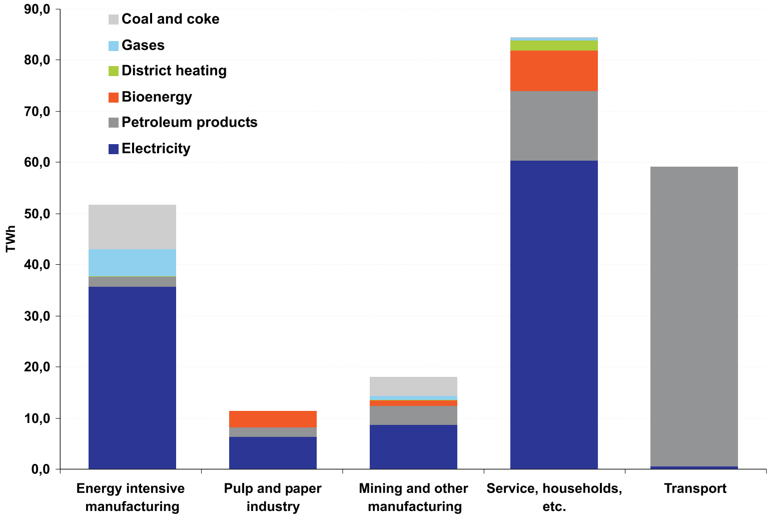

Figure 3.2 Energy consumption by carrier and sectors in 2005
Source: Energy accounts, Statistics Norway

3.1.2 Trends in energy use

Per capita energy use in Norway is somewhat higher than the OECD average. See figure 3.1. However, the proportion of energy use accounted for by electricity is considerably higher than in other countries. The main reason for high electricity consumption is that Norway has a large power intensive industry. In addition, electricity is used to a much wider extent for building heating and hot water production than in other countries.

Net domestic energy consumption in Norway in 2005 was 225 TWh. This is approximately the same as for the year before. Figure 3.2 shows energy use by carrier and consumer category in 2005.

Stationary energy use is defined as net domestic energy use minus energy utilised for transport purposes. In 2005, stationary energy use in Norway was 154,3 TWh. This was somewhat lower than the year before. Figure 3.3 shows trends in stationary energy use by energy carrier from 1980 to 2005.

Electricity is the energy carrier which is used most. In 2005, stationary electricity consumption was around 112 TWh. Oil products, wood and waste (bioenergy) are also important stationary energy carriers in Norway. Stationary energy consumption of oil products was just over 20 TWh and the consumption of different types of gases was 6.6 TWh. The registered use of bioenergy was 12.4 TWh. Use of district heating was 2.4 TWh. Coal and coke is in addition. See appendix 3.

A marked shift from oil products to electricity has taken place over the past 25 years, with consumption of the latter up by about 50 per cent since 1980. Stationary oil consumption has declined by about 65 per cent over the same period. The fall in water inflow to electricity supply and high electricity prices has partly resulted in higher use of heating oil than in 2002 and 2003.

The changeover from heating oils to electricity took place primarily up to the start of the 1990s. Figure 3.4 shows price trends for heating oil and electricity to households.

3.1.3 Energy use by sector

Studies of the distribution of stationary energy use between different consumer groups usually distinguish between

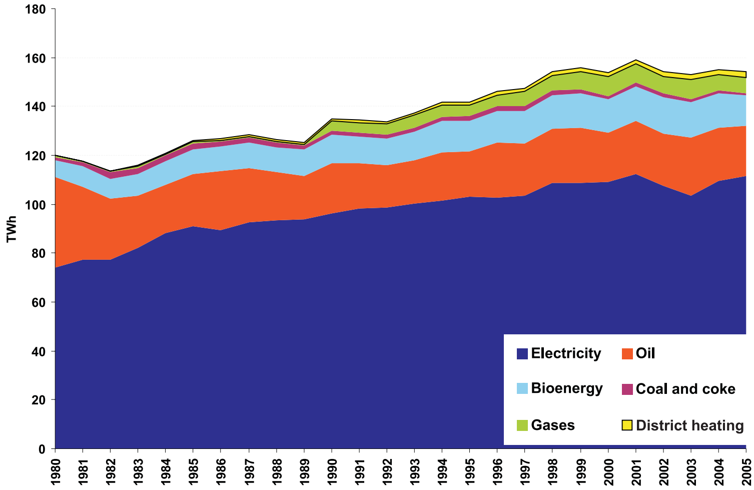

Figure 3.3 Trends in stationary energy consumption
Source: Statistics Norway

manufacturing and mining, households and other consumers in this context, primarily private and public service suppliers. Manufacturing is usually subdivided into energy-intensive manufacturing, the pulp and paper industry and other manufacturing and mining.

Figure 3.5 shows trends in stationary energy use by sector. Stationary energy consumption has increased most in the power intensive industries in the period 1980 to 2004. Energy use increased by more than 70 per cent in the sector in this period. There has also been significant growth in energy consumption in other sectors. The growth in the period was 26 per cent for the wood processing industry, 22 per cent for households, a reduction of 2.4 per cent for other industry and mining, while other

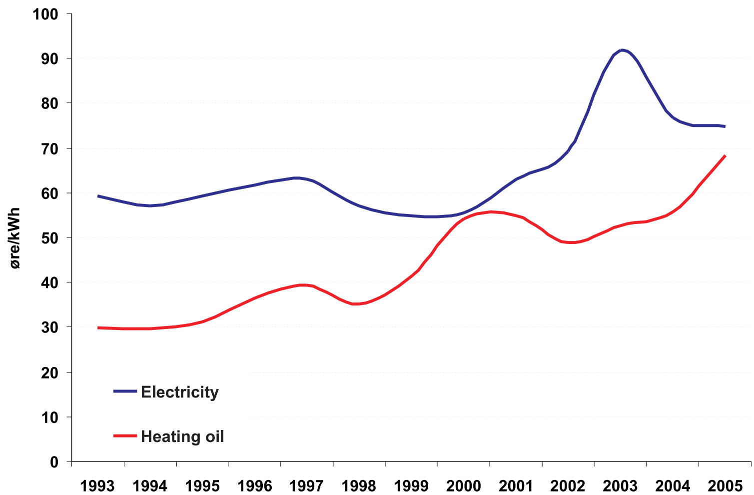

Figure 3.4 Price of utilised energy for households, including taxes. Fixed 2005 NOK
Source: Statistics Norway and Ministry of Petroleum and Energy

