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Energy Efficiency Policies and Measures in Norway – Monitoring of Energy Efficiency in EU27, Norway and Croatia (ODYSSEE-MURE)

Institute for Energy Technology

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Abstract

This report represents the national case study of Norway for the EIE-project "Monitoring of Energy Demand Trends and Energy Efficiency in the EU – ODYSSEE-MURE". It presents the recent energy efficiency trends in Norway on the basis of indicators extracted from the ODYSSEE database.

Total energy consumption (not including energy as feedstock) has increased from 16.6 Mtoe (195 TWh) in 1990 to 19.2 Mtoe (226 TWh) in 2007 and has been relatively constant the last ten years. Energy consumption in manufacturing industry has increased by 10 % from 1990 to 2007, but is lower in 2007 than in 1998. Final energy use in households has increased from 3515 ktoe (41 TWh) in 1990 to 3826 (45 TWh) in 2007. The climate corrected energy use has been at approximately 4000 ktoe since the mid 1990s. It seems to be an interrupt in the increase of energy use in households, despite the growth of all common used drivers in this sector.

Energy efficiency policies and measures implemented since 1990 have contributed to improve the efficiency by 13 %, or 0.7 % per year; this means that if these policies and measures would not have been implemented, the final energy consumption would have been 13 % higher in 2007 (or approximately 1.9 Mtoe or 22 TWh).

Keywords: Indicators, energy trends, energy savings

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1 Executive Summary

This report represents the national case study of Norway for the EIE-project "Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE)". The Norwegian part of the project is co-funded by Enova. The report presents the recent energy efficiency trends in Norway on the basis of indicators extracted from the ODYSSEE database. The database contains information on energy use in a detailed level of the industry, household and service sectors and other energy use. It also contains information on energy drivers like heated square meters in the households and services sectors, transported passenger-km and ton-km of gods, value added, production index, production volumes etc.

Total energy consumption (not including energy as feedstock) has increased from 16.6 Mtoe (195 TWh) in 1990 to 19.2 Mtoe (226 TWh) in 2007 and has been relatively constant the last ten years. The sector using most energy today is the industry, followed by the transport sector. From 1990 to 2007 the growth rate has been highest in the transport sector.

Energy consumption in manufacturing industry has increased by 10 % from 1990 to 2007. There has been an increase of 32 % in the non-ferrous metal production, while the energy use in the pulp and paper industry has been rather constant in this period.

Final energy use in households has increased from 3515 ktoe (41 TWh) in 1990 to 3826 (45 TWh) in 2007. The climate corrected energy use has been at approximately 4000 ktoe since the mid 1990s. It seems to be an interrupt in the increase of energy use in households, despite the growth of all common used drivers in this sector.

Final energy use in the service sector has increased with 20 % from 1990 to 2007. The share of electricity has been high the entire period and was 82 % in 2007.

Energy consumption in the transport sector has increased by 39 % from 1990 to 2007 from 3815 ktoe (45 TWh) in 1990 to 5405 ktoe (62 TWh) in 2007. The use of diesel oil is more than doubled, while the use of gasoline has decreased by 19 %.

The overall final energy intensity improved annually by 1.9 % from 1990 to 2007 (i.e. final energy over GDP). The improvement was higher during the nineties than after 2000. General growth in the economy plays an important role in this development, but also structural changes and more efficient use of energy contributes. An increasing share of the primary energy is not going to final energy consumers, mainly due to increased activity in the oil and gas production and non-energy use in chemical industry.

In the ODYSSEE-project an aggregate energy efficiency index, called the ODEX, is developed. The purpose of this index is to assess the actual results of energy efficiency policies and measures. It aggregates the trends in the many detailed indicators in a single indicator.

Energy efficiency policies and measures implemented since 1990 have contributed to improve the efficiency by 13 %, or 0.7 % per year; this means that if these policies and measures would not have been implemented, the final energy consumption would have been 13 % higher in 2007 (or approximately 1.9 Mtoe or 22 TWh).

The development has been positive for all sectors, according to the selected indicators. The energy efficiency index in industry decreased from 1990 to 1996 and then there were a slight increase followed by a decrease from 2000 to 2007. Within the sub-sectors there are structural changes that not are fully reflected in the production index, leading to higher increase in energy intensity than expected. For the transport sector the index was first constant and then shows improvements in energy efficiency from 1994 to 2004, followed by an increase in the end of the period. The household sector has a rather constant improvement after 1992 until 2001 when the energy efficiency rapidly improved until 2005.

The CO2-emissions from the household, transport and industry sector have in total increased by 3.9 Mt from 1990 to 2007. Due to increased activity, like more dwellings, more tons of gods transported, more person-km driven, the CO2-emissions would have increased by 7.6 Mt if no improvements of energy efficiency or structural changes had occurred. The CO2-savings can be calculated to 3.8 Mt.

The transport sector has highest increase in CO2-emissions, due to a large increase in activity (tons of gods and passenger transported). This sector also has the highest savings of CO2-emissions, calculated to 2.7 Mt. In industry the variations in CO2-emissions are small and can be explained by changes in activity. In total the CO2 emissions from the household sector has decreased by 0.7 Mt from 1990 to 2007. The effect of climate and more dwellings should have resulted in increased CO2 emission of 0.4 Mt. In total the savings in CO2 emissions is then 1.1 Mt. Most of this is due to substitution (0.9 Mt); less use of fuel oil and more use of electricity, wood and district heat. The effect of unit consumption per dwelling contributes with a saving of 0.2 Mt.

2 The Background to Energy Efficiency

2.1 Overall economic context

The overall gross domestic product (GDP) for the entire Norwegian economy had a growth of 3.1 % in 2007. The growth of on-shore activities was 6.1 % in 2007, and there was a decrease in the off-shore activities as well as in international shipping. The last 17 years there has been an annual increase of 4.1 % in overall GDP. The growth was highest the first half of this period, due to high activity in oil and gas drilling. Manufacturing value added has its highest growth the last five years. See Table 1 and Figure 1.

Table 1: Economic and industrial growth in Norway, % per year

	1990-1997	1997-2002	2002-2007	1990-2007
GDP	4.7	2.4	2.7	4.1
Private consumption	3.5	3.2	5.1	4.8
Manufacturing value added	1.8	-0.5	4.7	2.1

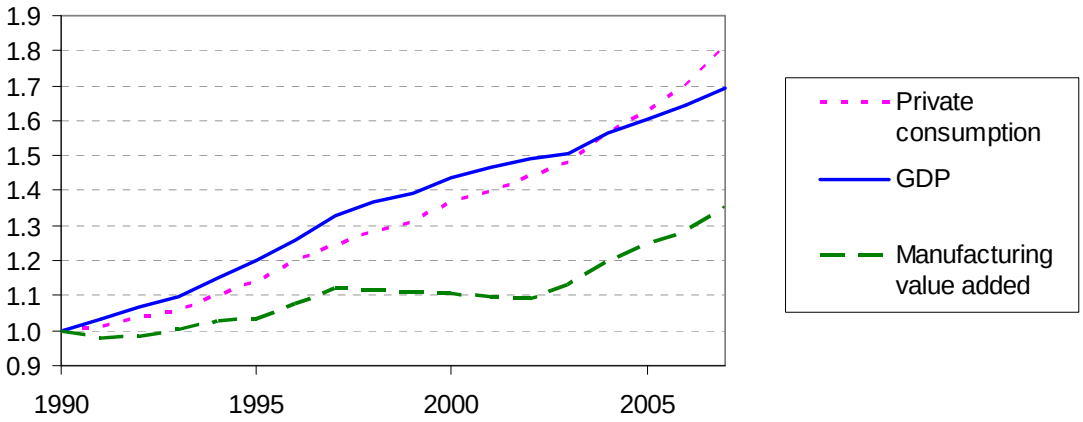


Figure 1 Macro-economic development in Norway 1990-2007 at constant prices

2.2 Energy consumption trends: by fuel and by sector

Norway is a major producer of oil, gas and hydropower. Most of the electricity production is based on hydropower, and this has historically made it possible to have low electricity prices and a large energy intensive industry as well as use electricity for heating purposes in private homes. Due to large economic growth the last 17 years and only minor new power supply, Norway is now a net importer of power in the joint Nordic electricity market, at least under average climate (precipitation) conditions.

Electricity is found to be a convenient and cheap energy carrier for many purposes and half of all end use energy is electricity. From 1990 to 2007 electricity consumption grew by 14 % or on average 0.8 % per year. The use of biomass has grown on average by 1.2 % per year and gas consumption has an annual average growth of 4.1 %. The share of gas is still quite small, but it is almost doubled since 1990. Oil consumption has increased by 17 % from 1990 to 2007 or in average increased by 1.0 % per year. District heat has an annual average growth of 14 % from 1990 to 2005.

The final energy consumption was 16.6 Mtoe (195 TWh) in 1990 and 19.2 Mtoe (226 TWh) in 2007. The total energy consumption has been on a relatively constant level from 1998 to 2007, see Figure 2. Coal and coke in e.g. metal production is included, while gas as feed stock is excluded. Energy use is not corrected for climate variations.

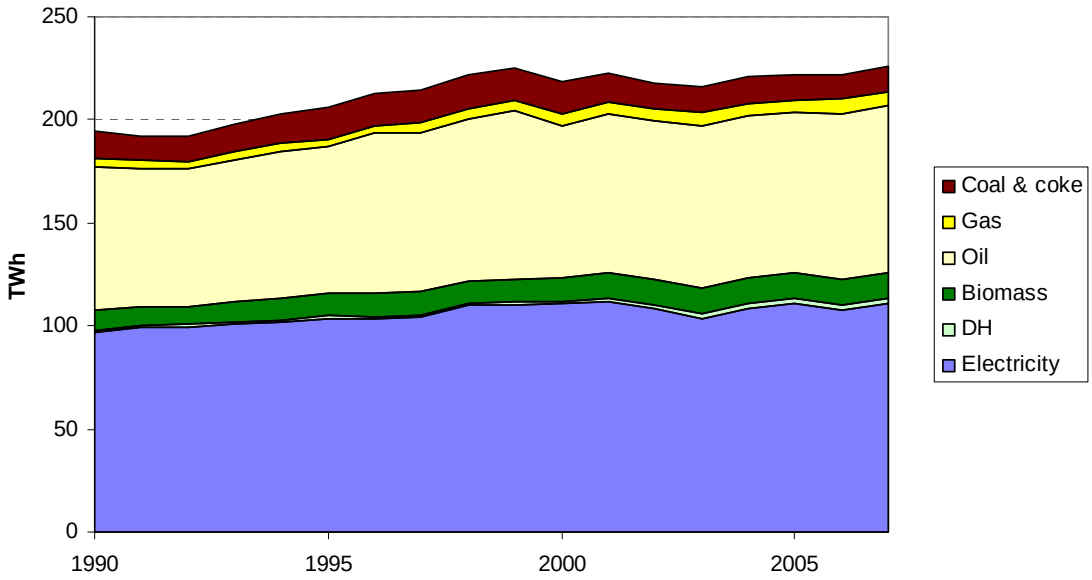


Figure 2 Final energy consumption in Norway 1990-2007 (Source: Energy balances)

The sector using most energy in 2007 was industry (36 %), followed by the transport sector (28 %), the residential sector (20 %) and other uses (16 %). The growth has

been highest in the transport sector, increasing from 23 % of final energy use in 1990 to 28% in 2007, see Figure 3.

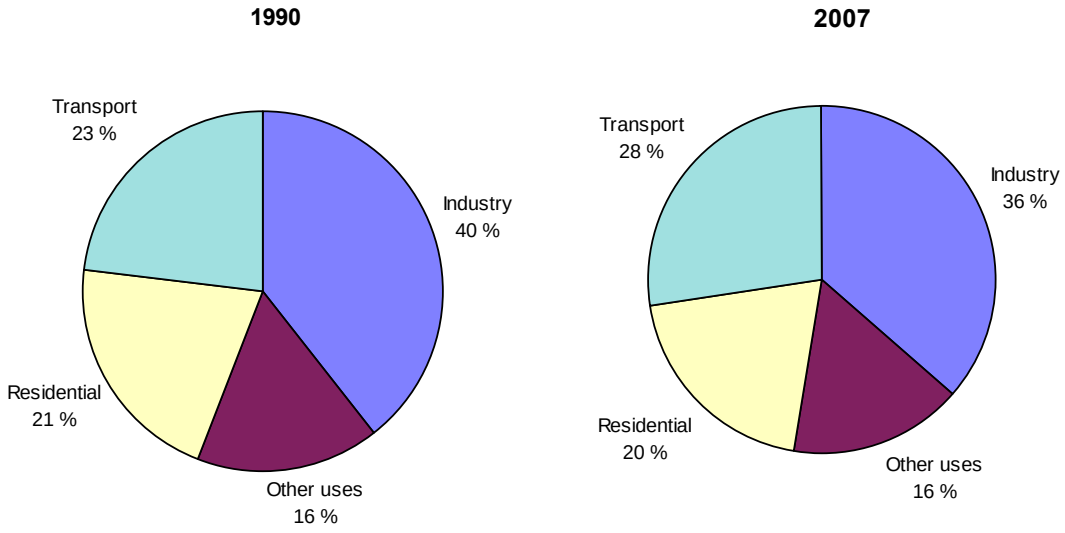


Figure 3 Final energy consumption by sector in Norway 1990 and 2007

2.3 The policy background to energy efficiency

The alteration to a more environmental friendly energy production and use in Norway is since 2002 managed by Enova SF. Enova is a public enterprise for promoting energy savings, new renewables and environmentally friendly natural gas solutions. Enova is owned by the Government of Norway, represented by the Ministry of Petroleum and Energy. Enova's main mission is to contribute to environmentally sound and rational use and production of energy, relying on financial instruments and incentives to stimulate market actors and mechanisms to achieve national energy policy goals.

A trading system for greenhouse gas emissions entered into force 1 January 2005 and the concept is in line with the EU emission trading system. As from 2008 the Norwegian system is a part of the EU emission trading system. The emission trading system stimulates the industry, to reduce their climate gas emissions. Companies are assigned emission quotas based on historical emissions in 1998-2001. Industries included in the emission trading system are oil refineries, iron and steel, cement and lime industry, pulp and paper industry, glass industry as well as several energy production plants. In the first period of the emission trading system, 2005-2007, emissions from energy use covered by the CO2-tax was not included. The new system includes e.g. emissions

from offshore petroleum activities that were not included in the previous system. The trading system includes approximately 40% of all climate gas emissions in 2008-2012.

ENOVA SF administrates the Energy Fund. The income of the energy fund comes from a levy of 1 øre/kWh (0.008 €/kWh) to the distribution tariffs that is mandatory. The electricity trade concessionaire adds a levy to the tariff of 1 øre/kWh of all tapping from the distribution grid to the end user, in connection with invoicing. The electricity trade concessionaire pays the energy fund 1 øre/kWh multiplied with the energy quantity consumed by the end users of the distribution grid.

In order to strengthen the priority area of the Fund, the government established a new fund called “statutory fund of energy conservation and renewable energy”. In the state budget of 2007, the government granted 10 000 MNOK (approx. 1200 M€) and in the state budget of 2009 it is suggested to grant another 10 000 MNOK (approx. 1200 M€) in 2009. The annual yield was approx. 400 MNOK in 2008, canalized through Enova. Enova administered approx. 790 MNOK (approx. 100 M€) in 2007 and 1400 MNOK (approx. 175 M€) in 2008. As a part of the extraordinary measures due to the financial crisis, the Government allocated additional MNOK 1200 to Enova in 2009.

ENOVA chooses the measures and administrate the fund in order to achieve the national goals in the best way. ENOVA are not an executive/operative company, but engages external actors to carry out definite tasks on behalf of ENOVA.

The energy fund is used to project related measures as purchasing services, payment of grants and other financing of measures in the field of consumption, environmentally friendly heat, wind and natural gas. The fund supports projects in industry, the tertiary sector, the household sector as well as production of new, renewable energy.

Norway and Sweden has come to an agreement concerning a common market for green certificates, with an intention to start 1 January 2012. Sweden has an ongoing market for green certificates that is mainly technology neutral and Norway intends to adapt to this.

