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Energy Efficiency Policies and Measures in Norway

Institute for Energy Technology

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Report title

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Summary

This report represents the national case study of Norway for the IEE-project "Monitoring of EU and national energy efficiency targets (ODYSSEE-MURE 2010)". 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, transport, 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.

Final energy consumption has increased from 195 TWh in 1990 to 229 TWh in 2010. The last ten years the energy consumption has varied between 212 TWh (2009) and 229 TWh (2010) with an annual average of 221 TWh. The sector using most energy is the industry, but the share has decreased from 40 % in 1990 to 31 % in 2010. From 1990 to 2010 the growth rate has been highest in the transport sector.

Half of the energy end-use was electricity in 2010, 42 % was fossil fuels and 6 % was biomass. The electricity use has an annual increase of 0.8 % since 1990, but the last decade the annual increase is reduced to 0.14 %. The consumption of oil products has decreased in stationary end-use (heating) and increased in the transport sector.

In ODYSSEE, an aggregate bottom-up energy efficiency index, ODEX, is calculated. This energy efficiency index aggregates the trends in the detailed bottom-up indicators in one single indicator. This ODEX has improved by 26 % from 1990 to 2010 or by 1.3 % per year. This means that energy efficiency policies and measures implemented since 1990 have contributed to a decrease in the energy use of 2010 of approximately 59 TWh.

	Name	Signature
Prepared by	Eva Rosenberg	Eva Rosenberg
Reviewed by	Kari Aamodt Espegren	Kari Aa Espegren
Approved by	Martin Kirkengen	

Institute for Energy Technology
P.O. Box 40, NO-2027 Kjeller, Norway
Telephone: +47 63 80 60 00/Telefax: +47 63 81 63 56
http://www.ife.no / firmapost@ife.no

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1 Executive Summary

This report represents the national case study of Norway for the IEE-project “Monitoring of EU and national energy efficiency targets (ODYSSEE-MURE 2010)”. 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, transport, 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.

Final energy consumption has increased from 195 TWh in 1990 to 229 TWh in 2010. The last ten years the energy consumption has varied between 212 TWh (2009) and 229 TWh (2010) with an annual average of 221 TWh. The sector using most energy is the industry, but the share has decreased from 40 % in 1990 to 31 % in 2010. From 1990 to 2010 the growth rate has been highest in the transport sector.

Half of the energy end-use is electricity, 42 % was fossil fuels in 2010 and 6 % was biomass. The electricity use has an annual increase of 0.8 % since 1990, but the last decade the annual increase is reduced to 0.14 %. The consumption of oil products has decreased in stationary end-use (heating) and increased in the transport sector.

The energy consumption in industry was at the highest in 2000 and reached a minimum in 2009, due to the recession. In 2010 the energy consumption increased again but was still below the average of the previous years. Decreased activity in the aluminium production was the most important factor to the decreased energy consumption in industry in 2009. In chemical industry, the sub-sector with the second highest energy consumption after non-ferrous metals, the effect of the financial crisis on total energy use was quite small. Value added of manufacturing industry has increased by 1.5 % per year from 1990 to 2011, with an increase most of the years (measured in constant prices). Value added of mining had a very strong increase from 1990 to 2004 (7.8 % per year), but has decreased by 3.4 % per year from 2004 to 2011.

Final energy use in households has increased from 41 TWh in 1990 to 51 TWh in 2010. The difference can partly be explained by different outdoor temperatures and the climate corrected end-use is calculated to 45 TWh in 1990 and 48 TWh in 2010. The climate corrected final energy use of households has increased annually by 0.2 % from 2000 to 2010. In 2010, electricity was 78 % of the total energy use and the second largest energy carrier was wood with 16 % of total energy use. Driving forces such as private consumption, number of households and population have all increased more

than the final energy use of households. Climate corrected energy use per capita, per household and per private consumption has all decreased from 1990 to 2010; respectively by 0.3 %, 0.6 % and 2.5 %.

Final energy use of the tertiary sector has increased from 23.5 TWh in 1990 to 33.1 TWh in 2010, corresponding to an annual increase of 2 % (not climate corrected). The increase can partly be explained by differences in climate and the introduction of a new standard of classification of energy statistics, but not all the increase in energy use is due to this. Of the energy use in the tertiary sector in 2010, 79 % was electricity. Fuel oil and district heating was almost at the same level; 10 % was fuel oil and 9 % was district heat in 2010. Energy use per area, employee and value added all decreased from 2001 to 2006, but since then these indicators have increased again and the increase was at the most in 2009.