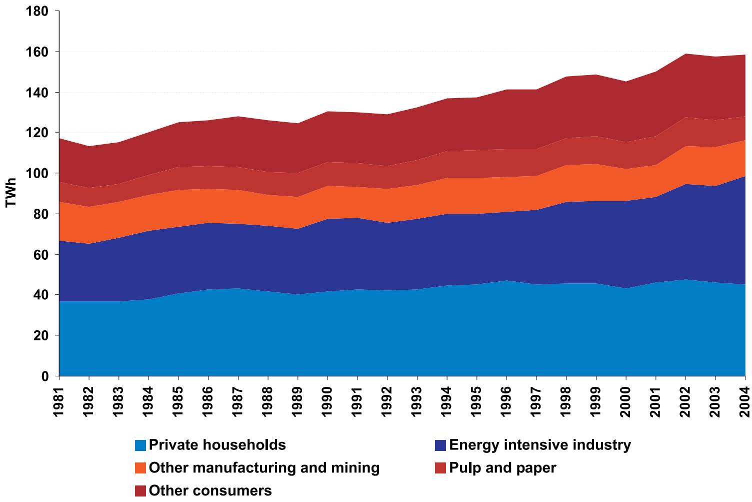

Figure 3.5 Stationary energy consumption by sector
Source: Energy accounts, Statistics Norway

commercial use increased consumption by 43 per cent.

In 2004, energy consumption in the power intensive industries was 53.5 TWh, while the level for wood processing was 11.6 TWh. Energy-intensive and pulp/paper production differ from other consumer categories in that their energy use is stable over 24 hours and over the year. Energy-intensive industry also differs by taking power from the grid at high voltages.

Statkraft SF has power contracts based on authority set conditions with the power intensive industries and the wood processing industry of around 12.9 TWh/year. Most of the power contracts run to 2011 (inclusive). Contracts for 2.9 TWh/year expire in 2006. In addition, the industry uses around 4 TWh/year linked to anticipated reversion agreements from the 1960's. 2.2 TWh/year of this runs to 2030. This sector meets its remaining power requirements largely from its own power plants as well as from contracts with other power suppliers and purchases on the spot market.

Other industry and mining used around 18 TWh in 2005. Households

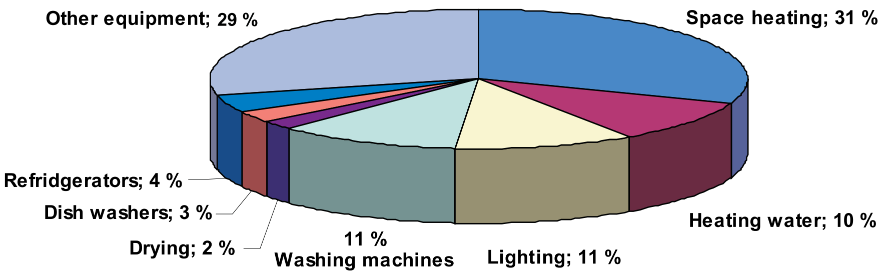

Figure 3.6 Electricity consumption in households by purpose in 2001
Source: Statistics Norway

used 45.1 TWh in 2004. Other commercial total energy use was 30.3 TWh in 2004. Electricity was the dominant energy carrier in all sectors.

3.1.4 Energy use by usage

Industry and mining used around 80 TWh in 2005. Electricity represented more than 50 TWh of this. The industry to a great extent uses energy as an input in industrial processes. There are no statistics of distribution of the industry's energy usage.

Based on SSB's household surveys, studies of energy consumption in Norwegian households have been carried out. Total household energy consumption was around 45 TWh in 2001. Around 46 per cent of total energy consumption in households was used for room heating and 8 per cent for water heating, so called thermal use.

35 TWh of household consumption was electricity. 41 percent of this was used for thermal purposes. The remaining use was electricity specific and could only be met by electricity. Figure 3.6 shows electricity consumption by usage for households.

The consumer can use various energy carriers for heating purposes. The possibility of alternating between different heating methods is crucial to the reliability of a supply system based on hydropower. To be able to change energy carrier at short notice, consumers must have installed several types of heating equipment. Refer also to 3.2.

After 1970, there was a significant fall in the proportion of Norwegian households using paraffin or oil burners. These have largely been replaced by electric heating equipment. SSB's consumption survey from 2001 shows that 97 per cent of households have electric heating equipment and 69 per cent have electricity as the primary heating source.

Around 26 per cent of households only have one heating source. This is usual in small houses or apartment blocks. 20 per cent have only electricity and around 6 per cent have on site central heating or district heating. In dwellings with two or more sources of heat, a combination of electricity and wood is most common.