3 Overall Assessment of Energy Efficiency Trends

3.1 Overall trends in energy intensity

Two general indicators are usually used to characterise the overall energy efficiency trends: the primary energy intensity (i.e. the ratio primary consumption over GDP), and the final energy intensity (ratio final consumption over GDP). The primary intensity provides an assessment of the energy productivity of the whole economy. The final intensity characterizes the energy productivity of final consumers only and so excludes losses in transformation and supply.

Since 1990 both the final and the primary intensity has decreased, with a small increase in the preliminary figures of primary use in 2007, see Figure 4. The decrease was in average higher during the 1990s, than during the 2000s, Table 2.

The final intensity has decreased from 0.131 koe/€2000 in 1990 to 0.089 koe/€2000 in 2007 (-32 %). The primary energy intensity has decreased less, only 27 % from 1990 to 2007. The reasons for these decreases are complex and will be further analysed later in this report. A part of it is due to more efficient use of energy, but also structural changes, increased production and a general growth in the economy play an important role.

The ratio final/primary intensity has decreased from 0.75 in 1990 to 0.69 in 2007. A decrease in this ratio means that more primary energy is needed per unit of final energy consumption. This means that an increasing share of the primary energy consumption is not going to final consumers, but is consumed by the transformation sector, mainly due to increased activity in the oil and gas production and non-energy uses in chemical industry.

Table 2 Variations in primary and final energy intensities in Norway (% per year)

	1990-2007	2000-2007	2006-2007
Final intensity	-1.9	-1.7	-1.3
Primary intensity	-1.5	-1.3	-0.5
Ratio final/primary	-0.5	-0.5	-0.8

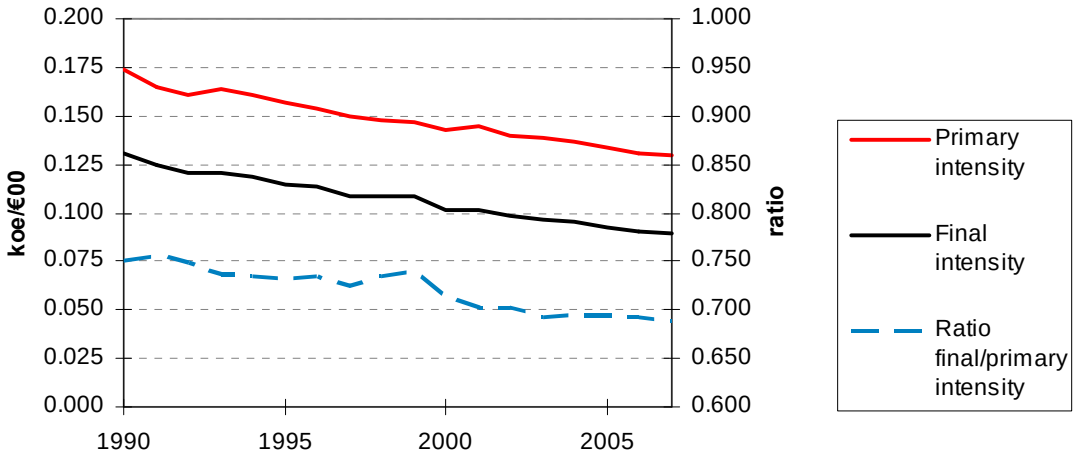


Figure 4 Primary and final energy intensity, 1990-2007

3.2 Industry

Industry is the major energy-consuming sector in Norway, using approximate 36 % of final energy use. Energy intensive branches as metals manufacturing, basic chemicals and pulp & paper production dominate the sector's energy use, using 79 % of total energy in manufacturing industry in 2007, see Figure 5.

The energy consumption in manufacturing industry has increased from 6009 ktoe (71 TWh) in 1990 to 6628 ktoe (78 TWh) in 2007, or by 10.3 %. The production of non ferrous metals uses 1/3 of the energy in manufacturing industry, and today this is mainly production of aluminium. The energy use in this sector has increased with 32 % since 1990. Several energy intensive plants has been moved in the energy balance from one industrial sub-sector to another (especially from iron and ferrous to chemicals), making it difficult to analyse the development in these sub-sectors. The energy use in the pulp and paper industry is almost the same in 2007 as in 1990.

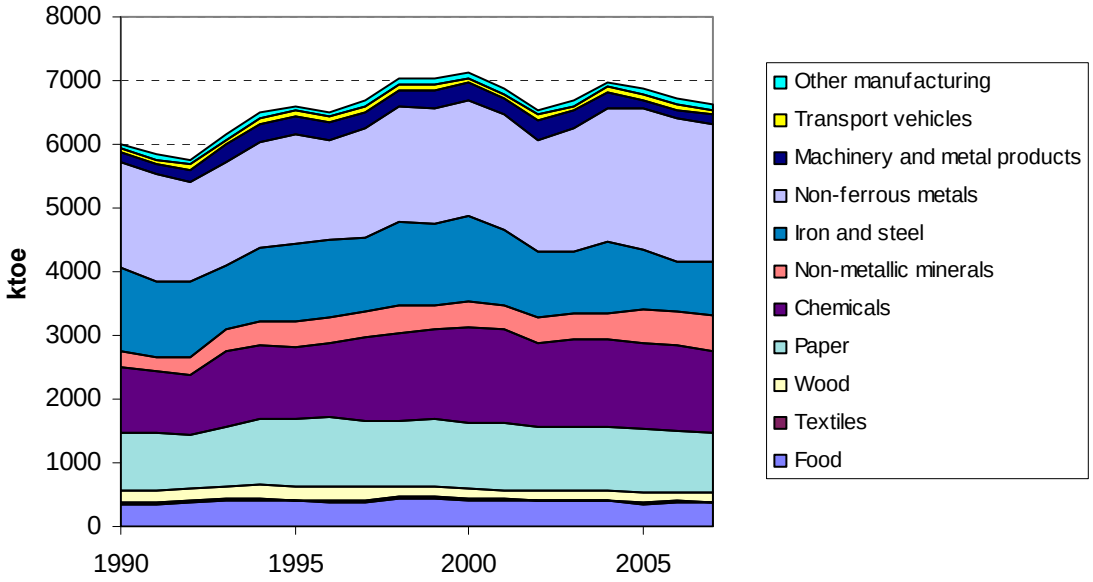


Figure 5 Trends in energy use per sector in manufacturing 1990-2007 (ktoe)

The share of electricity has been rather constant at 60 % in manufacturing industry from 1990 to 2007, with a smaller share in the late 1990s (a minimum of 56 %), see Figure 6.

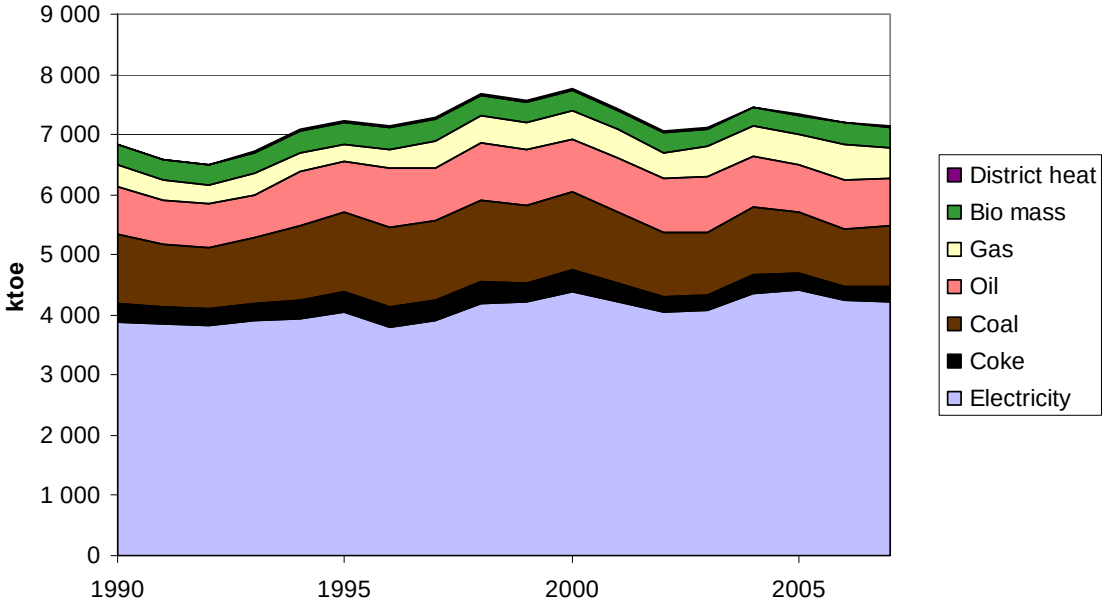


Figure 6 Final energy consumption by energy carrier in manufacturing 1990-2007 (ktoe)

Value added in manufacturing industry has grown with 35 % from 1990 to 2007. In oil and gas exploitation there has been a big increase (78 % from 1990 to 2007), with a maximum in 2004 (109% higher than in 1990), see Figure 7. The increase in value added is lower than the average manufacturing increase for important sectors like the primary metals and chemicals, while production of fabricated metals had the highest growth.

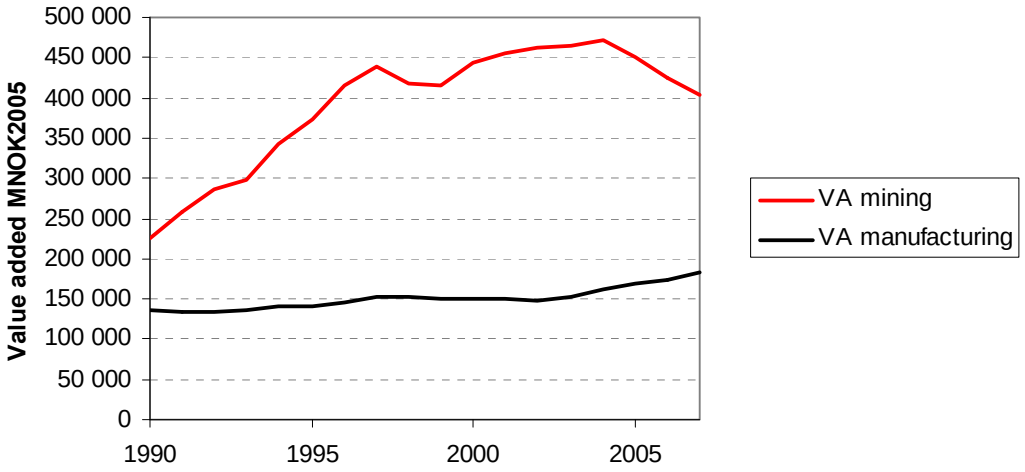


Figure 7 Value added in manufacturing industry and mining (including oil and gas exploitation) 1990-2007 in mill. NOK in constant 2005-prices

Production of primary metals uses almost half of the energy in the industrial sector and is divided in production of ferrous and non-ferrous metals. Non-ferrous metals includes production of aluminium, magnesium, nickel etc, and in Norway it is the production of aluminium that dominates the energy consumption of this sector. Aluminium is produced both by the older Søderberg technology and the newer more energy efficient pre-baked technology. The production in Søderberg plants was constant until 2001, when two plants were closed down. There has been an increase with the more modern and energy efficient pre-baked technology, with two new big plants starting up gradually from 2002 and forward. The total production volume was rather constant until 1997, and has since then increased by approximately 50 %. The energy intensity calculated as energy used per ton aluminium produced has been reduced with 17 %, mainly from 1997 to 2007, see Figure 8. In 2002 the only Norwegian magnesium plant was closed down.

The sector iron and ferroalloys includes production of steel, iron and ferroalloys were the last is dominating the sector in Norway. In 1993 the production of metallic silicon was moved from production of ferroalloys to production of chemicals. As this is a very

energy intensive production, the intensity of iron and ferroalloys went down in 1993 and the intensity of chemicals went up. The production of ferroalloys has been more and more energy intensive, as alloys with a higher degree of silicon has grown much more than other metals. Since plants with a main production of silicon metals are included in the chemical sector after 1993, the picture of the development is quite complicated. Since no statistics on production index or tons of produced ferroalloy are available, both the trend of production of primary metals (including ferroalloys) and production of aluminium are presented in Figure 8.

The chemical industry includes very different production plants and many of them are energy intensive, e.g. production of carbides, silicon metal, fertilizers and methanol. The high increase in the chemical sector in 1997 is due to the start of a new plant producing methanol. The production increased the following years and was in 2001 more than twice as high as in 1997 and 28 % higher than in 1998. The production of carbides has been considerable reduced after 2002, both due to close-down of one plant and due to lower production in the other three plants. One carbide-plant was closed down in 2002 and two plants producing metallic silicon was closed down in 2006, causing a reduction in energy intensity since this is very energy intensive production. The production index of all chemical industry has increased more than the production index of basic chemicals since 1997, and since basic chemicals are more energy intensive than other chemical industry this results in an decrease in energy intensity for the chemical industry (caused by structural changes within the sub-sector).

The energy intensity of paper, pulp and printing has decreased by 7 % from 1990 to 2007, when energy intensity is calculated as energy use per ton paper produced. The production of mechanical pulp is electricity intensive and increased until 2004 by approx 34 %, but has since then decreased. The production level in 2007 was 5 % higher than in 1990. On the other hand, the chemical pulp production has decreased by 10 % from 1990 to 2007. The production of chemical pulp uses most energy per ton of product, followed by mechanical pulp, while paper production is less energy intensive. A new, big paper machine was started up in 1993 at the same time as the production of mechanical pulp increased considerable. A chemical pulp plant was closed down in 1997. In 1996 the electricity price was high and more oil with lower boiler efficiency was used, causing an increase in intensity. The last ten years the energy intensity has been 5-12 % lower than in 1990.

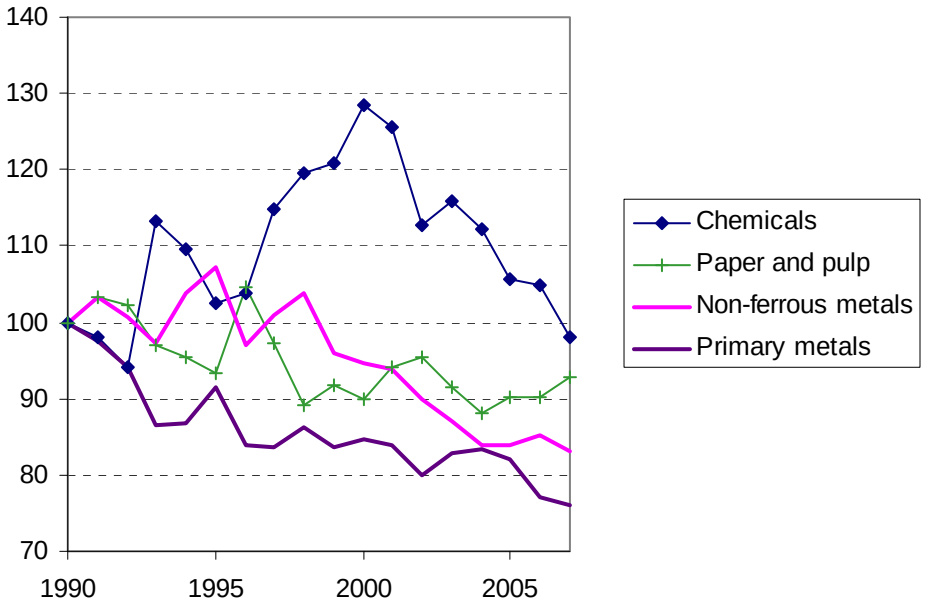


Figure 8 Relative energy intensities in heavy industries 1990-2007

The food industry has increased the energy intensity by 8 % from 1990 to 2007. The last ten years the energy intensity has been rather constant at a level approximately 10 % higher than in the beginning of the 1990s. One of the most energy intensive products in the food industry is the production of fish meal. In 1998 this production increased considerable, without any increase in the production index, thus causing a great increase in the energy intensity of food industry.