The energy use of transportation has increased most, from 45 TWh in 1990 to 62 TWh in 2010, an annual increase of 1.9 %. The use of diesel oil is more than doubled from 1990 to 2010, at the same time as the use of gasoline has decreased by 1.7 % per year. The share of diesel cars was 3 % in 1990 and 35 % in 2010. This shift has a positive effect on the energy use by cars, since the energy efficiency of diesel cars is higher than the efficiency of gasoline cars. An important reason to the increased share of diesel cars is the change of policy with a reduced purchase tax on diesel cars.

In ODYSSEE, an aggregate bottom-up energy efficiency index, ODEX, is calculated. This energy efficiency index aggregates the trends in the detailed bottom-up indicators in one single indicator. This ODEX has improved by 26 % from 1990 to 2010 or by 1.3 % per year. This means that energy efficiency policies and measures implemented since 1990 have contributed to a decrease in the energy use of 2010 of approximately 59 TWh. The development has been positive for all sectors, according to the selected indicators. The energy efficiency index in industry has the highest decrease, especially from 2000 to 2010 with an annual improvement of 1.5 %. The transport sector has in overall improved the energy efficiency index, but at the end of the period the index is slightly increasing. The household sector has a rather constant improvement after 1992 and in total the annual improvement has been 1.2 %.

2 Key messages

- The increase in electricity end-use is slowed down from an annual increase of 1.4 % in 1990-2000 to 0.14 % in 2001-2010.
- Use of oil products has the last decade been rather constant due to reduced use of oil for heating and an increased demand for transportation.
- Value added of mining increased rapidly from 1990 to 1997, had a slower increase in 1997- 2004 and has from 2004 to 2011 decreased by 3.4 % per year.
- The increase of manufacturing value added has in average been 1.5 % annually from 1990 to 2011.
- Energy consumption in industry decreased annually by 1 % from 2000 to 2008, decreased by 21 % in 2009 and increased from 2009 to 2010 by 12 %.
- The climate corrected final energy use of households has increased annually by 0.2 % from 2000 to 2010.
- There has been an increase in the indicators of the tertiary sector. It can partly be explained by climate variations and changes in energy statistics, but even if corrected for these factors, the energy use of the tertiary sector shows an increasing trend.
- The specific energy use by cars has decreased, partly due to an increased share of diesel cars, since the energy efficiency of diesel cars is higher than the efficiency of gasoline cars. The share of diesel cars was 3 % in 1990 and 35 % in 2010.
- The aggregate bottom-up energy efficiency index, ODEX, has improved annually by 1.3 % from 1990 to 2010, calculated to a decrease in the energy use of approximately 59 TWh.

3 The Background to Energy Efficiency

3.1 Overall economic context

The Norwegian economy was growing every year from 1990 to 2008, had a small recession in 2009 and continues the growth after that, measured as the overall gross domestic product (GDP). There has in average been no development of the GDP during the past five years, see Figure 1 and Table 1. In 2010 GDP increased by 0.3 % and in 2011 by 1.3 %. The growth in GDP was highest in the 1990s, due to high activity in oil and gas drilling.

Private consumption at constant prices has in average increased by 5.8 % annually from 1990 to 2011 but in 2009 there was a small decrease of 0.2 %. In 2011 private consumption increased by 2.5 %.

Industry value added had a rapid growth from 1990 to 1997, then had a slower growth until around 2004 and finally followed by a decrease from 2005 to 2011. The offshore activities had a strong increase from 1990 to 1997, a smaller increase until 2004 and have since been declining. In 2009 the industry value added decreased by 4.0 %, 2010 it was 2.2 % and in 2011 it was 0.6%. In average, industry value added has increased annually by 2.1% from 1990 to 2011. Value added in manufacturing industry increased annually by 1.5 % from 1990 to 2011, with a growth in 1996-1997, 2003-2008 and a slow growth.