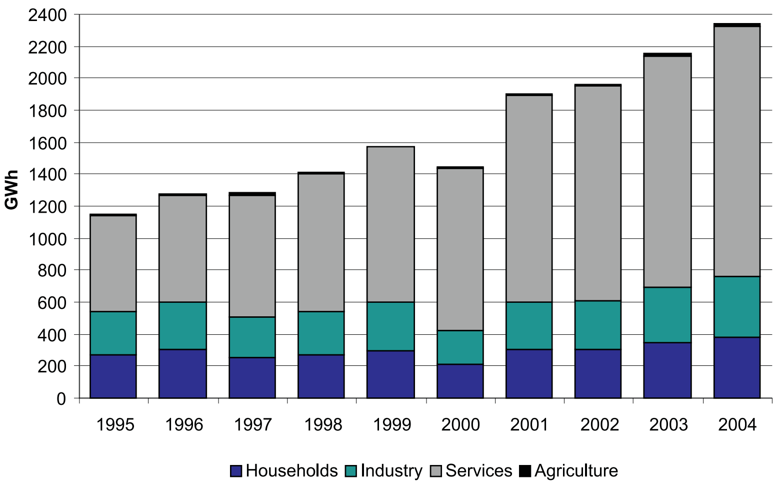

Figure 3.7 Consumption of district heating by various consumer groups
Source: Statistics Norway

According to Enova's statistics from the construction network, energy consumption for operation of industrial buildings in 2001 was 35 TWh of which 85 per cent was electricity. 18 TWh was used for heating. 12.5 TWh of this was provided by electricity. The distribution of energy consumption for different usages in industrial buildings varied significantly between building categories and also between buildings in the same category. For example, the proportion of energy used on room heating was 5 per cent in grocery stores and over 50 per cent in schools. Energy for fans and pumps varied from 5 per cent in hospitals to around 25 per cent in universities and colleges.

3.1.5 Measures to limit energy use

Means to limit energy consumption has been a part of Norwegian energy policy since the 1970s. Several measures are financed today through Enova, as described in chapter 3.4.4. Also the provisions of the Energy and Planning and Building Acts, labelling requirements and standards for electrical equipment, various grant schemes funded by other ministries and taxes all influence energy use.

A system of informative electricity bills has been introduced in Norway. All customers expected to consume more than 8 000 kWh per year receive bills from the grid company for actual

Examples of heating systems

Electricity based heating systems
In electricity-based heating systems, electricity is converted to heat by being conducted through a resistance such as a filament. Common electricity-based heating systems are convectors, underfloor heating cables, portable fan heaters and radiators, and electrical hot water tanks.

Water-based central heating
In water-based heating systems, a central source is used to heat water which then circulates through a piping system (radiators, convectors or underfloor pipes), releasing heat to the surroundings. A water-based heating system can utilise various sources of heat. Among the most common are oil, electricity, biomass, heat pumps and district heating, but gas, solar energy and geothermal energy can also be used.

Warm-air heating
Various solutions exist for distributing heat through the air. Warm air can circulate through a closed piping system which then releases heat, or the warm air can be blown directly into the space to be heated. As in the water-based systems described above, a number of heat sources can be used to warm up the air in these systems.

Independent heating devices
Independent heating devices such as wood-burning stoves, fireplaces and paraffin stoves are widely used in Norway. About 80 per cent of its 1.8 million households have installed some kind of independent heating device. The most widely used are wood-burning stoves, and about 70 per cent of all households can use firewood for heating in one way or another.

consumption. See chapter 7.2.4. Customers previously paid on the basis of estimated consumption. In addition, the bill must show how the customer's electricity consumption compares with the year before and specifies where advice on energy saving can be obtained. The aim is to make customers more aware of their electricity consumption. Further measures to improve the position of consumers are in preparation, including joint billing, reducing the time taken to change supplier and regulation of waiting tariffs.

The National Office of Building Technology and Administration is responsible for administering the building regulations. Technical regulations issued under the Planning and Building Act govern energy use in buildings. New requirements for such consumption and a different method for calculating energy use in new buildings are being prepared. At the same time, an energy marking system will be introduced for new buildings and for buildings which either are leased or are to be sold.

Through the EEA agreement, Norway participates in international collaboration on energy labelling of a number of consumer products. Refrigerators, freezers, dishwashers, washing machines, tumble dryers and household lighting are all now labelled. The marking should help consumers select the most energy efficient equipment. There are plans to also mark air conditioning equipment, cookers and hot water heaters.

Taxes and tax exemptions influence the relative price and cost of energy carriers, and in turn affect consumption. The most important taxes are the electricity tax and various taxes on heating oil. See chapters 2.5 and 3.3.3 respectively.

3.2 Heat production

Energy sources such as oil, natural gas and biomass are used in Norway primarily to produce heat energy. The energy can be transported in pipes as district heating or is produced on site. The heat energy is primarily used in households and industry. It is used in households for heating buildings and hot water and in industry for different processes which require heat.

Under current conditions, oil and in some cases natural gas and bioenergy provide valuable flexibility in the Norwegian energy system, and can make it easier to adapt to dry years and peaks in consumption. It is possible to increase consumption of these energy sources both in industry and in private households when necessary. Rapid switching between different energy carriers is possible in systems utilising combined oil/electric boilers.

The consumption figures for oil, natural gas and bioenergy presented in the following sections show energy supplied. Efficiency varies with energy source and combustion processes.

3.2.1 District heating

The technology used to supply hot water or steam to households, commercial buildings and other consumers from a central source is known as district heating. Heat transported through insulated pipes is mainly used for space heating and hot water.

District heating systems can utilise energy extracted from waste and sewage, or waste heat and gas from industrial sources which would otherwise be lost. Hot water or steam in district heating installations can also be produced using heat pumps, electricity, gas, oil, chippings or coal. About half of Norway's net deliveries of district heating are derived from waste incineration plants.

Figures for 2005 show that consumption of district heating was 2.4 TWh supplied energy. This is an increase of around 4 per cent in relation to 2004. In 2004, around two thirds of consumption was used within service sectors, while households and industry used around 15 per cent.

District heating is most widely used in Oslo, Fredrikstad and Trondheim. About 80 per cent of the district heating used in Norway is delivered to these areas. The country has 31 district heating installations. Much less use is made of this form of heating in Norway than in other Scandinavian countries. District heating represents around 2 per cent of energy supplied for heating in Norway. Some district heating systems can also supply cooling.