Production of non-metallic minerals had a high increase in energy intensity in the beginnings of the nineties, see Figure 9. The largest energy consumers in this sector are two cement plants and one of them changed process from wet to dry in 1990-1992 and was then partly out of operation. Since the middle of the nineties, the energy consumption has been rather constant while the production index has increased, causing a decreased energy intensity. This trend changed in 2003, when the energy use was constant but the production index decreased, despite a constant production of cement. This indicates that other products with higher influence on the production index and less influence on energy use decreased. In 2005 production of anodes for the aluminium industry seems to be moved from machinery to non-metallic minerals and since this is very energy intensive the index increased rapidly in non-metallic minerals at the same time as there was a corresponding decrease in the index of machinery, see Figure 9. This production did not belong to production of machinery before 1993 and hence the energy intensity shows a big increase in 1993, see Figure 9. The energy

consumption was the highest in 1993 and has then decreased. During the same time the production index first increased and then slightly decreased again. In total the energy intensity of the equipment industry decreased by 40 % from 1990 to 2007, but the picture is complicated by the different contents of plants in this sub-sector.

The energy consumption of the wood industry is more difficult to measure than other branches, due to the high use of internal fuels as bark and chips. The quality of the statistics is less accurate than for other energy carriers, and the large reduction in 1998 and some of the ragged profile of the energy intensity of the wood industry may be explained by this (e.g. 1999). The trend from 2000 to 2007 is slightly decreasing energy intensity.

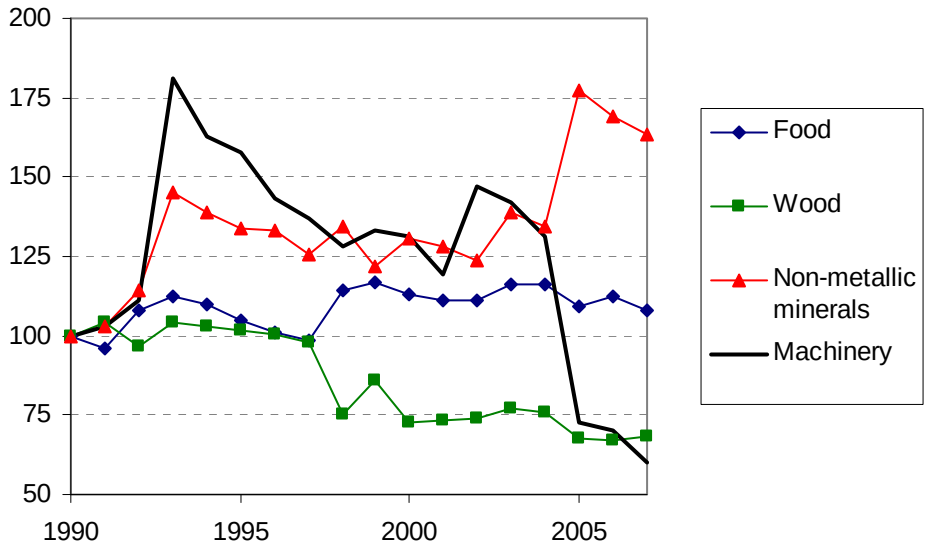


Figure 9 Relative energy intensities in light industries. Final energy use/production index: 1990-2007

The actual energy intensity of industry decreased by 20 % from 2000 to 2006, see Figure 10. If the intensity is kept at the same level as in 1990, the structural changes would have decreased the energy intensity by 14 % (-4 % in 2005). Until 2004/2005, structural changes have caused an increase in energy intensity, but after that the structural changes have decreased the energy intensity. The energy efficiency may be calculated as the difference between the actual and structural energy intensity and this was reduced from 2000 to 2005 by 18 % but increased in 2006 and ended 6 % lower than in 2000. This means that if the intensity had been the same as in 2000, the energy use in 2006 would have been 4.9 TWh higher.

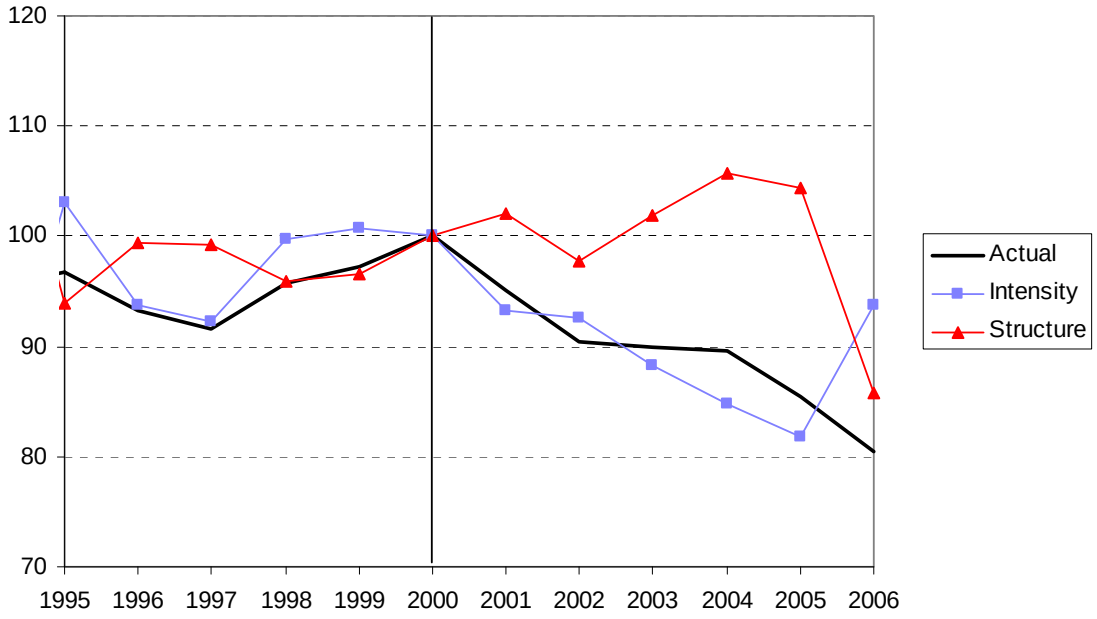


Figure 10 Effect of structure and intensity in manufacturing industry 1995-2006.

3.3 Households

Final energy use in households has increased from 3515 ktoe (41.3 TWh) in 1990 to 3826 ktoe (45 TWh) in 2007, see Figure 11. The energy use has been on the same level since mid 1990s. The electricity share was 73 % in 1990, increased to 77 % in 1991 and has been between 75 and 79 % since then, with an exception in 2003 when the share only was 72 % due to high electricity prices. The use of fuel oil has decreased from 425 ktoe (5.0 TWh) in1990 to 169 ktoe (2.2 TWh) in 2007. The use of fire wood increased from 483 ktoe (5.7 TWh) in 1990 to 585 ktoe (6.8 TWh) in 2007. The use of district heat was 48 ktoe (0.6 TWh) in 2007 and the gas consumption was 19 ktoe (0.2 TWh) in 2007. Climate variations explain to a large extent short-term variation in energy use, see the line in Figure 11. The climate corrected final energy use [1] has been rather constant the last ten years at approximate 4000 ktoe.

[1] In ODYSSEE, climate corrections are carried out for all countries using the same methodology, even if climate-corrected national data exist. They are only applied to a certain proportion of the space heating consumption (90%) to account for the fact that some losses are not dependent on the number of degree-days. The correction is done for each country in a linear way on the basis of the ratio between the normal degree-days and the real degree-days.

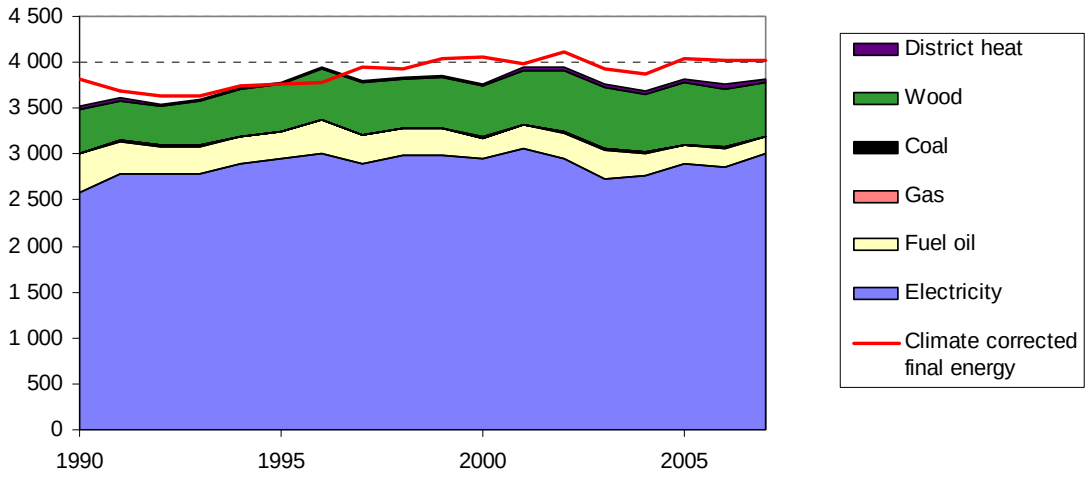


Figure 11 Final residential energy use by fuel (not climate corrected); 1990-2007 (ktoe)

Despite large increase in driving forces like private consumption, area and number of households, the climate corrected useful energy[2] has remain at the same level the last 10 years, see Figure 12.

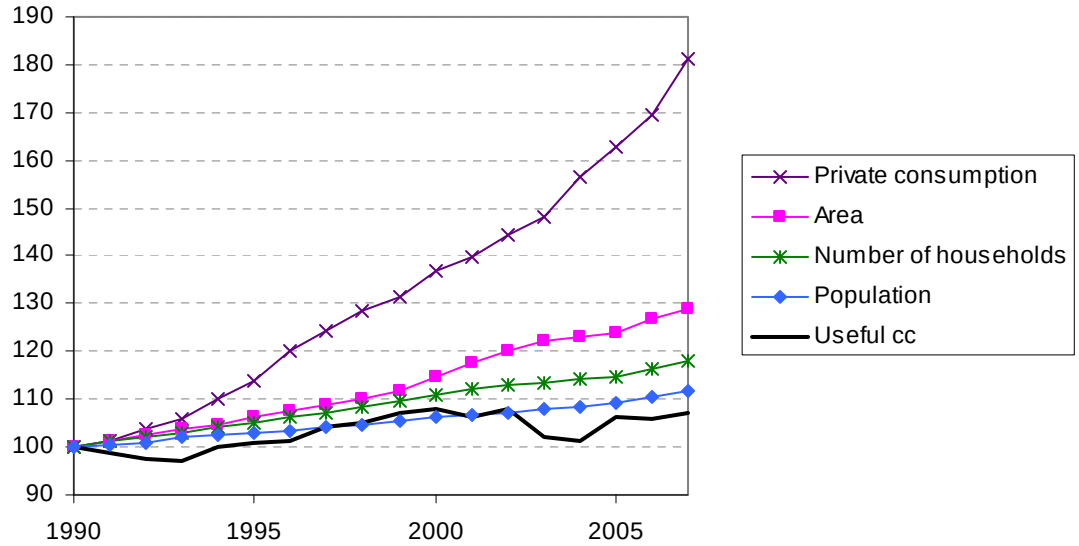


Figure 12 Trends in useful, climate corrected energy, private consumption, area, number of households and resident population 1990-2007

[2] Useful energy is calculated from final energy with efficiencies of each energy carrier corresponding to those used by Statistics Norway in the Energy balance.

In the first part of the 1990s an increasing residential area can explain the growth in energy use in the residential sector. But the last ten years the energy use has stopped growing despite a continued growing area, see Figure 13. A higher share of electricity with higher energy efficiency gives a lower growth in final energy than in useful energy. In 2007 the final energy would have been 2 % higher if the share of fuels was as in 1990. In average the households used 21 770 kWh/dwelling and 180 kWh/m² in 2007 of final energy (not climate corrected).

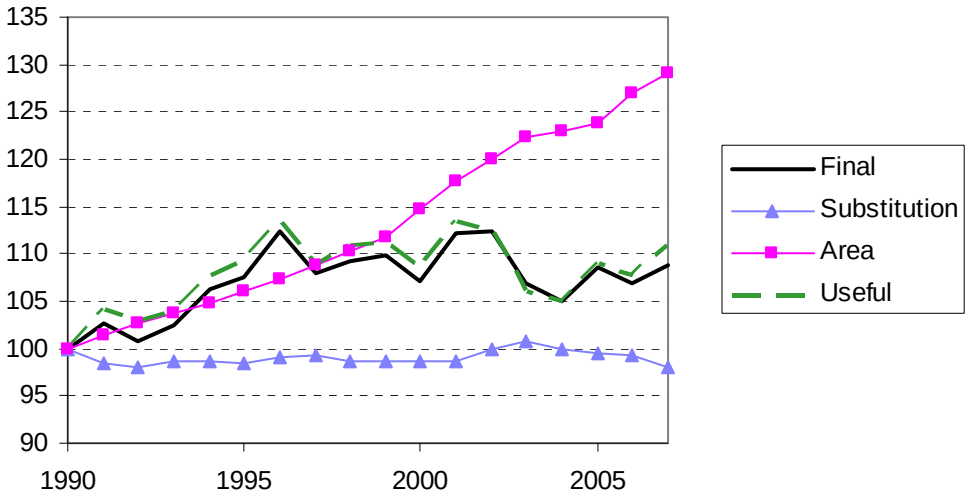


Figure 13 Effect of fuel substitution and heated area on final energy use, 1990-2007

Useful energy per capita has been rather constant from 1990 to 2002, but after that it decreased by approximate 4 %, see Figure 14. Useful energy per household has decreased since 1999, and was in 2007 9 % less than in 1990. Useful energy per NOK in private consumption has decreased by 41 % from 1990 to 2005.

Climate corrected useful energy per heated area was rather constant from 1994 to 2000 and has since then been reduced every year except in 2005. Climate corrected energy per heated area is used as energy intensity indicator in the residential sector in Odyssee, and a decrease of 17 % indicates an annual saving of 680 ktoe (8 TWh).

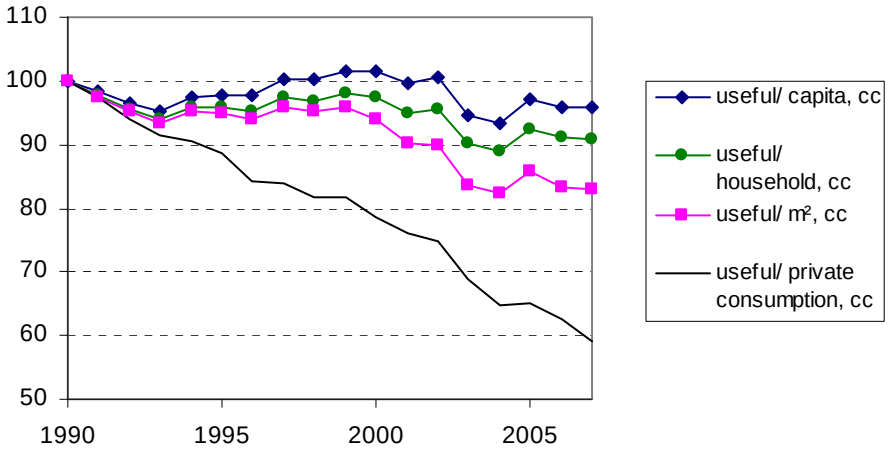


Figure 14 Useful energy use per capita, household, area and private consumption in the residential sector, 1990-2007

The area per capita was 46 m² in 1990 and has increased to 53 m²/person in 2007, see Figure 15. The area per household has increased from 110 m² in 1990 to 121 m² in 2007. The number of persons per household constantly decreased from 2.42 in 1990 to 2.30 in 2002, but since then the reduction has stopped up.