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

	1990-2000	2000-2011	1990-2011
GDP	4.3%	1.4%	3.1%
Private consumption	5.4%	4.0%	5.8%
Value Added industry	5.3%	-0.6%	2.1%
Value Added mining	9.7%	-1.7%	2.8%
Value Added manufacturing	1.2%	1.6%	1.5%

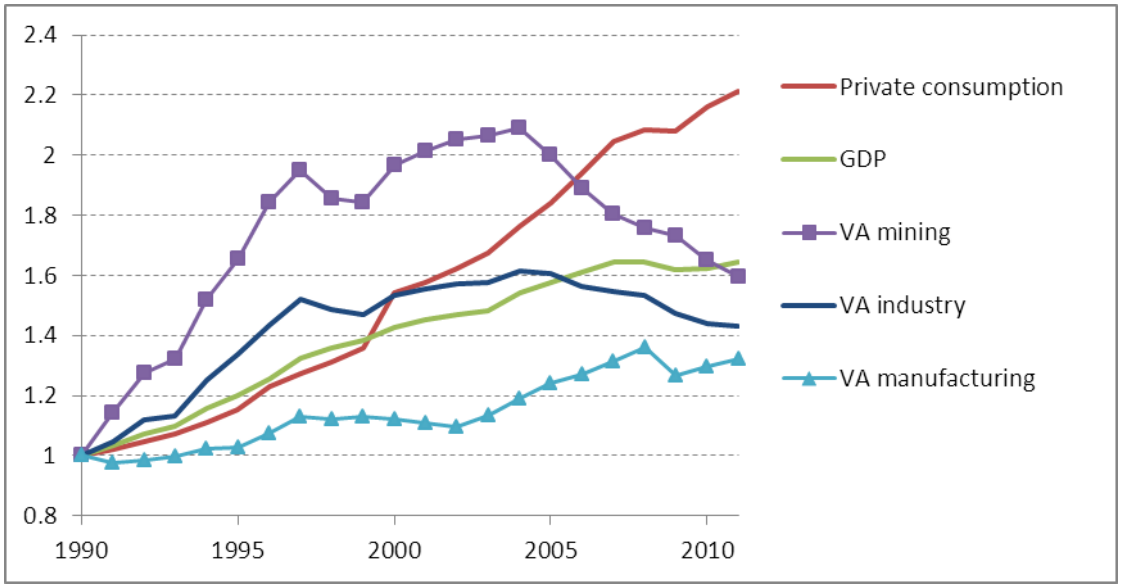


Figure 1 Macro-economic development in Norway 1990-2011 at constant prices; VA = Value Added (1990=1)

3.2 Energy consumption trends

The Norwegian electricity production is based on hydropower. Historically this has made it possible to have low electricity prices and a large energy intensive industry as well as use electricity for heating of buildings.

Half of all energy end use in Norway is electricity, see Figure 2. The electricity use has an annual increase of 0.8 % since 1990, but the last decade the annual increase is reduced to 0.14 %, down from an annual increase of 1.4 % in the period 1990-2000. Use of oil products increased until 1999 and has after that been rather constant, due to a reduced use of oil for heating and an increased demand of transportation. The share of gas is rather small, but shows an annual increase of 4.3 % from 1990 to 2010. District heating has increased by 21 % annually and was in 2010 4.5 TWh. The use of wood products shows an annual increase of 2.3 % and was 14.5 TWh in 2010.

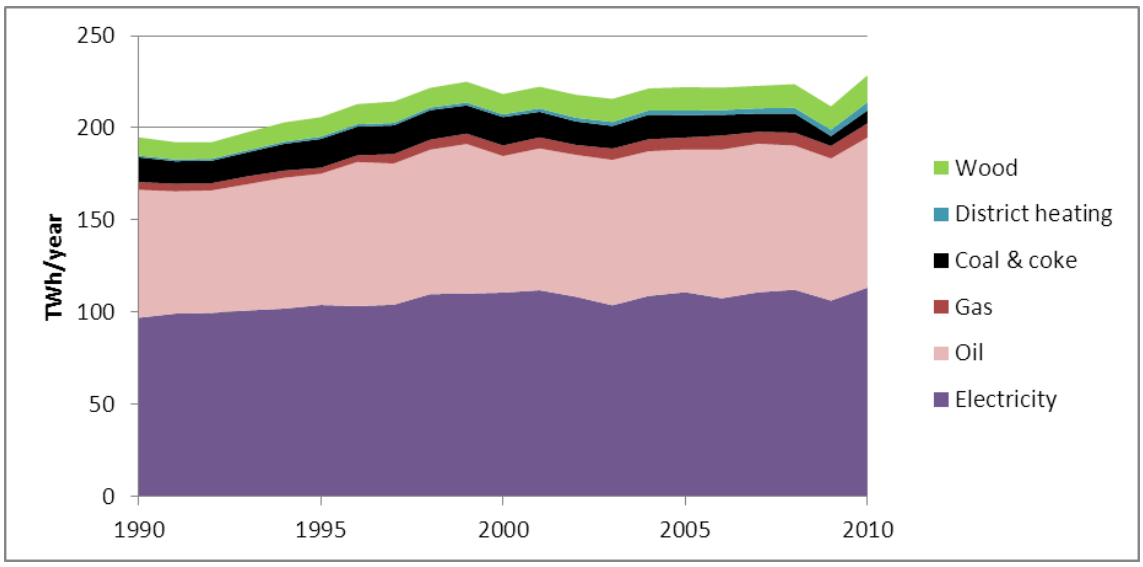


Figure 2 Final energy consumption in Norway 1990-2010

The sector using most energy both in 1990 and in 2010 was industry, but the share has decreased from 40 % in 1990 to 31 % in 2010, see Figure 3. All the other sectors have a higher share in 2010 and the transport sector has increased its share the most.