District heating is regulated by the Energy Act. See Chapter 4.3.7. District

District heating in Oslo

The district heating system in Oslo is the largest in the country and accounts for about half the total in Norway. Figure 3.8 shows trends in district heating for Oslo.

Viken Energinett distributed and sold just less than 1 TWh of district heating in 2005. 55 per cent of production was based on waste incineration and bioenergy while 45 per cent was based on oil/electricity. Use of oil or electricity varies from year to year and is dependent on the relative prices of these energy carriers.

Development of the district heating system in central Oslo began in 1937, but only really got going in the early 1980s in order to utilise heat from two waste incineration plants at Brobekk and Klemetsrud. These are the main heat sources today. In addition, electric and oil-fired boilers are used to meet peak demand for power in winter. At low outdoor temperatures, heat is distributed in the system at a temperature of 120 °C. The heat is transferred to the customer terminal, normally located in the customer's basement and is returned to the plant at a temperature at around 70 °C. Around 850 business customers and 2,370 household customers are connected to the remote heating system.

Oslo's district heating installations now meet about 15 per cent of its heating needs. These systems have been developed in the city centre and three other areas. These areas have been linked together in a single network since 1998.

The main campus of the University of Oslo and Ullevål University Hospital are two examples of large customers. The hospital's boiler room is now used mainly to meet its special needs for steam, but it can also be used as part of the district heating system – either to help meet peak power demand or as a reserve source of heat. All the hospital's heating needs have been met by district heating since the autumn of 1999.

Most of the individual dwellings which use district heating are in one of Oslo's newer residential areas, where each is equipped with district heating via an individual substation, and energy consumption is also metered individually.

By replacing small oil-fired boilers, district heating helps to eliminate emissions immediately above roof level in residential areas and the city centre. This helps to improve air quality in Oslo.

heating installations included in the system of mandatory connection to a grid are not permitted to charge a higher price than for the equivalent amount of electrical heating in the same area.

Since 1997, the authorities have provided support for the utilisation of bioenergy and other renewable energy sources to produce heat. Enova manages financial support for district heating. Refer to chapter 3.4 on Enova.

3.2.2 Oil for stationary consumption

The total stationary consumption of oil products in 2005 corresponded to 20.5 TWh of supplied energy. Oil is mainly used for space and water heating, and to generate heat for various applications in industry and elsewhere. Industry in 2005 used 7.2 TWh of oil for stationary purposes. This is distributed as follows. Energy intensive industry 1.9 TWh, wood processing 1.7 TWh and 3.6 TWh for mining and other industry. Households, service sectors, construction, agriculture and fisheries used more than 13 TWh of oil for stationary purposes.

Sales of oil for stationary consumption are split between paraffin, light heating oil, heavy distillates and heavy heating oil. They differ in density and sulphur content. Figure 3.9 shows trends in the consumption (sale) of heating oil for stationary purposes measured in millions of litres. As the figure shows, the products which contain most sulphur have shown the greatest reduction in use. At the same time, the sulphur content of most oil products has been greatly reduced. This is illustrated by the fact that the average sulphur content of heating oil in 1998 was only 27 per cent of the 1980 level.

Paraffin is used mainly in stoves in private households. Light heating oil is used both in small heating systems in private households and in larger systems in commercial buildings and industry. Light heating oil is largely used in water-based central heating systems. Heavy heating oils with a higher sulphur content are cheaper than light heating oils, and are used in larger combustion plants where stricter emission standards apply. The oil is also used to produce hot water or steam

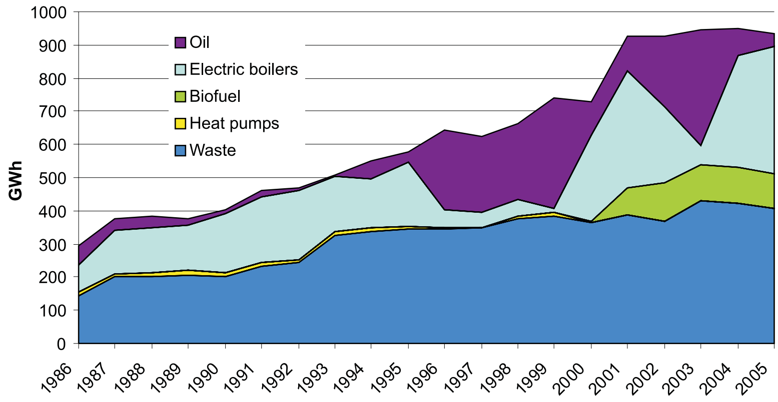

Figure 3.8 District heating in Oslo 1986-2005
Source: KanEnergi

in these plants. Efficiency differences exist between old and new paraffin and oil heating systems. The efficiency of older installations averages about 80 per cent, whereas it may be as high as 95 per cent in new systems.

Oil is the principal fuel used in Norwegian water-based central heating systems. Renewable energy sources, heat pumps and waste heat can also be used in such systems.

3.2.3 Biomass

Bioenergy can be produced by incinerating or fermenting biomass or by treating it chemically. Biomass includes firewood, black liquor[3], bark and other forms of wood waste, and waste from households and industry used to provide district heating. Fuel such as gas, oil, pellets and briquettes can be produced from biomass.

The registered use of bioenergy was around 12.4 TWh in 2005. The industry accounted for around 4.4 TWh, or one third of this. The remaining 8 TWh is primarily used by households.

The extent to which biofuel is used and its applications depend on fac-

[3] Black liquor is a residual product from cellulose production and consists of wood pulp and liquor.

tors such as available supplies and their quality and emission standards. Manufacturing of paper and pulp and of wood and wood products requires large amounts of heat for various drying processes, so that the energy in wood waste such as bark and chippings can be used without further processing in large incineration plants. A proportion of the waste in large landfills can be incinerated, and the heat energy can be used directly or in thermal power generation. Biofuel used in households and in small incineration plants often requires more processing to be suitable for transport, storage and handling.