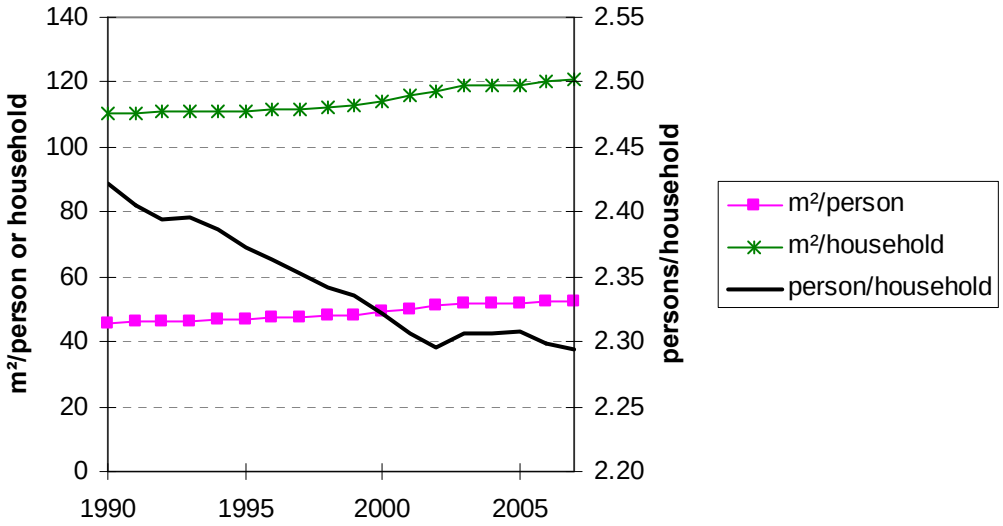


Figure 15 Area per capita and household and persons per households 1990-2007

The share of flats of the total stock of permanent dwellings was 20% in 1990 and 24 % in 2007. Since 1999/2000 the share of flats in the new dwellings has increased, see Figure 16. Of the new dwellings, 26 % was flats in 1990 and 51 % in 2007. The energy

use in flats is usually lower than in single-family houses and the increased share of flats contributes to the reduction in energy use per household and m².

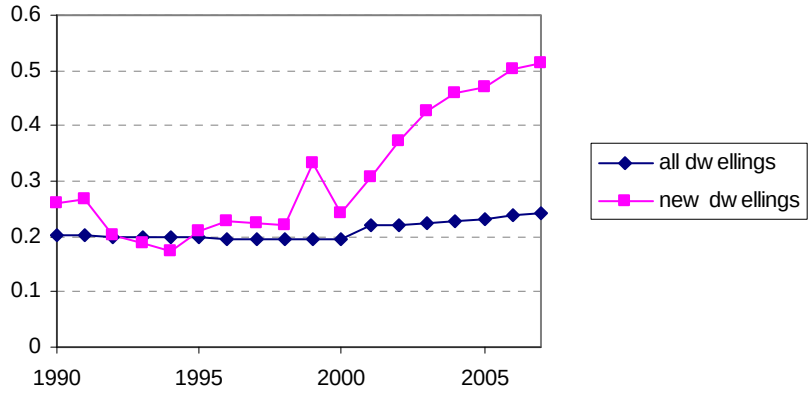


Figure 16 Share of flats of total dwellings and of new dwellings 1990-2007

3.4 Services

Final energy use in the service sector has increased from 2002 ktoe (23.5 TWh) in 1990 to 2397 ktoe (28.2 TWh) in 2007 (+20 %), see Figure 17. In 1990 electricity use was 83 % of total energy use and it has been at the same level all the period, with a minimum share in 2003 (78 %) due to high electricity prices. The share of fuel oil was 15 % in 1990 and 10 % in 2007. 1970 ktoe (2 TWh) of district heating was used in 2007 and the annual growth in district heating has been 12 % in average since 1990.

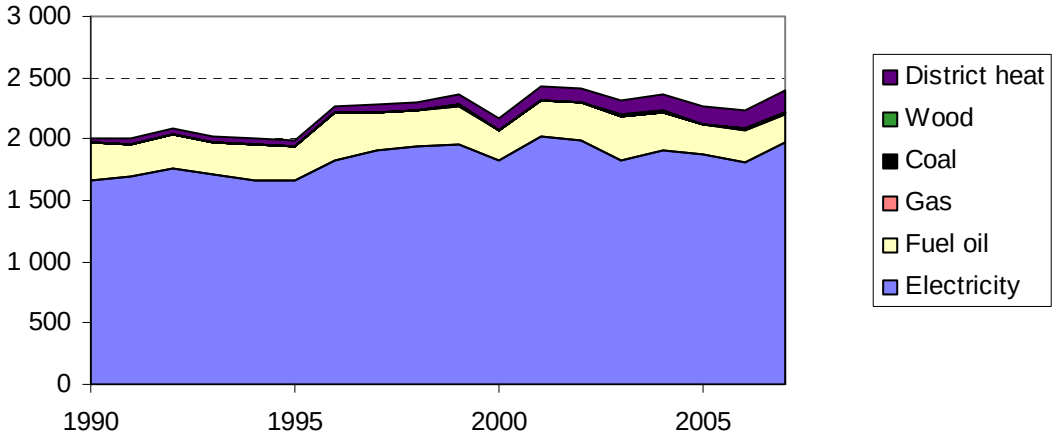


Figure 17 Final energy use by fuel in service sector (not climate corrected); 1990-2007

Value added has increase with 73 % in the service sector while the use of energy has increased with 20 % from 1990 to 2007, see Figure 18. The energy intensity calculated as energy use per value added has therefore decreased considerable. The trends in area and number of employees have a more similar development as final energy use, especially from 1990 to 2001. After 2001 the energy use has decreased at the same time as the area and number of employees continues to increase.

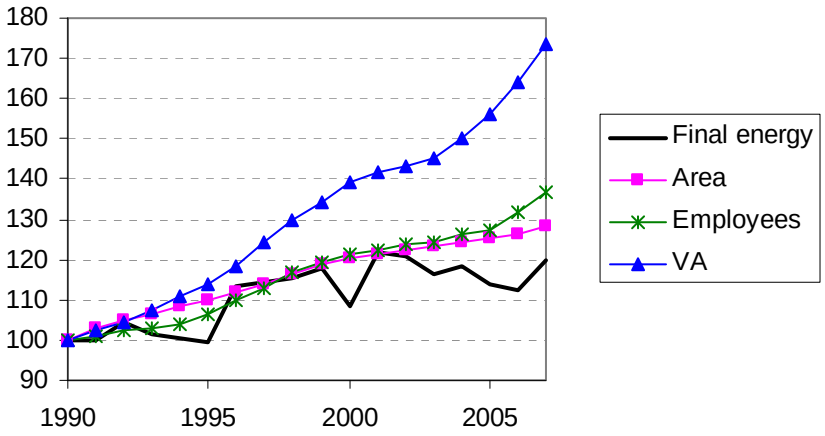


Figure 18 Trends in final energy use, value added, area and number of employees in service sector 1990-2007

Useful energy per employee and per surface (m²) shows a similar development, and has decreased by 12 % and 7 % since 1990, see Figure 19. Useful energy per value added in the service sector has decreased by 31 % from 1990 to 2007.

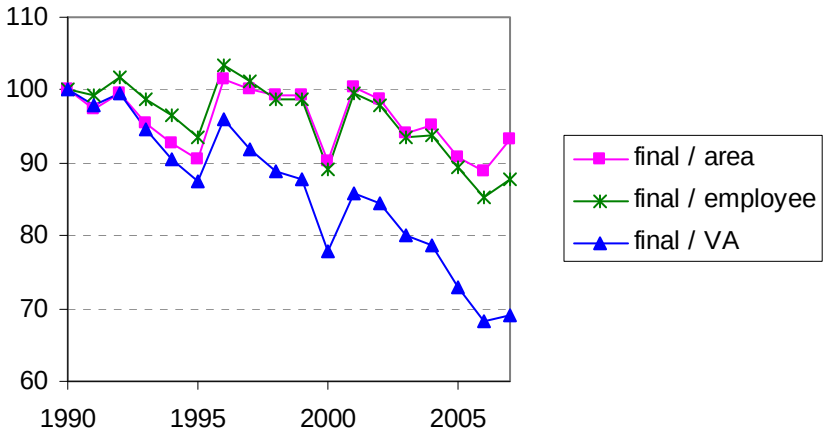


Figure 19 Trends in final energy use per area, employee and value added in service sector 1990-2007

Figure 20 shows energy use for some sub-sectors of the service sector. Wholesale and retail trade is using most energy, 554 ktoe (7 TWh) in 2007.

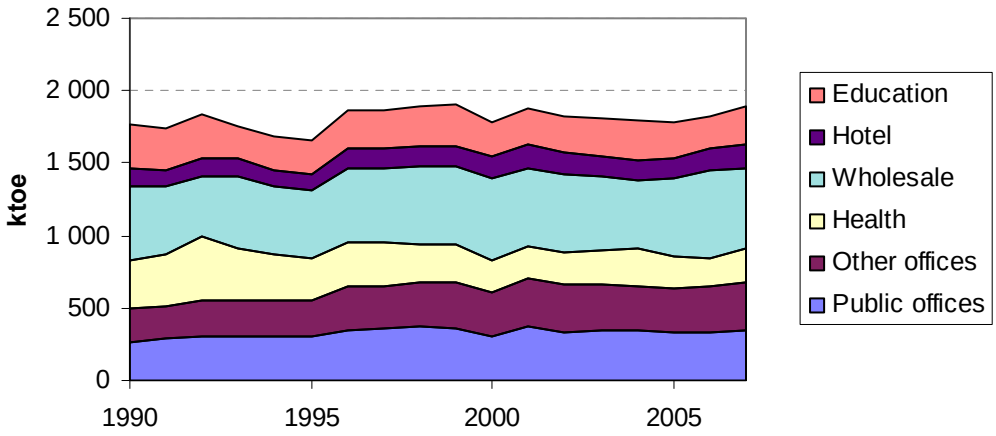


Figure 20 Energy consumption in sub-sectors in the service sector: 1990-2007

The trend in energy use in offices, both public and other, is increasing, see Figure 21, but since 1996 the energy use is more constant. Energy use in hotels has also increased since 1990, while wholesale and retail trade has in average been more constant. Education and especially the health sector have decreased their energy use since 1990.

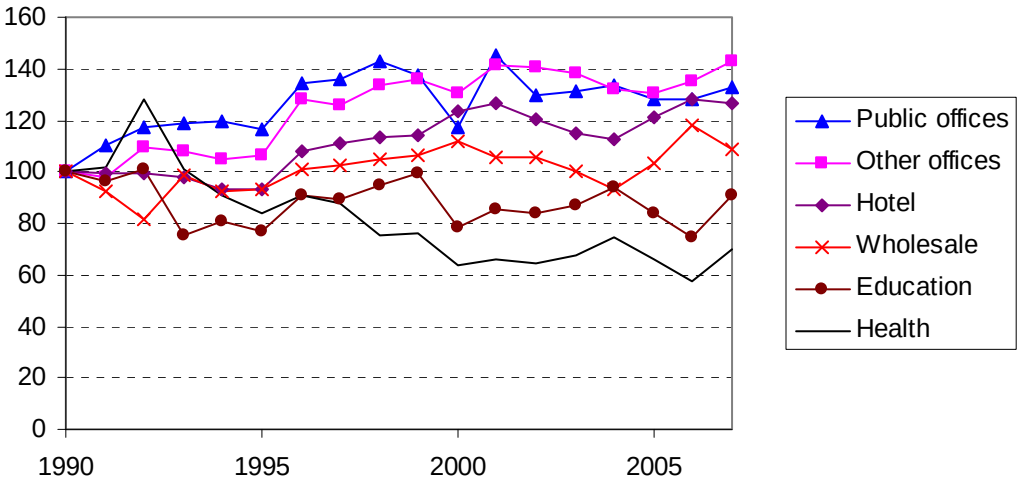


Figure 21 Trends in energy use in service sub-sectors: 1990-2007

3.5 Transport

The total energy consumption in the transport sector has increased from 3815 ktoe (45 TWh) in 1990 to 5303 ktoe (62 TWh) in 2007 or by 39 %, see Figure 22. The use of diesel oil is more than doubled from 1990 to 2007, while the use of gasoline has decreased by 19 %. Jet fuel has increased by 47 % in this period.

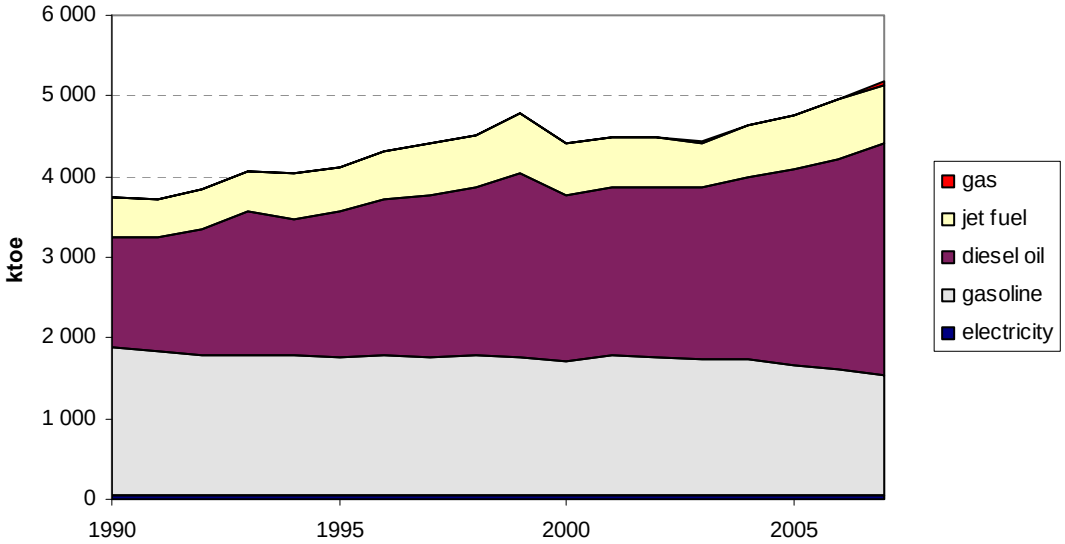


Figure 22 Energy use by fuel type in transport sector 1990-2007

In person transport, private cars are the dominating mode, 79.1 % in 2007 compared to 80.4 % in 1990, see Figure 23. Domestic air transport has increased most, from 5.0 % in 1990 to 6.4 % in 2007. Buses have decreased from 7.3 % 1990 to 6.1 % in 2007. Motorcycles are doubled, from 1.3 % in 1990 to 2.2 % in 2007. Transport by water and rail is rather constant in this period.

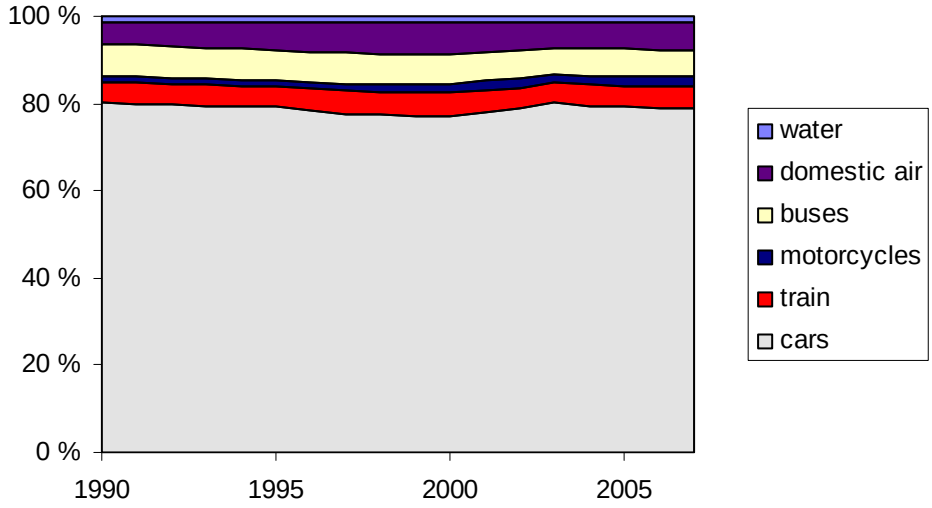


Figure 23 Travel by mode, % of person kilometres, 1990-2007

The stock of diesel cars is ten times higher in 2007 than it was in 1990, see Figure 24. In 1990 the share of diesel cars was only 3 % and in 2007 it has increased to 24 %. The energy efficiency of diesel cars is higher than for gasoline cars and the shift has thus a positive effect on the energy use by cars.