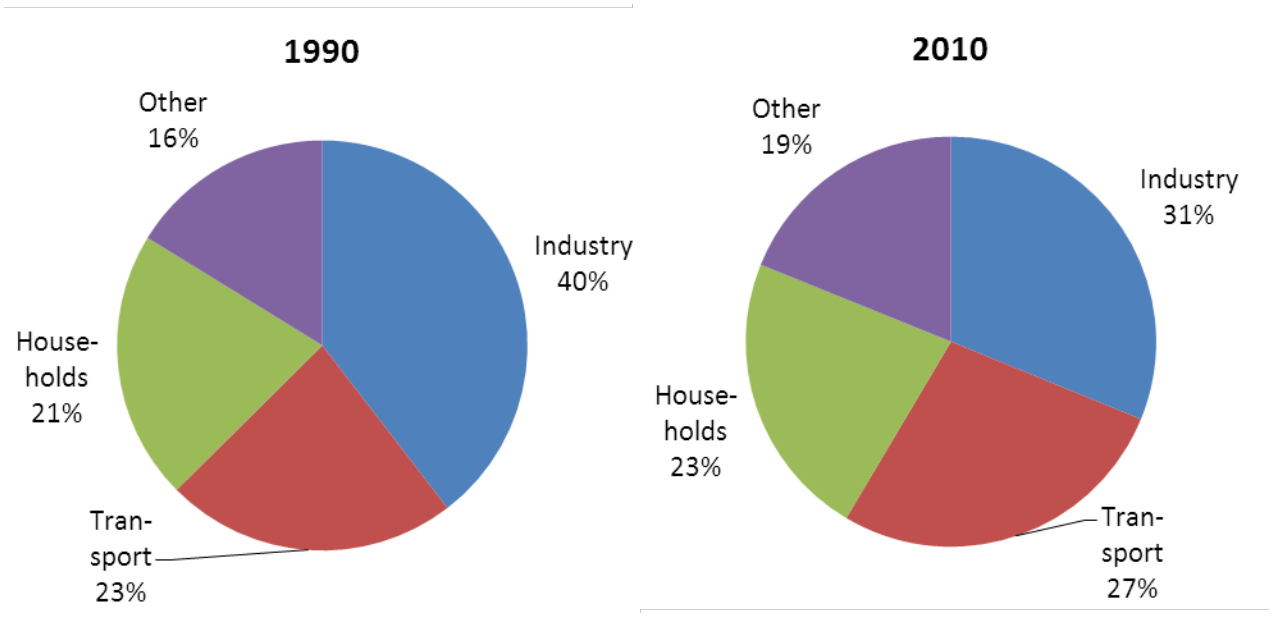


Figure 3 Final energy consumption by sector in Norway in 1990 and 2010

3.3 The policy background to energy efficiency

Enova SF is managing the alteration to a more environmental friendly energy production. Enova is a public enterprise for promoting energy savings, new renewables and environmentally friendly natural gas solutions. It 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.

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 and from allocation from the state budget. In 2011, Enova had NOK 2329 million for disposition. This is NOK 237 million lower than in 2010 and NOK 1427 million lower than in 2009 when Enova received an extraordinary transfer through the Government's stimulus package due to the financial crisis.

Main goals for the Energy Fund are:

- More efficient use of energy
- Increased use of energy carriers other than electricity, natural gas and fuel oil for heating
- Increased production of energy from renewable energy sources
- Introduction and development of new technologies and solutions in the energy market
- Well-functioning markets for efficient and environmentally friendly energy solutions
- Increased general knowledge in society regarding the possibilities for utilising efficient and environmentally friendly energy solutions

With resources from the Energy Fund, Enova has in cooperation with the market triggered annual energy results totalling 16.6 TWh during the period 2001 to 2011. The goal for this period was 18 TWh.