Processing of biofuel has increased in recent years. Biofuel in the form of pellets and briquettes is more suitable for storage, transport and use in automated incineration plants.

3.2.4 Domestic natural gas use

Domestic use of natural gas for stationary energy supply in 2005 was 265 million Sm^3, equivalent to around 3 TWh supplied energy. This is up by 11.5 per cent from the year before. It is, however, only 1.4 per cent of the total domestic end consumption of energy. In addition, 12 million Sm^3 of natural gas was converted to other energy carriers in district heating and combined heat and power stations. Use of propane and butane is in addition to this.

Natural gas usage began in the last ten years and has primarily replaced heavier heating oils in industry. The chemicals industry used 1.5 TWh for energy purposes in 2005. The metals industry used 0.5 TWh while the food and drinks industry used natural gas equivalent to 130 GWh for energy purposes. Household use of natural gas was equivalent to 67 GWh in 2005.

Natural gas consists mainly of methane and can be distributed by pipeline, or as compressed natural gas (CNG) or liquefied natural gas (LNG). See the box on natural gas on page 45 for an explanation of these terms. 76.5 per cent of domestic consumption of natural gas in 2005 was supplied by pipe while LNG and CNG were 21.1 and 2.4 per cent respectively.

Consumption is highest in the areas around the landfall terminals for gas pipelines from the Norwegian continental shelf. Norway currently has three pipeline terminals for natural gas: Kårstø north of Stavanger, Kollsnes near Bergen and Tjeldbergodden west of Trondheim. Plant for landing gas

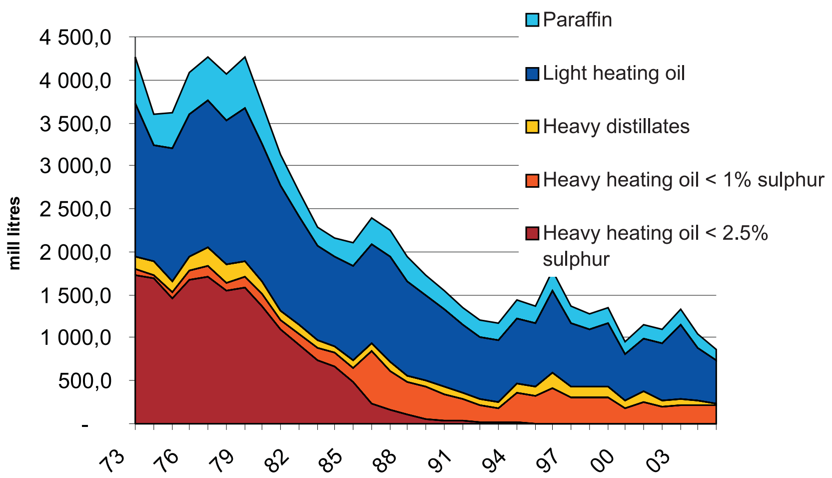

Figure 3.9 Consumption of oil for stationary combustion by product
Source: Norwegian Petroleum Institute

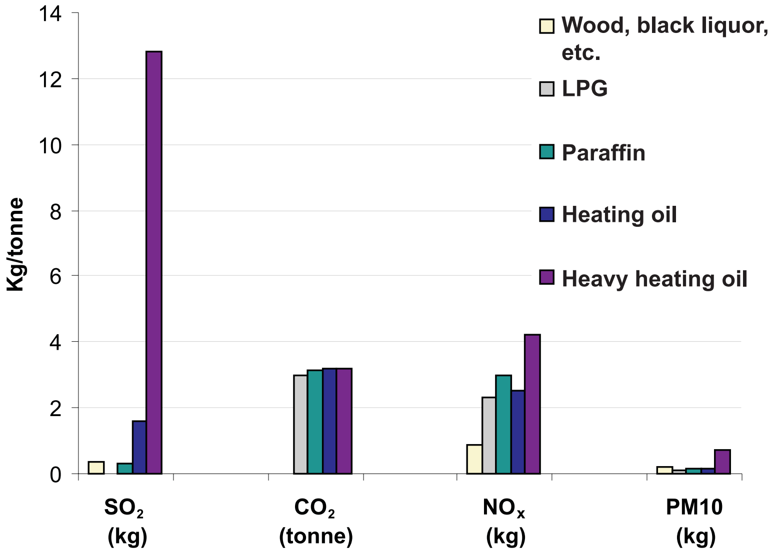

Figure 3.10 Emissions to the air from boilers (kg/tonne fuel)
Source: Statistics Norway

from the Ormen Lange field in Aukra municipality in mid-Norway, and from the Snøhvit field on Melkøya island outside Hammerfest in northern Norway is under construction.

Gasnor is the markets largest supplier of domestic natural gas. In 2005, Gasnor supplied around 110 million Sm^3 of natural gas. Gasnor has constructed a pipeline network in the Haugesund area of south-west Norway to distribute natural gas. Gasnor has a LNG production plant on Karmøy which can produce 20,000 tonnes of LNG a year, equivalent to around 25 million Sm^3 of natural gas. Gasnor also has a LNG production facility at Kollsnes with a capacity of 40,000 tonnes a year. Gasnor supplies LNG to a number of locations in the country. LNG is distributed by truck and via a specially constructed coastal tanker ship.

Lyse Gass has constructed a high-pressure pipeline from Kårstø to Risavik in Sola municipality south of Stavanger. A distribution system has been constructed from Risavik which covers large parts of the Jæren region. Lyse Gas supplied 36.6 million Sm^3 of natural gas in 2005, which is equivalent to 367 GWh.