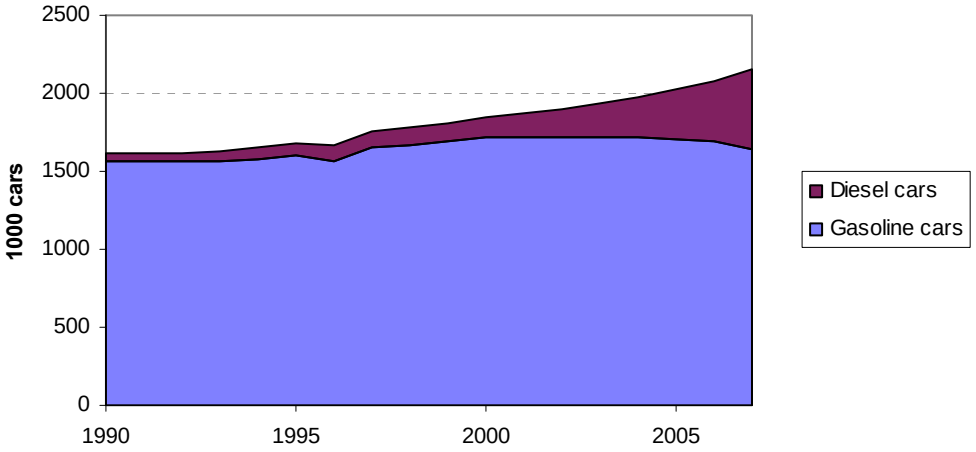


Figure 24 Stock of gasoline and diesel cars 1990-2007

Energy use per transport mode has to be calculated and the uncertainty therefore increases. Figure 25 shows specific energy use for some personal transport modes. All modes but motorcycles have improved their efficiency. Energy use per passenger-km by train has decreased most, by 46 % from 1990 to 2007. Transport by cars has improved by 16 % or 1 % per year. A higher share of diesel cars with a higher efficiency and general efficiency improvements of both gasoline and diesel cars contribute to the improvement. The efficiency of the stock of gasoline cars has improved from 8.2 litre/100 km in 1990 to 7.6 litre/100 km in 2006 (7 %), according to TØI[3].

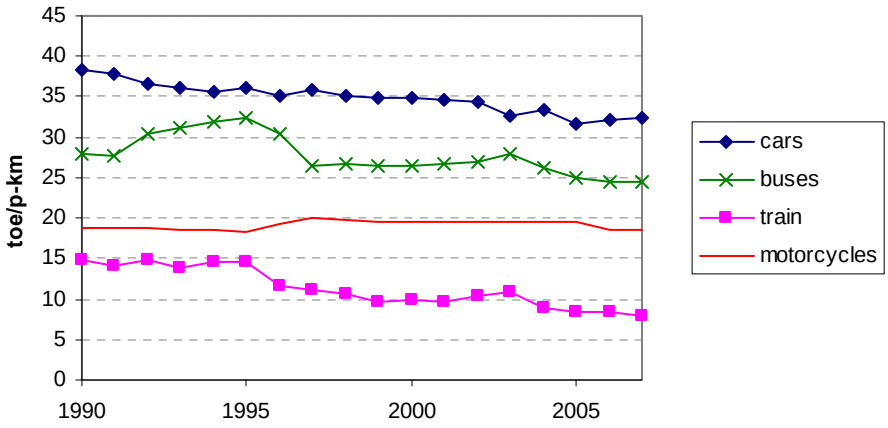


Figure 25 Energy per passenger-km for transport by car, train, bus and motorcycle, 1990-2007.

[3] Transportytelser i Norge 1946-2007, TØI-rapport 979/2008

The unit consumption for transport of goods on roads has been more efficient since the mid-1990s until 2004, but has increased again at the end of the period. Road transport of goods uses much more energy per ton of km transported than transport by rail, see Figure 26.

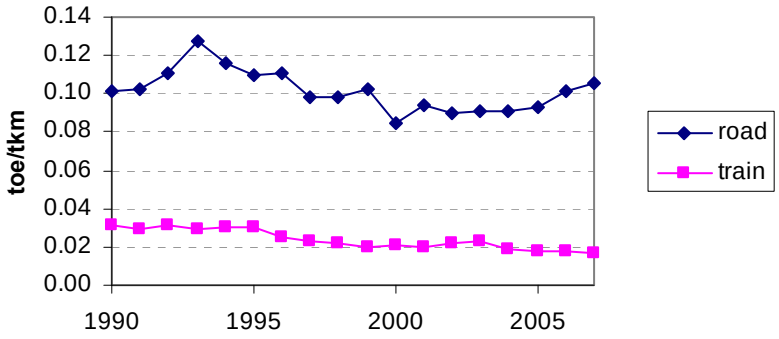


Figure 26 Unit consumption for freight modes (toe/tkm) 1990-2007

3.6 Assessment of energy efficiency/savings through ODEX: total and by sector

In order to assess the actual results of energy efficiency policies and measures, it is necessary to use a bottom-up approach, i.e. to start from the achievements observed for the main energy end-uses and appliances, and to compile them into an aggregate **bottom-up energy efficiency index, ODEX**, (all end-uses and appliances being weighted according to their weight in the total final consumption). This energy efficiency index aggregates the trends in the detailed bottom-up indicators (by end-use and equipment) in a single indicator. It provides somehow a substitute indicator to energy intensities (industry and transport) or unit consumption (per dwelling for households) to describe the overall trends by sector.

Energy efficiency policies and measures implemented since 1990 have contributed to improve the efficiency by 13 %, or 0.7 % per year, see Figure 27. This means that if these policies and measures would not have been implemented, the final energy consumption would have been 13 % higher in 2007 (approximately 1.9 Mtoe or 22 TWh).

The development has been positive for all sectors, according to the selected indicators. The energy efficiency index in industry decreased from 1990 to 1996, and then there was a slight increase followed by a decrease from 2000 to 2007. The transport sector

was first constant and then shows improvements in energy efficiency from 1994 to 2004, followed by an increase in the end of the period. The household sector has a rather constant improvement after 1992 until 2001 when the energy efficiency rapidly improved until 2005.

In order to calculate the ODEX of the household sector, the energy consumption should be known for end-use sectors as space heating, hot water, cooking and large appliances. Since this data is not available in Norway, the calculations are simplified and based on estimates. The household ODEX is therefore to be regarded as an estimate of the development in the sector.

The ODEX of the industry sector is weighted with the shares of energy consumption of the sub-sectors. Important sectors in Norwegian industry then become the chemical, primary metals and paper industry. In the chemical industry there have been major structural changes, which not are fully reflected in the production index. This leads to a high increase in energy intensity of the chemical sector and a quite small overall reduction in the manufacturing industry.

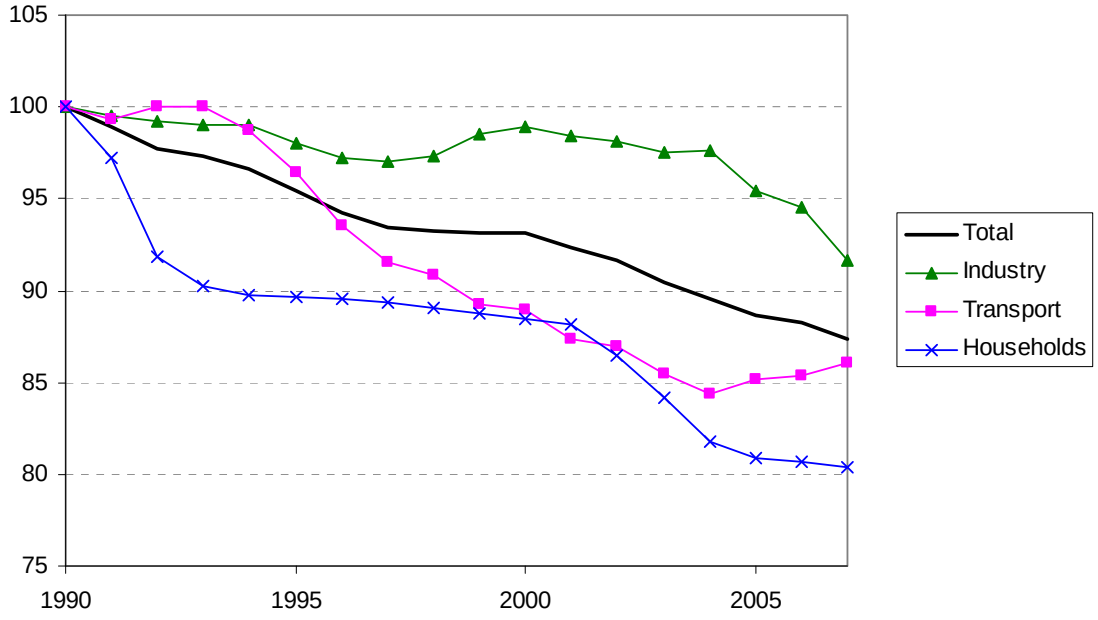


Figure 27 Energy efficiency progress (at normal climate), ODEX total, industry, transport and households 1990-2007

ODEX

ODEX stands for „ODYSSEE energy efficiency index".

ODEX by sector is calculated from unit consumption trends by sub-sector:

- By aggregation of unit consumption indices by sub-sector in one index for the sector on the basis of the current weight of each sub-sector in the sectors energy consumption
- Unit consumption by sub-sector is expressed in different physical units so as to be as close as possible to energy efficiency evaluation; toe/m², kWh/appliance, toe/ton, litre/100 km...)
- Energy efficiency gains are measured in relation to the previous year („sliding ODEX") and not to a base year (e.g. 1990), so as to avoid to have results influenced by the situation of the base year.

3.7 CO_2-emissions trends

The CO2-emissions from the household, transport and industry sector have in total increased by 3.9 Mt from 1990 to 2007. Due to increased activity, like more dwellings, more tons of gods transported, more person-km driven, the CO2-emissions would have increased by 7.6 Mt if no improvements of energy efficiency or structural changes had occurred. As shown in Figure 28, the CO2-savings can be calculated to 3.8 Mt. The figure presents changes from 1990 to 2007 for the household and transport sector and from 1990 to 2006 for the industry sector.

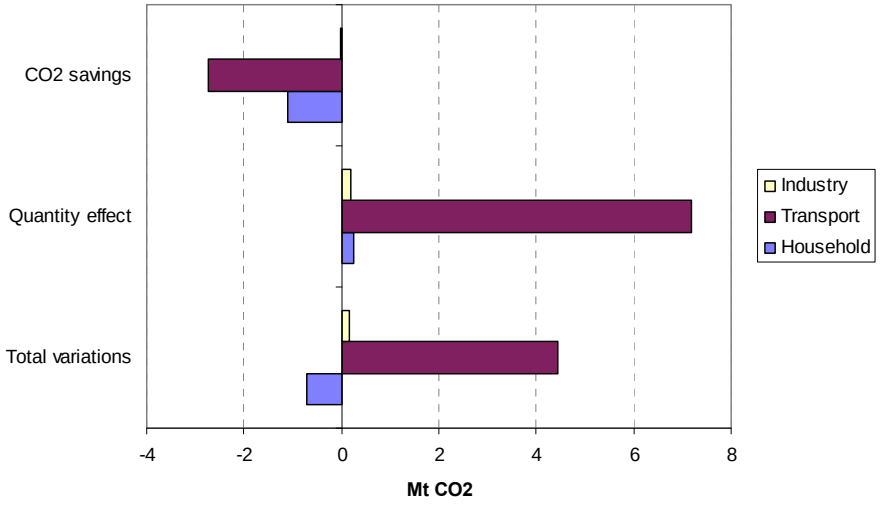


Figure 28 Variations in CO2 emissions in the household, transport and industry sector and the effect of changes in quantity (activity) and savings in CO2-emissions from 1990 to 2007 (2006 for industry)(Mt CO2)

The transport sector has highest increase in CO2-emissions, due to a large increase in activity (tons of gods and passenger transported). This sector also has the highest savings of CO2-emissions, calculated to 2.7 Mt.

In industry the variations in CO2-emissions are small and can be explained by changes in activity. The structural changes are not separated from the CO2-savings.

In total the CO2 emissions from the household sector has decreased by 0.7 Mt from 1990 to 2007, see Figure 29. The effect of climate and more dwellings should have resulted in increased CO2 emission of 0.4 Mt. In total the savings in CO2 emissions is then 1.1 Mt. Most of this is due to substitution (0.9 Mt); less use of fuel oil and more use of electricity, wood and district heat. The effect of unit consumption per dwelling contributes with a saving of 0.2 Mt.

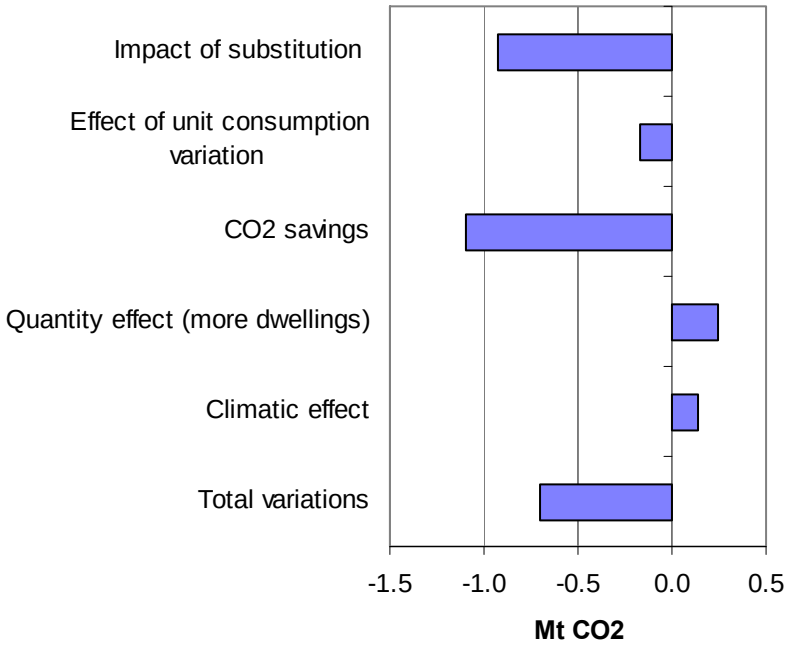


Figure 29 Interpretation of CO2 emissions variations in households in 2007 compared to 1990 (Mt CO2)

4 Energy efficiency measures

4.1 Recent Energy Efficiency Measures

Residential Sector

Grants for electricity savings in households. The autumn 2006 the parliament introduced a new grant scheme with the objective to reduce the electricity consumption in households and this programme is still running. The target group of the grant scheme is private households. They can apply for grants for investments in heat pumps (not air-to-air heat pumps), pellets boilers, fireplaces using pellets and electric heating control devices. The grant is restricted to 20 % of the investment costs or a maximum grant of 4000 NOK (approximate 500 €) for boilers or fireplaces using pellets or for heating control devices and a maximum of 10 000 NOK (approximate 1250 €) for heat pumps (not air-to-air heat pumps). A similar grant scheme was in use in the spring 2003.

Energy information helpline Information and advice are provided free of charge through a national energy information helpline. The information helpline covers all the country and may be contacted by telephone, e-mail or Internet. The helpline is operated from 8 a.m. to 4 p.m. and during campaigns the operating time is enlarged. Private people may free of charge get energy advices, publications or other information material. Questions sent by e-mail are guaranteed an answer within 24 hours.

"Regnmakerne" An important objective of this measure is to teach children and youths how they easily can save energy by checking the stand-by use of appliance, reduce unnecessary heating, check energy labelling etc. A "regnmaker" is a person that is particularly interested in decreasing people's energy use, basically use resources as wind-, water- and solar energy and is engaged in environmental aspects on earth. One can sign up for free at their homepage www.regnmakerne.no to become a member and receive information, posters, and surprises and get access to their online club room to learn more about sustainable energy use. Books about "Regnmakerne" are written by Klaus Hagerup and are sent for free to all Norwegian schools (6th grade) and may be used in the education together with other material. Together with the educational directorate and the centre for environmental science (Naturfagsenteret), Enova introduced a programme for energy and environment learning in the school system. By working through a set of different tasks, the school can be addressed a "Regnmaker" school. Ten of the "Regnmaker" schools win a grant of 10 000 NOK and a "Regnmaker" school of the year will be chosen. The concept has been adapted by several

European countries. The page www.rainmakers-eu.eu is a portal to all of the Rainmakers in Europe.