Natural gas is used as fuel for buses in several towns. The largest use is in the Bergen region where around 80 buses use natural gas. Two supply ships to oil installations in the North Sea and one car ferry use natural gas. From 2007, five new gas ferries will be in operation on routes between Bergen and Stavanger.

At Tjeldbergodden, 456,000 tonnes of wet gas was used in methanol production in 2004. 9,000 tonnes of LNG a year is also produced at Tjeldbergodden, which corresponds to roughly 12 million Sm^3 of natural gas.

Several smaller natural gas companies have been established in recent years, including connection to the new landing sites at Melkøya and Aukra and establishing new LNG reception terminals. At the end of 2005, there were around 20 LNG reception terminals in operation in Norway and several new terminals are planned and are under construction.

Natural gas

Natural gas from Norwegian offshore fields is called rich gas and usually contains 60–95 per cent methane. This is separated into natural gas liquids (NGL) and dry gas (methane) at the landfall terminal. Also called wet gas, NGL comprises ethane, propane, butanes, natural gasoline and condensate. Liquefied petroleum gases (LPG) is a sub group of wet gas. Methane is referred to as dry gas or natural gas. Propane and butanes are shipped to customers in Norway and abroad by tanker, while most of the dry gas is piped to continental Europe. Gas is exported from Kårstø and Kollsnes through the major Europipe, Statpipe, Zeepipe and Franpipe systems.

Pipeline distribution of gas involves high investment costs. The larger the volume of gas transported through a pipeline system, the lower the cost per unit transported.

Compressed natural gas (CNG) is natural gas stored at a pressure of 250-300 bar (250-300 times atmospheric pressure). This makes it suitable for distributing relatively small gas volumes over short distances. Transport is by truck or ship.

Liquefied natural gas (LNG) is created by refrigerating natural gas to -162°C, when it liquefies. Stored in insulated vessels under atmospheric pressure, LNG occupies only about one-600th of its gaseous volume. Because its energy density is much higher than with CNG, it can be transported over greater distances by road, sea or rail at lower cost. LNG can be stored or regasified for transport to end users as CNG or by pipeline.

Liquefied petroleum gases (LPG)

LPG is a mixture of propane and butane,. LPG is liquid at moderate pressures and temperatures. It part of the natural gas wet gas, and can be produced during the refining of crude oil. These gases are easier to store and transport than propane.

Applications for LPG include heating or processing by industry or space and water heating in households. Norway's total consumption in 2004 was 291 000 m^3– a decrease of 4.2 per cent on the year before. Most of this was used by industry, but there was also a marked increase in consumption by private individuals.

The figures for LPG in the environmental accounts are comparable with those for natural gas, but CO_2 emissions from LPG are 10% higher.

Source: The Norwegian Petroleum Industry Association

3.3 Environmental impact of energy use

Due to the extensive use of hydropower electricity, releases to the air from stationary energy use in Norway is low. The environmental impact of stationary energy use relates largely to the combustion of energy commodities. Stationary incineration is mainly in directly-fuelled furnaces burning energy commodities to provide heat for an industrial process, boilers using energy commodities to heat water for steam, and small stoves burning oil or wood to heat dwellings. In addition are emissions to air from mobile combustion and processes.

3.3.1 Emissions to the air from stationary combustion

Emissions from stationary combustion derive from many different sources of energy in a wide variety of applications. Waste, heating oil, biomass and gas are all among the fuels used in district heating plants. Industry utilises heavy and light heating oils, natural gas, coal and coke. Some sectors, including pulp and paper, also employ large quantities of wood waste and black liquor.

Burning oil releases sulphur dioxide (SO_2), carbon dioxide (CO_2), nitrogen oxides (NO_x) and some particulate matter (PM). The size of these emissions depends on the technologies and fuels used. Key factors are the size and age of the boiler and the quality of the fuel.

Biomass embraces wood waste, bark and black liquor as well as waste from households and commercial activities burnt in district heating systems. Burning biomass releases polycyclic aromatic hydrocarbons (PAHs), PM, nitrogen oxides NO_x, carbon monoxide (CO) and benzene. The size of these emissions and the damage they cause depends on a number of factors. The most important are whether the fuel is wet or dry, the type of furnace/stove and the amount of air supplied.

Releases from the burning of different fuels are dependent on the release source. Figures 3.10 and 3.11 show releases to air from the burning different fuels for boilers and individual fireplaces/furnaces. These figures are calculated averages for emissions per tonne of fuel, and may deviate considerably from actual emissions by a particular boiler or furnace/stove. From the figures, we can see that boiler units using heavy oils generate particularly high levels of sulphur dioxide, while wood firing in small stoves results in large releases of suspended dust/particles.

Table 3.1 shows the total releases of CO_2, NO_x and SO_2 for the 3 largest release sources. These are mobile combustion, process emissions and

Table 3.1 Emissions of selected substances in Norway in 2004 * (1000 tonnes)

	CO_2	SO_2	NO_x	Particles (tonne)	PAH	nmVOC
Total emissions	43827	25.3	214.8	61.5	152.7	265.2
Process emissions	8433	14.7	10.7	12.5	83.1	202.7
Mobile combustion	16117	4.4	145.7	4.7	11.0	49.0
Stationary combustion	19 278	6.1	58.4	44.2	58.7	13.5
- wood/wood waste/black liquor and pellets	0	0.6	2.8	41.3	53.7	10.5
- gas (incl. natural gas, LPG, landfill gas, furnace gas and ironworks gas)	14 852	0.0	44.1	0.7	0.1	1.6
- diesel, gas and light heating oil, special distillate	2 467	1.2	6.5	0.2	0.2	0.6
- waste (used in district heating)	194	0.2	0.8	0.0	0.7	0.5
- other sources	1765	4.0	4.0	2.0	4.0	0.2