Measures covering the entire building sector as e.g. building regulations are described under the section “tertiary”.

Transport Sector

Many measures in the transport sector in Norway are local measures like road pricing, reduced speed limits in specific areas due to environmental reasons, tax for use of studded tyres in city centre etc. The duties on petrol and diesel, as well as the registration tax on vehicles, are high.

Transnova In 2009, the Ministry of Transport and Communications established a three years pilot scheme in order to reduce the CO2-emissions from the transport sector. The government is aiming at making it a permanent scheme when the pilot phase is over. The main objective of Transnova is to contribute to substitution of fossil fuels with low or non-emission fuels. Secondary goals might be to encourage more environmental friendly transportation or to reduce the transportation. Infrastructure projects will not be supported.

Reward scheme for better public transportation and reduced use of cars in cities The objective of the scheme is to stimulate to a more trafficable area, better environment and health in the large city areas, by suppressing the growth in need for transportations and increase the number of public transportations at the sacrifice of transportation by private cars. The larger cities get the opportunity to apply for support to transportation measures in order to solve the transportation challenges in the different city areas. The applicants have to present specific plans (the first years of the scheme) and gradually results, with the aim to solve local challenges in association with transportation and environment. A local transportation policy that contributes to limitation of the use of private cars and increases the use of public transportation is a central factor in the assignment of funds from the reward scheme.

Measures to be supported could mainly be divided in three areas:

1. Measures to reduce the use of private cars
2. Measures for planning of land use and transportation that is more in favour of public transportations
3. Measures to make the public transportation more attractive

Industrial Sector

Energy consumption - industry. Enova is working to boost the competitiveness of Norwegian industry through environmentally friendly and efficient energy use. In the course of 2005 Enova extended its main programme oriented towards Norwegian on-shore industry. Via the programme "Reduced energy use – industry", all companies that have projects with total potential energy results of more than 0.5 GWh can apply for investment support.

Projects that can be supported are energy-efficient solutions or processes, measures for energy recovery or use of waste heat and conversion to renewable energy sources. The maximum grant level is 20 % of approved project costs.

The companies have to report energy consumption and production figures to Enova at least five years after the project is finished. As a part of the program, Enova gathers energy consumption and production figures in a database. The companies have to once a year report their figures on a web-based reporting scheme. Enova calculates specific energy consumption for different industry sectors and presents the anonymous data on web. These benchmarking figures may be used to compare the company with other similar companies or with their own historical figures (see http://www.enova.no/industrinettverk/).

Energy efficiency in energy intensive industry. Pulp and paper companies are offered the possibility to participate in a five-year programme, which requires that certain energy efficiency obligations are fulfilled, and stipulates penalty arrangements in case the obligations are not fulfilled. These commitments are considered to replace the steering effect of the electricity tax, and the companies are therefore granted a full exemption from the electricity tax on electricity used in the industrial production process during the programme period.

The objective of the tax exemption is to achieve a more efficient use of energy. The motivation for the programme is to establish a system for improving energy efficiency in companies characterised by high energy consumption and where the potential for savings is therefore significant, if the companies were given an incentive to take energy saving measures during a five-year period because they would receive a tax relief.

Emission trading. A trading system for greenhouse gas emissions entered into force 1 January 2005 and the concept is in line with the EU emission trading system. As from 2008 the Norwegian system is a part of the EU emission trading system. The emission trading system stimulates the industry, to reduce their climate gas emissions. Companies are assigned emission quotas based on historical emissions in 1998-2001. Indus-

tries included in the emission trading system are oil refineries, iron and steel, cement and lime industry, pulp and paper industry, glass industry as well as several energy production plants. In the first period of the emission trading system, 2005-2007, emissions from energy use covered by the CO2-tax was not included. The new system includes e.g. emissions from offshore petroleum activities that were not included in the previous system. The trading system includes approximately 40% of all climate gas emissions in 2008-2012.

Tertiary Sector

Building regulations The objective of the plan and building regulations is that planning in accordance to the law will arrange coordination of national, regional and local activities and be a foundation for decisions on use and protection of resources, development, and secure aesthetic considerations. The measure is valid for the whole country without differences between regions. The scope and extent of the regulation is all types constructions and products for constructions. The current law entered into force for the first time 1 July 1986 and was amended in 1997 and in 2007. In February 2008 the regulation was changed to partly implement EU directive 2002/91/EC concerning energy efficiency and energy use in buildings. The new building regulation is calculated to reduce the energy demand by 25 % in new buildings.

Grants for energy savings in homes, buildings and outdoor equipment areas. In order to achieve better communication with the market actors in the homes, buildings and outdoor equipment areas, Enova changed the programme structure in these areas from several sub-programmes to a single overall programme in 2005. The idea was to make it simpler for the actors, by having everyone wanting to apply for support for their projects deal only with a single programme. The target group for the programme is people who take decisions and make investments in projects with energy targets. Advisers, architects, contractors, manufacturers and suppliers of goods serve as driving forces for the development and implementation of these projects.

Projects that can be supported are investments with a minimum of 10 % savings of energy in buildings, portfolio of buildings, outdoor equipment like road lighting, railways, sports grounds, water works, sewage treatment plant and waste management. Grants are also given to prototype projects covering the extra cost of the project to achieve the energy goal. These projects could be rehabilitation or new buildings (both dwellings and non-residential buildings). The energy goal has to be at least 50 % below normal standard. The grant has to be a triggering factor.

In 2009, an extraordinary program “Grants to energy efficiency measures in public buildings in 2009” that will contribute to new measures, started. The objective of the

program is to contribute to employment in the construction sector at the same time as increasing energy efficiency in public buildings.

Cross-cutting measures

Energy fund ENOVA SF administrates the Energy Fund (Energifondet). The income of the energy fund comes from a levy of 1 øre/kWh (0.008 Euro/kWh) to the distribution tariffs that is mandatory and from allocation from the state budget. In order to strengthen the priority area of the Fund, the government established a new fund called "statutory fund of energy conservation and renewable energy" in 2007, funded over the state budget. ENOVA chooses the measures and administrate the fund in order to achieve the national goals in the best way. The energy fund is used to project related measures as purchasing services, payment of grants and other financing of measures in the field of consumption, environmentally friendly heat, wind and natural gas. The fund supports projects in industry, the tertiary sector, the household sector as well as production of new, renewable energy.

4.2 Patterns and Dynamics of Energy Efficiency Measures

The graphs in this section are a product of the MURE database (see description of MURE in the box below). The spider graphs below presents the number of type of measures started in the period after Enova was established (2001-) and the measures started in the period 1993-2000. If a measure is linked to more than one type of measure, each type is counted. The figures present the number of measures, not weighted by quantitative impact. For the importance of measures, see 4.4. The graphs only show the number of measures that is started in the two periods and measures started before the actual period and still ongoing are not included. A box explaining the abbreviations used in the graphs are at the end of this chapter.

In all sectors the number of financial measure has increased after 2000.

The MURE database

The MURE database (www.mure2.com) provides an overview of the most important energy efficiency policy measures by sector (households, industry, transport and tertiary), as well as general or cross-cutting measures. Information about these measures is collected by national energy agencies or institutes according to harmonised guidelines. The measures are classified according to various criteria:

- their status (completed, ongoing or planned);
- their year of introduction and completion;
- their type: legislative/normative (e.g. standards for new dwellings), legislative/informative (e.g. obligatory labels for appliances), financial (e.g. subsidies), fiscal (e.g. tax deductions), information/education, co-operative (e.g. voluntary agreements) and taxes (on energy or CO2-emissions).
- their qualitative impact: low, medium or high impact, based on quantitative evaluations or expert estimates (see methodological issues)
- the targeted energy users, the actors involved, etc.

For each policy measure a detailed description is available which contains, if available, a quantitative impact in terms of energy savings and/or CO2 emission reduction.

Residential Sector

In the residential sector, most of the measures after 2001 are financial, see Figure 30. Before 2001, the measures were more of the type information and legislative. After 2000 a total of 7 measures are introduced in the household sector. Four of these are financial measures and since some of them also are linked to more than one type of measure, this increases the number of measures to a total of 11. Even if the numbers of legislative measures are lower after 2000, the importance is high. The only legislative measure after 2000 is the new building regulations and before 2000 there were in addition to building regulations, minimum energy efficiency standards of boilers and energy efficiency requirements on refrigerators etc. Energy efficiency label schemes are of the type legislative/informative.

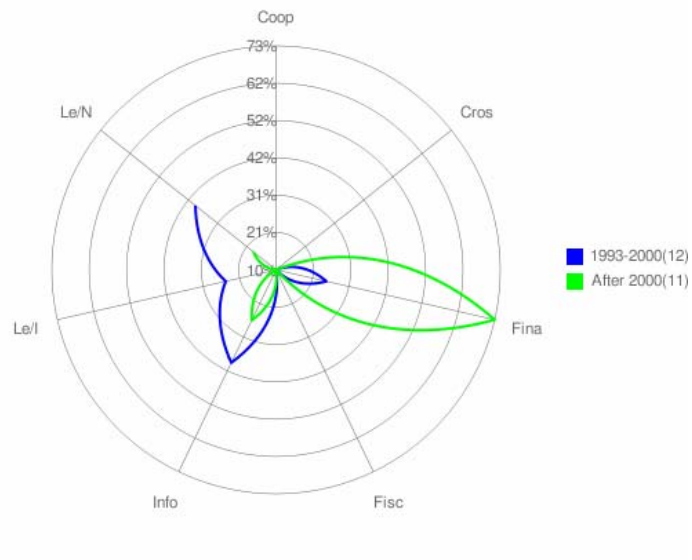


Figure 30 Energy efficiency measure patterns residential sector: development of measure by type over time

Transport Sector

The types of measures in the transport sector were mostly of legislative and infrastructure before 2001, see Figure 31. After 2000, there are two measures; the establishment of Transnova and the reward scheme for better public transportation and reduced use of cars in cities. Since the first measure is linked to several types of measures, the total of measures increase to 8 after 2000 and the focus on information measures increases at the same time as the legislative/normative measures decrease.

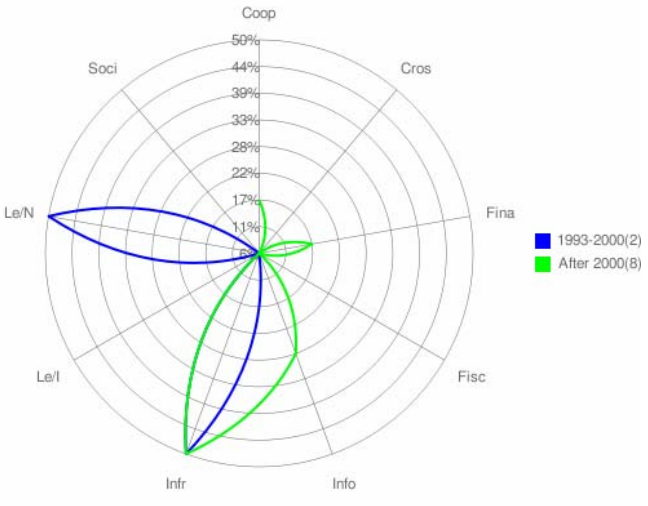


Figure 31 Energy efficiency measure patterns transport sector: development of measure by type over time

Industrial Sector

The types of measures in the industry sector are dominated by financial measures, both before and after 2000, see Figure 32. In the period 1993-2000 the only measures introduced are of the financial type, while also other measures are introduced after 2000.

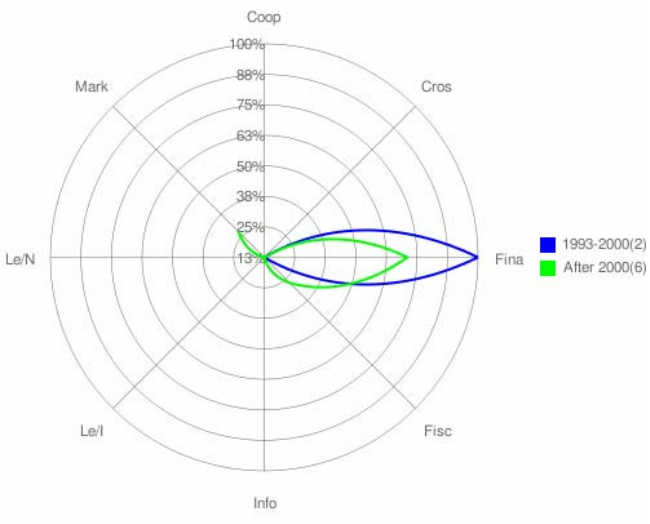


Figure 32 Energy efficiency measure patterns industry sector: development of measure by type over time

Tertiary Sector

In the tertiary sector, measures of the financial type are more frequent after 2000, see Figure 33. Before 2001, legislative and cooperative measures were also introduced.

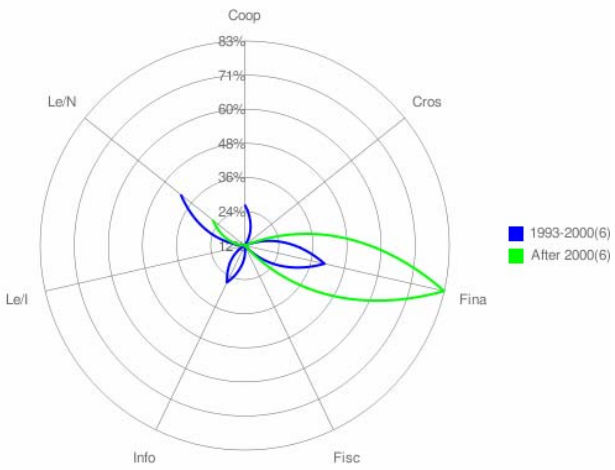


Figure 33 Energy efficiency measure patterns tertiary sector: development of measure by type over time

Cross-cutting measures

There are only a few Norwegian cross-cutting measures in the MURE database. In the period 1993-2000 it it's the Norwegian energy policy as described in the white paper of 1999. The two measures of the present period are Local energy studies and the Energy Fund that is funding many of the measures in the different sectors and is of high importance.

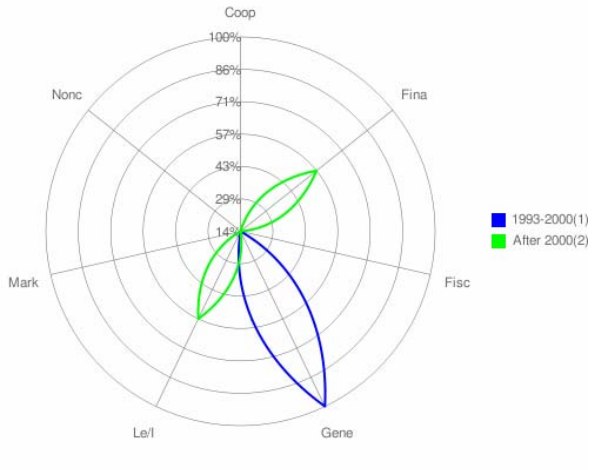


Figure 34 Energy efficiency measure patterns general cross-cutting sector: development of measure by type over time

Abbreviations used in the spider graphs:

Coop: Co-operative Measures

Cros: Cross-cutting with sector-specific characteristics

Fina: Financial

Fisc: Fiscal/Tariffs

Gene: General Energy Efficiency / Climate Change / Renewable Programmes

Info: Information/Education

Infr: Infrastructure

Le/I: Legislative/Informative

Le/N: Legislative/Normative

Mark: Market-based Instruments

Nonc: Non-classified Measure Types

Soci: SocialPlanning/Organisational

4.3 Innovative Energy Efficiency Measures

As a part of the Enova programs for industry, the companies have to report energy consumption and production figures to Enova at least five years after the project is finished. Enova gathers energy consumption and production figures in a database. The companies have to once a year report their figures on a web-based reporting scheme. The benchmarking scheme is open for all industry plants, not only those participating in one of the industry programs.

Enova calculates specific energy consumption for different industry sectors and presents the anonymous data on web. Benchmarking is based on comparing the SEC (e.g. kWh/kg) of the companies. SEC is calculated according to total energy use and total production of the site. To date, 43 different benchmark groups have been established among the 800 participating companies that once a year report their figures for energy and volume of production into the web-application. Because one factory usually produces different products with different energy intensities, weighting factors are used to normalise these differences in some of the groups. More information can be found at http://www.enova.no/industrinettverk/ .

Earlier, this reporting was part of the Norwegian Energy Efficiency Network and the annual reporting was based on paper forms. The reporting started in 1990 with three industrial branches and has been enlarged year by year.

In the EIE-project BESS, a web-based tool for international benchmarking of key indicators for selected sectors within the European food and drink industry is developed.

The tool which is currently tested by pilot companies from the dairy, bakery and meat industries within the BESS project builds upon the Norwegian benchmarking system. The primary objective of the BESS project is to promote widespread use of best practice energy management and benchmarking tools and to improve energy efficiency in industrial small and medium-sized enterprises (SMEs), with particular focus on the food and drinks industry. For more information, see http://www.bess-project.info.

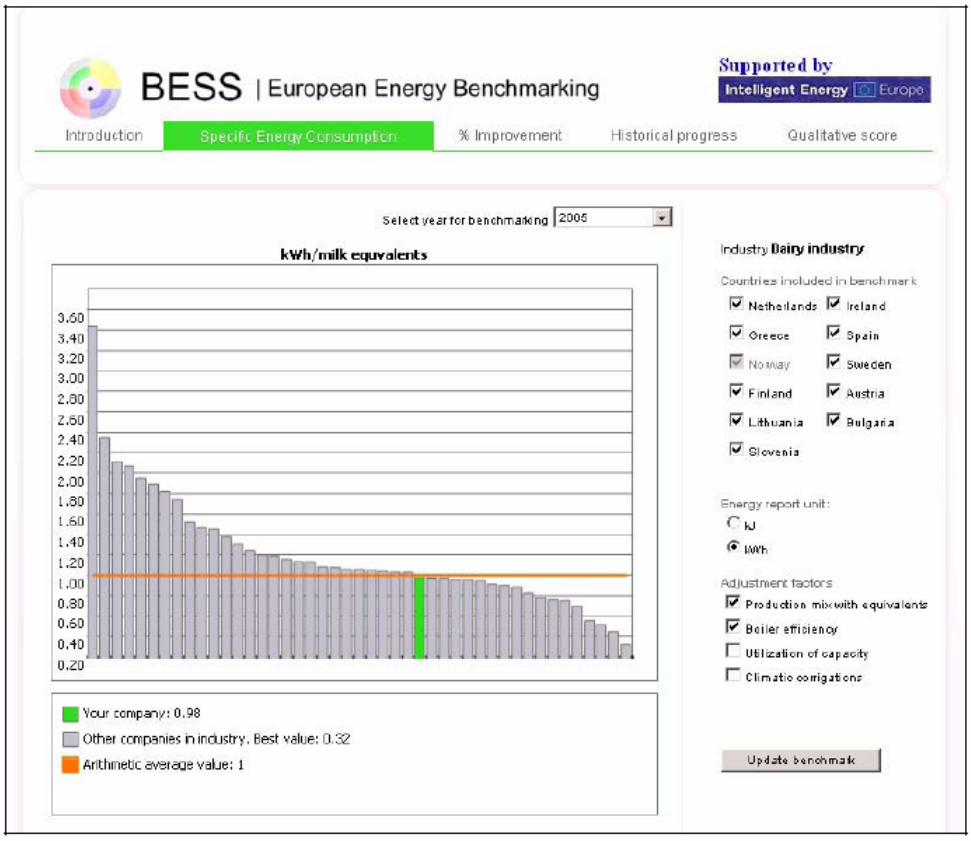


Figure 35 Example of specific energy consumption graph of the BESS system

Enova also has a benchmarking system for the building sectors, as a part of the Norwegian Building Network. The network is based on support to building owners that cooperate in networks based on energy efficiency agreements with the authorities. Through network processes based on energy efficiency agreements, building owners and users will increase their knowledge in energy efficiency to make the right decisions. The main target groups are private and public owners of non-residential buildings and housing associations.

A complete network process qualifies for membership in the Building Network. In return, the building owners must report energy use annually for a selection of building objects. Support in research and development projects, information and training

schemes and in test construction is also provided. Energy statistics are an integrated part of the activities in the Building Network. The objective is to give the players a tool in the work of planning and managing buildings.

4.4 Energy efficiency measure evaluations

4.4.1 Semi-quantitative Impact Estimates of Energy Efficiency Measures

In the measure descriptions, which are included in the MURE database, information related to the impact evaluation of a measure is included. If a quantitative evaluation is available, the methods used and the results of the evaluation are provided, including as far as possible the impacts in terms of energy savings and CO2 savings. If no quantitative evaluation is available, or in addition to the quantitative evaluation, a qualitative expert judgement is reported, too, namely an assessment of the measure's impact (high/medium/low) in terms of energy and CO2 savings. The definition of the impact level is described in the box below. In the following, tables listing all ongoing measures in the different sectors are presented. The lists include title, type and semi-quantitative impact of the measures.

Definition of the (semi-quantitative) impact level

In general: definition of the impact in terms of final energy. All electricity savings should be linked only to electricity, all other savings (except for those involving fuel substitution and CHP) to the overall final energy consumption.

Fuel substitution and CHP savings: the savings should be linked to the primary energy, calculated with a fixed factor of 2.5.

The categories (low, medium, high) should be linked to the aggregate electricity or energy consumption of the respective sector (households, transport, industry or tertiary), and not to a particular end-use, because the aggregation of the impacts is easier.

The following limits (in each case in % of the overall final energy or electricity consumption of the sector; in case of fuel substitution and CHP: of primary energy consumption) are defined for the three impact levels:

- **low impact: <0.1 %**

- medium impact: 0.1-<0.5 %

- high impact: ≥0.5 %)

Table 3 lists all ongoing measures in the Norwegian household sector. It is a total of 14 measures and two of the measures are regarded as of high importance, five of medium

importance and eight of low importance. The new building regulations and informative billing are the two measures with high importance.

Table 3 Impact of ongoing measures in the household sector

Title	Type	Semi-quantitative Impact
Building regulations 2007 (Byggeforskrift 2007)	Legislative/Normative	High
Energy Act on informative billing (Energiloven)	Information/Education	High
Environmental taxes	Cross-cutting with sector-specific characteristics	Medium
Energy taxes	Cross-cutting with sector-specific characteristics	Medium
Local energy efficiency fund in Oslo (Enøkfondet i Oslo)	Financial	Medium
Grants for energy savings in the built environment (Bygg, bolig og anlegg)	Financial	Medium
Energy efficiency requirements on refrigerators, freezers and their combinations	Legislative/Normative	Medium
Energy saving loans (Husbanken)	Financial	Low
Grants for electricity savings in households (Tilskuddsordningen i husholdningene)	Financial	Low
Energy information helpline (Enovas svartjeneste)	Information/Education	Low
Educational awareness program for children about energy use and environmental impacts (Regnmakerne)	Information/Education	Low
Energy efficiency label scheme for domestic appliances (Energimerking)	Legislative/Informative	Low
Energy efficiency label scheme for residential lighting	Legislative/Informative	Low
Minimum energy efficiency standards for boilers	Legislative/Normative	Low

The list of ongoing measures in the transport sector is shown in Table 4. Many measures in the transport sector in Norway are local measures like road pricing, reduced speed limits in specific areas due to environmental reasons, tax for use of studded tyres in city centre etc. and these are not included, since only national measures are included.

Speed limits are regarded as the measure with the highest impact in the transport sector, followed by fiscal measures as purchase tax on vehicles and taxes on gasoline and auto diesel.

Table 4 Impact of ongoing measures in the transport sector

Title	Type	Semi-quantitative Impact
Speed limits	Legislative/Normative	High
Purchase tax on vehicles (Engangsavgift på motorvogner)	Fiscal	Medium
Taxes on gasoline and auto diesel oil	Fiscal	Medium
Energy labelling of new cars	Legislative/Informative	Low
Semi-annual technical inspection of vehicles	Legislative/Normative	Low
Reward scheme for better public transportation and reduced use of cars in cities (Belønningsordningen)	Infrastructure	Low
Transnova	Co-operative Measures, Financial, Information/ Education/ Training, Infrastructure	Low

There are six ongoing measures in the industry sector, see Table 5. The measure with highest importance is the programme “Energy consumption – industry”.

Table 5 Impact of ongoing measures in the industrial sector

Title	Type	Semi quantitative Impact
Energy Consumption - Industry (Energibruk - industri)	Financial	High
Energy taxes	Cross-cutting with sector-specific characteristics	Medium
Environmental taxes	Cross-cutting with sector-specific characteristics	Medium
Energy efficiency in industry (Program for energieffektivisering i energiintensiv industri)	Fiscal/Tariffs	Medium
Grants to local heating plants (Program for lokale energisentraler)	Financial	Medium
Emission Trading System (Klimakvoteloven)	New Market-based Instruments	Low

The ongoing measures in the tertiary sector are presented in Table 6. There are 11 ongoing measures and the new building regulations are most important. Taxes and some grant schemes are of medium importance.

Table 6 Impact of ongoing measures in the tertiary sector

Title	Type	Semi-quantitative Impact
Building regulations 2007 (Byggeforskrift 2007)	Legislative/Normative	High
Energy taxes	Cross-cutting with sector-specific characteristics	Medium
Environmental taxes	Cross-cutting with sector-specific characteristics	Medium
Grants for energy savings in the built environment (Bygg, bolig og anlegg)	Financial	Medium
Grants to local heating plants (Program for lokale energisentraler)	Financial	Medium
Grants to energy efficiency measures in public buildings in 2009 (Energibruk bygg - tiltak i offentlige bygg 2009)	Financial	Medium
Energy plans in municipalities (Kommunal energi- og klimaplanlegging)	Financial	Low
Local energy efficiency fund in Oslo (Enøkfondet i Oslo)	Financial	Low
Energy statistics of the Norwegian Building Network (Bygningsnettverkets energistatistikk)	Information/Education/Training	Low
Conversion of direct electric heating to central heating (Progam for konvertering av varmeanlegg i bygg - fra elektrisk oppvarming til vannbåren varme)	Financial	Low
Minimum energy efficiency standards for boilers	Legislative/Normative	Low

There are three general cross-cutting measures, as can be seen in Table 7. The measure of high importance is the energy fund that is funding many of the measures in the different sectors.

Table 7 Impact of ongoing measures in the general cross-cutting sector

Title	Type	Semi-quantitative Impact
Energy Fund	Financial Measures	High
Local energy studies (Lokale energiutredninger)	Legislative/Normative Measures	Low
Energy policy	General Energy Efficiency / Climate Change / Renewable Programmes	Low

5 National Developments under the EU Energy Efficiency Directive and the 20% Energy Efficiency Target of the EU

The Energy Efficiency Directive is not yet implemented in Norway. The Norwegian Ministry of Petroleum and Energy are discussing future national developments and measures under the EU Energy Efficiency Directive and the Energy Efficiency Action Plan. New measures to be taken under the Action Plan will not be reported until the Directive is implemented. The Energy Efficiency Directive has been submitted to relevant institutions and organizations in Norway, and the statements are in general positive.

Through the regulations for the Energy Fund (Energifondet) and the already established objectives towards an energy alteration, Norway has measures which contribute to efficient use of energy. According to the methodology used by Enova to day, investments in new energy production capacity and investments in energy savings are equal. New regulations as a consequence of the Energy Efficiency Directive must be considered. The Directive might have administrative, economic and legal consequences, and the Ministry of Petroleum and Energy are assessing the impact.

The key features of the Norwegian energy policy are improved energy efficiency, more flexibility in the energy supply and decreased dependence on direct electricity for heating, and an increased share of renewable energy sources, other than large hydropower, in the energy supply mix.

The Storting, (the Norwegian Parliament) approved in 2004 to implement the Directive 2002/19/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings in Norway. In October 2004 the Norwegian Water Resources and Energy Directorate (NVE) got responsible to implement the directive in Norway and the work with the new law started. An extensive work with the formulation of the legal framework and the practical accomplishment are in progress. The new law was sent out for public hearing from the Royal Ministry of Petroleum and Energy in 2007. A proposal for an energy performance scheme has been on public hearing in 2007 and 2008. The proposal is described in Ot.prp.nr.24 (2008-2009) from the Royal Ministry of Petroleum and Energy and Innst. O. nr. 52. The proposal is not yet passed. In the mean time a mandatory scheme is available.

Annex 1

Energy Efficiency Measure Summary by Country

Definition of the (semi-quantitative) impact level

In general: definition of the impact in terms of final energy. All electricity savings should be linked only to electricity, all other savings (except for those involving fuel substitution and CHP) to the overall final energy consumption.

Fuel substitution and CHP savings: the savings should be linked to the primary energy, calculated with a fixed factor of 2.5.

The categories (low, medium, high) should be linked to the aggregate electricity or energy consumption of the respective sector (households, transport, industry or tertiary), and not to a particular end-use, because the aggregation of the impacts is easier.

The following limits (in each case in % of the overall final energy or electricity consumption of the sector; in case of fuel substitution and CHP: of primary energy consumption) are defined for the three impact levels:

- **low impact: <0.1 %**

- medium impact: 0.1-<0.5 %

- high impact: ≥0.5 %)

Table 8 All Norwegian measures in the household sector of MURE

Code	Title	Status	Type	Starting Year	Ending Year	Semi-quantitative Impact
NOR1	Energy efficiency label scheme for domestic appliances (Energimerking)	Ongoing	Legislative/Informative	1996		Low
NOR2	Local energy efficiency fund in Oslo (Enøkfondet i Oslo)	Ongoing	Financial	1981		Medium
NOR3	Environmental taxes	Ongoing	Cross-cutting with sector-specific characteristics	1991		Medium
NOR4	Building regulations 1987 (Byggeforskrift 1987)	Completed	Legislative/Normative	1987	1997	Medium
NOR5	Energy efficient low energy houses (Energibruk i boliger)	Completed	Financial	2003	2004	Low
NOR6	Energy information helpline (Enovas svartjeneste)	Ongoing	Information/Education	2003		Low
NOR8	Information and education financed by NVE (Opplæring og informasjon)	Completed	Information/Education	1990	2001	Low
NOR10	Energy taxes	Ongoing	Cross-cutting with sector-specific characteristics	1975		Medium
NOR11	Mandatory Energy Efficiency Activities through Regional Energy Efficiency Centres (Lovpålagt enøk - Regionale enøksentra)	Completed	Information/Education	1994	2001	Low
NOR12	Energy saving loans (Husbanken)	Ongoing	Financial	1996		Low
NOR14	Grants to electricity savings in households (Elsparetiltak i husholdningene)	Completed	Financial	2003	2003	Low
NOR15	Energy efficiency label scheme for residential lighting	Ongoing	Legislative/Informative	1999		Low
NOR16	Building Regulations 1997 (Byggeforskrift 1997)	Completed	Legislative/Normative	1997	2008	Medium
NOR17	Energy Act on informative billing (Energiloven)	Ongoing	Information/Education	1999		High

NOR18	Simple Energy Audit (Enøk-sjekken)	Ongoing	Information/Education	1997	2006	Low
NOR19	Energy performance of buildings (Bygningsenergidirektivet)	Proposed (advanced)	Legislative/Informative			High
NOR20	Energy efficiency requirements on refrigerators, freezers and their combinations	Ongoing	Legislative/Normative	1999		Medium
NOR21	EcoBuild support scheme (ØkoBygg-programmet)	Completed	Financial	1998	2002	Medium
NOR22	Grants for electricity savings in households (Tilskuddsordningen i husholdningene)	Ongoing	Financial	2006		Low
NOR23	Grants for energy savings in the built environment (Bygg, bolig og anlegg)	Ongoing	Financial	2005		Medium
NOR25	Educational awareness program for children about energy use and environmental impacts (Regnmakerne)	Ongoing	Information/Education	2003		Low
NOR26	Minimum energy efficiency standards for boilers	Ongoing	Legislative/Normative	1998		Low
NOR27	Building regulations 2007 (Byggeforeskrift 2007)	Ongoing	Legislative/Normative	2007		High