** preliminary figures*

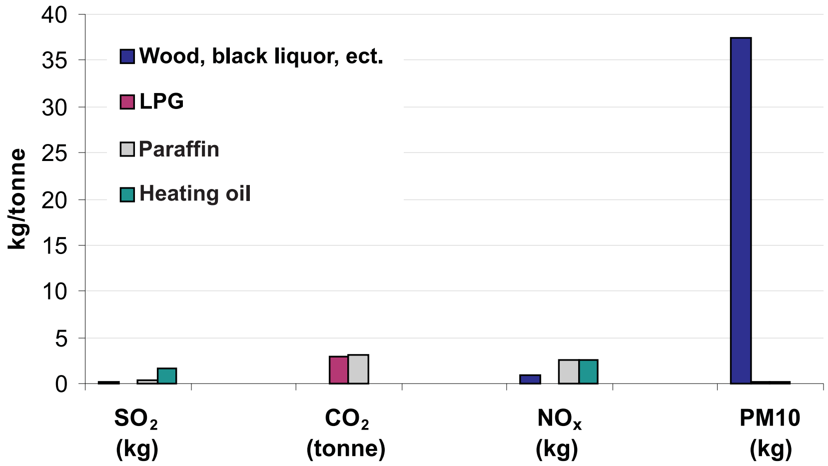

Figure 3.11 Emissions to the air from small stoves (kg/tonne fuel)
Source: Statistics Norway

stationary combustion. Unlike other energy statistics, the figures for stationary combustion include emissions from oil and gas activities on the Norwegian continental shelf. Oil and gas activities account for around 66 per cent of CO_2 releases from stationary combustion and 29 per cent of the total CO_2 release in 2004. 79 per cent of NO_x releases from stationary combustion are from oil and gas activities, while the activity accounts for 21 per cent of the total NO_x releases. Mobile combustion is the largest source of NO_x, and accounts for 68 per cent of total release. Road and sea traffic generate large NO_x releases.

The most important energy carriers, besides electricity, for heating are biomass (wood, wood waste and black liquor) and various types of heating oils. Table 3.1 shows that various types of heating oil accounted for about 13 per cent of total CO_2 emissions from stationary combustion in 2004, and about six per cent of Norway's total CO_2 emissions. Wood and oil firing contributed about 7 per cent of total SO_2 emissions in 2004. Some 16 per cent of NO_x emissions are derived from heating based on wood and oil in 2004, while such fuels as natural gas, propane and landfill gas accounted for almost 75 per cent of such emissions from stationary combustion.

Fuelwood accounted for 93 and 92 per cent of total PM10 and PAH emissions respectively. About 7 per cent of the total PM10 emissions in 2004 derived from mobile combustion.

Emissions of non-methane volatile organic compounds (nmVOC) from fuel wood made up almost 4 per cent of total emissions in 2004. Natural gas, propane and landfill gas contributed only 0.6 per cent, while the largest source in 2004 was industrial processes. These accounted for 76 per cent of the total.

3.3.2 International agreements and obligations

Norway has accepted a number of international commitments to reduce emissions of CO_2, nmVOC and SO_2.

Global climate pollution is regulated internationally by the UN's Climate Convention. Norway's obligation in accordance with the Kyoto protocol means that average releases in 2008-2012 are not to exceed more than 1 per

cent of the release level of 1990. This represents an 8 per cent reduction on the current level. This obligation can be met through national reductions and in other countries by the use of the Kyoto mechanism (international quota trading, the green develop mechanism and joint implementation). Norway has established a national quota system for greenhouse gases in Norway from 2005 to 2007 as a follow up of the Kyoto protocol.

Releases which result in regional environmental consequences in different protocols under the convention for long range transboundary air pollution (LRTAP convention 1979) are regulated. Together with the USA, Canada and other European countries, Norway signed in 1999 the Gothenburg protocol which aims to solve the pollution, over fertilization and ground level ozone environmental problems. The Gothenburg protocol came into effect on 17 May 2005 and is currently the latest protocol under the LRTAP convention. In accordance with the protocol, Norway is to reduce NO_x releases to 156,000 tonnes by 2010. This represents a 27 per cent reduction for Norway compared with the release level for 1990. For nmVOC, this new commitment is approximately the same as that Norway is committed to under the current Geneva protocol. According to the above, the requirement is that the annual nmVOC releases from the entire mainland and the Norwegian economic zone south of latitude 62, is as soon as possible to be reduced to 30 per cent of the 1989 level. The total national release should, in accordance with the Gothenburg protocol, not exceed 195,000 tonnes/year by 2010. SO_2 releases are also regulated by the Gothenburg protocol. Norway has committed to reduce the releases of SO_2 to 22,000 tonnes before 2010. Releases of SO_2 fell each year in the period 1987 to 2002. From 2002 to 2004, releases increased by 14 per cent to 25,200 tonnes, mainly due to an increase in activity in the process industry. Norway must therefore reduce releases by about 13 per cent from the current level by 2010, to meet the obligations of the Gothenburg protocol.

3.3.2 Instruments to limit emissions of pollutants and greenhouse gases

Extensive measures have been initiated to limit emissions of pollutants

and greenhouse gases. Mineral oils (including paraffin, light and heavy heating oil and autodiesel), petrol and coke are subject to a carbon tax, which currently applies to about 68 per cent of Norway's CO_2 emissions. The CO_2 tax on mineral oil in 2006 is NOK 0.52 per litre. Heating oil is also subject to a basic tax of NOK 0.414 per litre. Mainland use of natural gas is exempt from the carbon tax.

The climate quota establishes a system of quotas and freely tradable quotas in the period 2005 – 2007. The purpose of the law is to limit the releases of greenhouse gases in a cost efficient way, through a system of quotas for the release of CO_2 and freely tradable release quotas. Energy plants larger than 20 MW, such as district heating plants, gas fired power plants and gas processing and gas terminals are subject to the quota. In total, 11 per cent of the total release of CO_2 in Norway is covered by the climate quota.

A sulphur tax is also levied on most mineral oil consumption at a rate of NOK 0.07 per litre for each 0.25 per cent of sulphur content by weight. This corresponds to about NOK 17 per kilogram of SO_2. The sulphur tax is not levied on oil with a sulphur content of 0.05 per cent by weight or less. The scheme has resulted in the sulphur content of a number of product categories being reduced to less than 0.05 per cent by weight in order to escape the tax. Sulphur tax can also be wholly or partly refunded if it can be documented that the sulphur has been wholly or partly removed.

NO_x releases are highly dependant on combustion technology and fuel. However, large emission sources must be covered by discharge permits under the Pollution Control Act.

Emissions of PM10 can be reduced by treating the flue gases. At present, only large incineration plants are required to reduce emissions of PM10 under the Pollution Control Act. No such requirements apply to emissions from small heating systems, but their users can be held financially responsible under the regulations on local air quality for their contribution to poor air quality. All newly-installed wood-burning furnaces/stoves in dwellings must be clean-burning. The cities face the greatest problems from high concentrations of PM10 in the air.

A more detailed description of emissions by source and sector and the impact of these emissions can be found in Natural Resources and the Environment 2004 from Statistics Norway and on the latter's web site at www.ssb.no.

3.4 More on Enova SF and management of the Energy Fund

Enova was set up by the Royal Decree of 1 June 2001, and came into effect from 22 June 2001. The Royal Decree is based on the government decision of 5 April 2001 and ratifies the government's proposal for a new financing model and reorganisation of the work on restructuring energy use and energy production as specified in Report to Storting no. 29 (1998 – 199) 'Om energipolitikken'. Parliament expressed, in the processing of the report, a wish for a more efficient management of the means and measurable results than previously. It resulted in a change in the Energy Act, Proposition to the Odelsting no. 35 (2000-2001), where the Ministry of Petroleum and Energy established an energy fund and a new state owned company (Enova) to manage the funds.

As from 1 January 2002, responsibility for allocation of financial support to new renewable energy production was moved from NVE to Enova. At the same time, grid company compulsory Enøk activities were terminated and responsibility for a nationwide information and advice service was transferred to Enova.

Enova's responsibilities are specified in the agreement between the Ministry of Petroleum and Energy and Enova SF. The agreement defines the goals for Enova's activity, responsibilities delegated, system requirements and reporting requirements.

The Ministry of Petroleum and Energy emphasises that Enova is to find practical solutions and manage the funds in a way that ensures that the energy policy goals are achieved in the most cost efficient method possible.

The Energy Fund was, at the start, partly allocated funds from the national budget and partly from the grid tariff supplement. As from 2005, the Energy Fund is fully financed by the grid tariff supplement. The grid tariff supplement is today NOK 0.01/kWh. The Energy Fund received around NOK 680 million in 2006.

In addition to the Energy fund, Enova since 2004 has managed grants for the construction of a natural gas infrastructure. The funds are structured as PSO contracts (Public Service Obligations). Funds are granted from the state budget. NOK 30 million was granted to this for 2006.

3.4.1 Goals for Enova activity

The goals for the management of the Energy Fund are set as follows:

- The Energy Fund should be used to promote an environmentally friendly conversion of energy consumption and energy production.
- The funds should contribute to energy saving and new environmentally friendly energy which is equivalent to minimum 12 TWh by the end of 2010 of which

- minimum 4 TWh should be increased access to water borne heating based on new renewable energy sources, heat pumps and waste heat and
-minimum 3 TWh should be increased production of wind power.

Based on this goal structure, Enova has directed its activity towards the following main areas: energy use, wind power and heating. Enova also has a program for technology development within these main areas.

In addition to this, Enova is responsible for providing a nationwide information and advice service for environmentally friendly energy use and energy production.

3.4.2 Heating

Enova works to establish new heating plants, distribution systems for heating and stable supplies of biofuel. Enova provides economic support to projects throughout the value chain, from extraction, transport and production of biofuel to development of heating plants and distribution systems.

Through Enova's heating program, it is possible to receive professional and financial support for establishing stable supplies of biofuel, for construction, operation and ownership of local and district plants and for building and owning heating distribution systems.

3.4.3 Wind power

Wind power is the renewable energy source which most investment is focussed on and which is the source which is closest to commercial viability. Investment grants represent the most important policy instrument in this context and are awarded only to facilities which have been granted a licence by NVE. The grant from Enova is allocated after being applied for by the developer and an individual profitability evaluation of the project has been submitted. Enova has provided support to around 25 per cent of the investment.

3.4.4 Energy saving

Contractual reductions in energy consumption corresponding to 999 GWh had been secured by Enova in 2005. These cuts are divided between several programme areas, with energy management in commercial buildings as the largest. In total, NOK 200 million was granted in 2005 to different energy use programs.

Enova's work with energy measures and increasing energy efficiency are both linked to the information and advice activity and to ordinary support measures within central industries where the potential and motivation for energy efficiency increase is large. Support from Enova obliges grant recipients to carry out activities (analysis, mapping saving potential etc.) or introduce new efficient energy technologies.

More information on the project can be found on Enova's web site at www.enova.no. Enova has also established a free telephone service which provides information on energy saving and consumption.

3.4.5 Results from Enova's work

Enova reports results from the allocation of grants to projects in the form of contractual or realised energy results. The results are prepared by adding the energy amounts in the contracts Enova enters into with players who are allocated funds. The projects included in the result reporting are therefore not necessarily completed in the course of the year in which they are reported in. Several of the projects are of a size that means they are completed across several years.

From 2001 to 2005 (inclusive) Enova has allocated support to projects which together provide 6.6 TWh new production or saved energy. The results are distributed across the main areas as follows:

- Wind power 1559 GWh.
- Heating 2277 GWh.
- Energy use 2756 GWh.
- Technology 54 GWh.