Table 9 All Norwegian measures in the transport sector of MURE

Code	Title	Status	Type	Starting Year	Ending Year	Semi-quantitative Impact
NOR1	Purchase tax on vehicles (Engangsavgift på motorvogner)	Ongoing	Fiscal	1959		Medium
NOR2	Energy labelling of new cars	Ongoing	Legislative/Informative	2001		Low
NOR3	Taxes on gasoline and auto diesel oil	Ongoing	Fiscal	1986		Medium
NOR4	Speed limits	Ongoing	Legislative/Normative	1965		High

NOR5	Semi-annual technical inspection of vehicles	Ongoing	Legislative/Normative	1998		Low
NOR6	Reward scheme for better public transportation and reduced use of cars in cities (Belønning-sordningen)	Ongoing	Infrastructure	2004		Low
NOR7	Public transport packages	Completed	Infrastructure	1996	2000	Low
NOR8	Transnova	Ongoing	Co-operative Measures , Financial, Information/Education/Training, Infrastructure	2009		Low

Table 10 All Norwegian measures in the industry sector of MURE

Code	Title	Status	Type	Starting Year	Ending Year	Semi-quantitative Impact
NOR1	Energy taxes	Ongoing	Cross-cutting with sector-specific characteristics	1975		Medium
NOR2	Market introduction of energy efficient technologies	Completed	Financial	1994	2002	Medium
NOR3	Pilot and demonstration projects in industry (PEI)	Completed	Financial	1990	1993	Low
NOR4	Investment grants for energy-saving measures (Tilskuddsordningen)	Completed	Financial	1990	1993	High
NOR5	Audits: Cleaner technology and energy efficiency in industry (RENOK)	Completed	Information/Education/Training	1991	1994	Low
NOR6	Demonstration programme: Energy in industry (EII)	Completed	Financial	1986	1989	Low

NOR7	Environmental taxes	Ongoing	Cross-cutting with sector-specific characteristics	1991		Medium
NOR8	Energy efficiency in industry (Program for energieffektivisering i energiintensiv industri)	Ongoing	Fiscal/Tariffs	2005	2014	Medium
NOR10	Research programme: Energy efficient technologies in industry (EEI)	Completed	Financial	1992	1994	Low
NOR11	Norwegian industrial energy efficiency network	Completed	Financial, Information/Education/Training	1989	2002	High
NOR12	Grants to heating plants	Completed	Financial	1997	2007	Medium
NOR13	Emission Trading System (Klimakvoteloven)	Ongoing	New Market-based Instruments	2005		Low
NOR14	Energy management – companies in networks (Energistyring – bedrifter i nettverk)	Completed	Financial	2003	2007	High
NOR15	Energy Consumption - Industry (Energibruk - industri)	Ongoing	Financial	2003		High
NOR16	Grants to local heating plants (Program for lokale energisentraler)	Ongoing	Financial	2008		Medium

Table 11 All Norwegian measures in the tertiary sector of MURE

Code	Title	Status	Type	Starting Year	Ending Year	Semi-quantitative Impact
NOR1	Norwegian Building Network	Completed	Co-operative Measures	1996	2004	High
NOR2	Information and education financed by NVE	Completed	Information/Education/Training	1990	2001	Low
NOR3	Building regulations 1987 (Byggeforskrift 1987)	Completed	Legislative/Normative	1987	1997	Medium
NOR4	Energy taxes	Ongoing	Cross-cutting with sector-specific characteristics	1975		Medium

NOR5	Building Regulations 1997 (Byggeforskrift 1997)	Completed	Legislative/Normative	1997	2008	Medium
NOR6	Energy performance of buildings (Bygningsenergidirektivet)	Proposed (advanced)	Legislative/Informative			High
NOR7	Market introduction of energy efficient technologies	Completed	Financial	1994	2002	Low
NOR8	Investment grants for energy-saving measures (Tilskuddsordningen)	Completed	Financial	1990	1993	High
NOR9	Environmental taxes	Ongoing	Cross-cutting with sector-specific characteristics	1991		Medium
NOR10	Mandatory Energy Efficiency Activities through Regional Energy Efficiency Centres (Lovpålagt enøk - Regionale enøksentra)	Completed	Information/Education/Training	1991	2001	Low
NOR12	Grants to heating plants	Completed	Financial	1997	2007	Medium
NOR13	Energy plans in municipalities (Kommunal energi- og klimaplanlegging)	Ongoing	Financial	2005		Low
NOR14	Grants for energy savings in the built environment (Bygg, bolig og anlegg)	Ongoing	Financial	2005		Medium
NOR15	Local energy efficiency fund in Oslo (Enøkfondet i Oslo)	Ongoing	Financial	1981		Low
NOR16	Energy statistics of the Norwegian Building Network (Bygningsnettverkets energistatistikk)	Ongoing	Information/Education/Training	1997		Low
NOR17	Grants to local heating plants (Program for lokale energisentraler)	Ongoing	Financial	2008		Medium
NOR18	Grants to energy efficiency measures in public buildings in 2009 (Energibruk bygg - tiltak i offentlige bygg 2009)	Ongoing	Financial	2009	2009	Medium
NOR19	Conversion of direct electric heating to central heating (Progam for konvertering av varmeanlegg i bygg - fra elektrisk oppvarming til vannbåren varme)	Ongoing	Financial	2009		Low

NOR20	Minimum energy efficiency standards for boilers	Ongoing	Legislative/Normative	1999		Low
NOR21	Building regulations 2007 (Byggeforskrift 2007)	Ongoing	Legislative/Normative	2007		High

Table 12 All Norwegian measures in the cross-cutting sector of MURE

Code	Title	Status	Type	Starting Year	Ending Year	Semi-quantitative Impact
NOR1	Energy Fund	Ongoing	Financial Measures	2002		High
NOR2	Local energy studies (Lokale energiutredninger)	Ongoing	Legislative/Normative Measures	2003		Low
NOR4	Energy policy	Ongoing	General Energy Efficiency / Climate Change / Renewable Programmes	2000		Low

Annex 2

Country Profile

Energy Efficiency Profile : Norway

October 2008

Energy Efficiency Trends

Overview

In the period 1990-2006 the energy efficiency bottom-up index for the whole economy (ODEX) decreased by 13 % (11% for the EU since 1997). The improvement has been greatest in the transport and household sectors, while the industry sector has a smaller increase in efficiency.

Industry

The efficiency in the industrial sector (measured at the level of 10 branches - in terms of energy used per production index or per ton - and aggregated to the whole sector) has improved by 6 % in the period. Norway has had a strong growth in chemical industry, especially until 2000, increasing the energy consumption more than the production index. After 2000 part of the energy intensive basic chemical industry has decreased the production, resulting in improved energy efficiency. The decrease of efficiency in the chemical industry contributes most negatively to the total energy efficiency in industry while the production of primary metals (mainly aluminium and ferroalloys) has a positive development of 20 %. The pulp and paper industry also shows an increase in energy efficiency from 1990 to 2006, by 13 %.

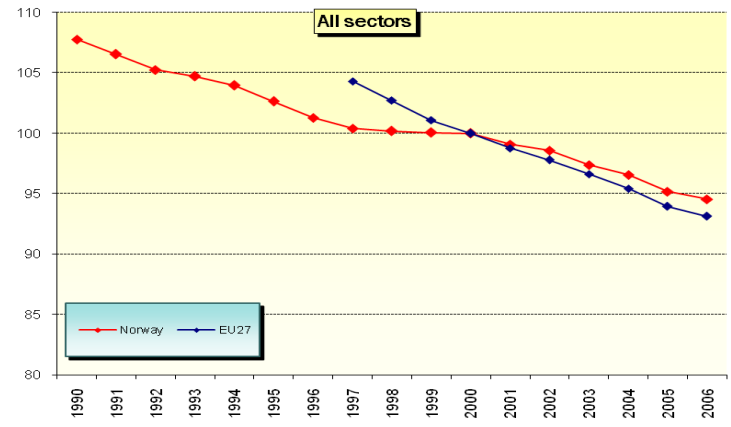
Households

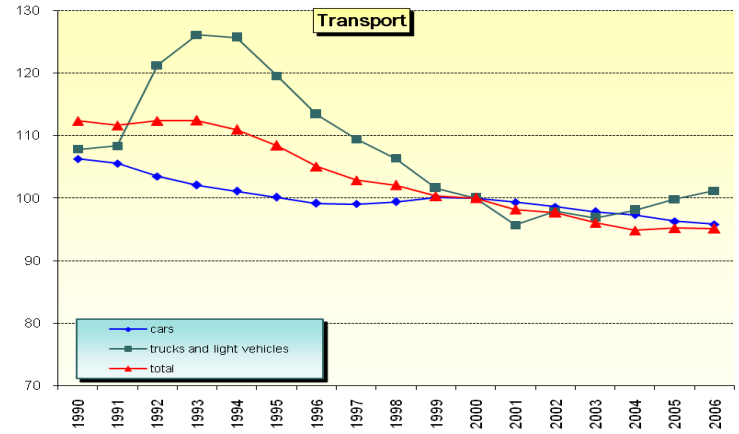
Between 1990 and 2006, the household sector as a whole had an improvement of energy efficiency by 21 %. The household energy efficiency index is calculated based on energy use for space heating per m² and water heating per dwelling. On the whole, the climate corrected energy consumption of the household sector has been stabilizing since the mid 1990s. The unit consumption per square meter and corrected for climate changes, has decreased as well as the energy consumption per dwelling and per capita.

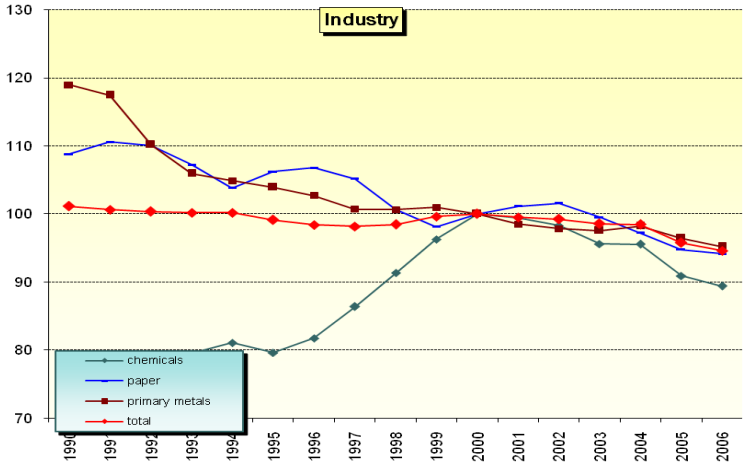
Transport

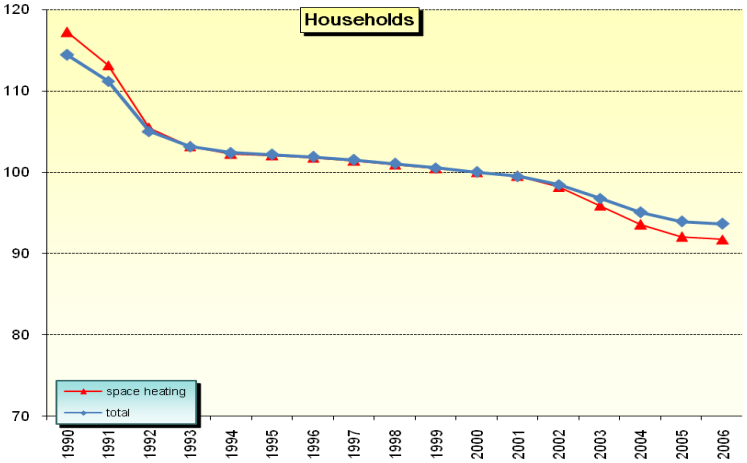
In 2006, the energy efficiency index of the transport sector improved by 15 % compared to the base year 1990. This development is partly caused by the efficiency improvements in the car park as a consequence of the penetration of new, more efficient cars (measured by a specific consumption in l/km) and the dominating role of cars within the transport sector. Unit consumption of trucks and light duty vehicles grew during the early 1990s, while it has decreased after that. Air transport is the third most important transport mode and there has been a large decrease in energy use per passenger travelling by air.

Energy efficiency index, base 100=2000









Source: ODYSSEE data base

Energy Efficiency Policy Measures

Institutions and programmes

The alteration to a more environmental friendly energy production and use in Norway is since 2002 managed by Enova SF. Enova is a public enterprise for promoting energy savings, new renewables and environmentally friendly natural gas solutions which is fully owned by the Government of Norway, represented by the Ministry of Petroleum and Energy. Enova's main mission is to contribute to environmentally sound and rational use and production of energy, relying on financial instruments and incentives to stimulate market actors and mechanisms to achieve national energy policy goals.
Alteration of energy use and production is financed through the Energy Fund. The budget in 2007 was 1277 mill. NOK (160 mill. €). The Energy Fund is primarily financed through a surcharge on the grid tariff for tapping power from the distribution grid (1 øre/kWh).

Industry

Enova is working to boost the competitiveness of Norwegian industry through environmentally friendly and efficient energy use. Companies that have projects with total potential energy results of more than 0.5 GWh can apply for investment support. Projects that can be supported are energy-efficient solutions or processes, measures for energy recovery or use of waste heat conversion to renewable energy sources. The maximum grant level is 20 % of approved project costs.
The companies have to report energy consumption and production figures to Enova at least five years after the project is finished. As a part of the program, Enova gathers energy consumption and production figures in a database. The companies have to once a year report their figures on a web-based reporting scheme. Enova calculates specific energy consumption for different industry sectors and presents the anonymous data on web. These benchmarking figures may be used to compare the company with other similar companies or with their own historical figures (see http://www.enova.no/industrinettverk/).

Households, Services

Enova has a helpline, giving energy savings advices free of charge or distributing information material etc. There is also a special information program for children from 6 to 15 years old, with books, website, networks, competitions etc. Enova SF has developed a programme called "Regnmakerne" that is approaching children and youths to become more aware of energy use and its environmental impacts. A "regnmaker" is a person that is particularly interested in decreasing people's energy use, basically use resources as wind-, water- and solar energy and is engaged in environmental aspects on earth.
Private and public building owners can apply for grants for additional costs in planning, implementation and/or investments in energy efficient buildings. The grant level is normally 0.2-0.50 NOK/kWh (0.02-0.06 €/kWh) saved or produced energy. The Housing Bank administers various loan and grant schemes for residential energy efficiency measures.
Heat production from biomass, waste heat and heat pumps may be supported in order to make the projects profitable. There are also support schemes for biomass processing, heat distribution and for other renewable energy sources.

Transport

The government considers cost-efficiency to be essential in regulating the environmental impact of transport. The duties on petrol and diesel, as well as the registration tax on vehicles, are high. Road pricing is also in use in order to finance road infrastructure and/or to reduce traffic in cities.

Energy prices and taxes

The electricity tax in Norway has been very low in a European perspective (13 €/MWh from 1 January 2007) while mobile energy use is heavily taxed. The CO_2 tax is currently the most important instrument to reduce emissions of greenhouse gases. From 1 January 2005 a Norwegian emission trading system was adopted.

Selected Energy Efficiency Measures

Sectors	Title of Measure	Since	Energy saved
Industry, buildings	Energy fund	2002	10 TWh[1]
Households	Grants to electricity savings in households 2003	2003	0.1 TWh
Households	"Regnmakerne"	2003	
Industry	Norwegian industrial energy efficiency network	1989	0.7 TWh[3]
Buildings	Norwegian building network	1996	0.7 TWh[4]
Transport	Public transport packages	1996	

[1] Based on supported projects in 2001-2007
[2] In the period 1995-2000
[3] In the period 2002-2006
[4] In the period 1996-2002

Source: MURE data base
www.mure2.com

Institute for Energy Technology

ADEME

Enerdata

Fraunhofer ISI Institute Systems and Innovation Research