Transnova is a government agency in the field of low emission transportation and it was established in 2009 as a trial funding programme. The goal is to halt the trend of the fast increase of greenhouse gas emissions from transport in order to reduce emissions.

The EU Renewables Directive (RES) was implemented into the EEA Agreement[1] at the end of 2011 and in 2012 Norway implemented the directive. The Norwegian goal for the share of renewable energy in 2020 is 67.5%, an increase from 60.1% in 2005.

The governments of Sweden and Norway have agreed on a common market for green certificates (GCM) in order to promote new renewable energy projects until 2020. The new market mechanism is expected to annually generate 26.4 TWh electricity by 2020, where each country is financing 13.2 TWh. The system is neutral regarding renewable technologies, and the two countries share the same level of ambition regarding production increases of the common market.

[1] the European Economic Area (EEA) that unites the 27 EU Member States and Iceland, Liechtenstein and Norway into an Internal Market governed by the same basic rules

4 Overall Assessment of Energy Efficiency Trends

4.1 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.

Both the primary and final energy intensity decreased from 1990 until 2009 and the last year there has been an increase, see Table 2 and Figure 4. The decrease until 2008 can be explained by more efficient use of energy, structural changes, increased production and a general growth in the economy. From 2008 the GDP has declined, the most in non-energy intensive sectors. In 2010 the final energy use of particularly some energy intensive industry increased again, but the overall GDP is almost unchanged, resulting in increased energy intensity.

The trend of decreasing ratio of final/primary intensity was changed from 2009 to 2010. A decrease of the ratio final/primary intensity 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. In 2009 and 2010 about 4 % of electricity production was gas power, an increase from around 0.5 - 1 % in the previous years.

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

	1990-2010	2000-2009	2009/2010
Primary intensity	-0.8	-0.8	5.8
Final intensity	-1.4	-1.6	7.7
Ratio final/primary	-0.7	-0.9	1.8

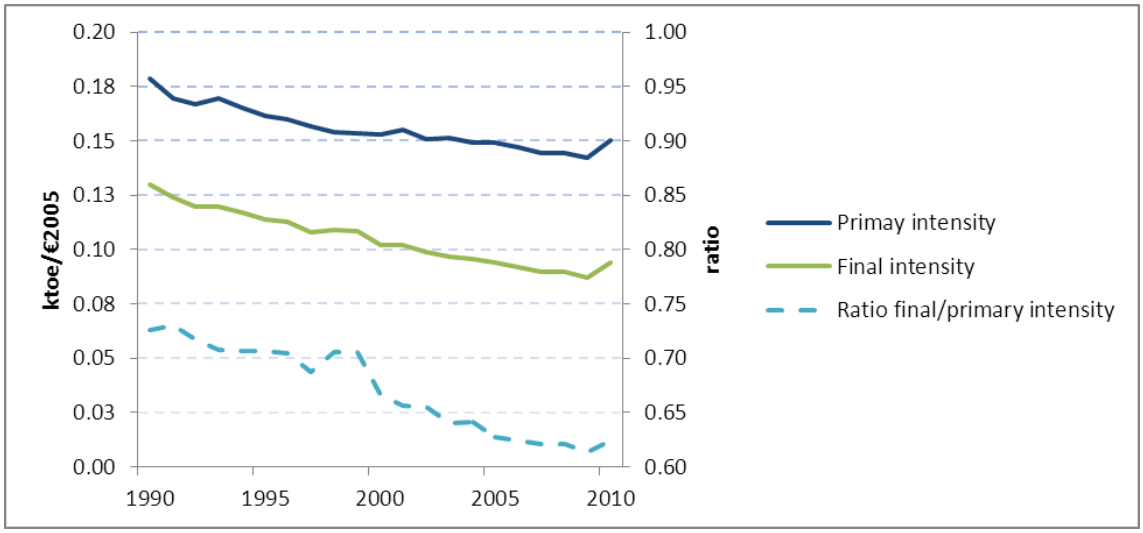


Figure 4 Primary and final energy intensity, 1990-2010

4.2 Industry

The industry sector uses about one third of the final energy in Norway and this share has decreased the last decades. In total, the energy use of industry was on the highest in the year 2000. Until 2008 the decrease was only 1 % per year, but in 2009 the energy use decreased by 21 % followed by an increase of 12 % in 2010. The energy consumption of industry (including mining and construction) was 88 TWh in 2000, 63 TWh in 2009 and 71 TWh in 2010. In 2010, 62 % of the energy use in industry was electricity, 31 % was fossil energy, 7 % was biomass and 1 % was district heat.

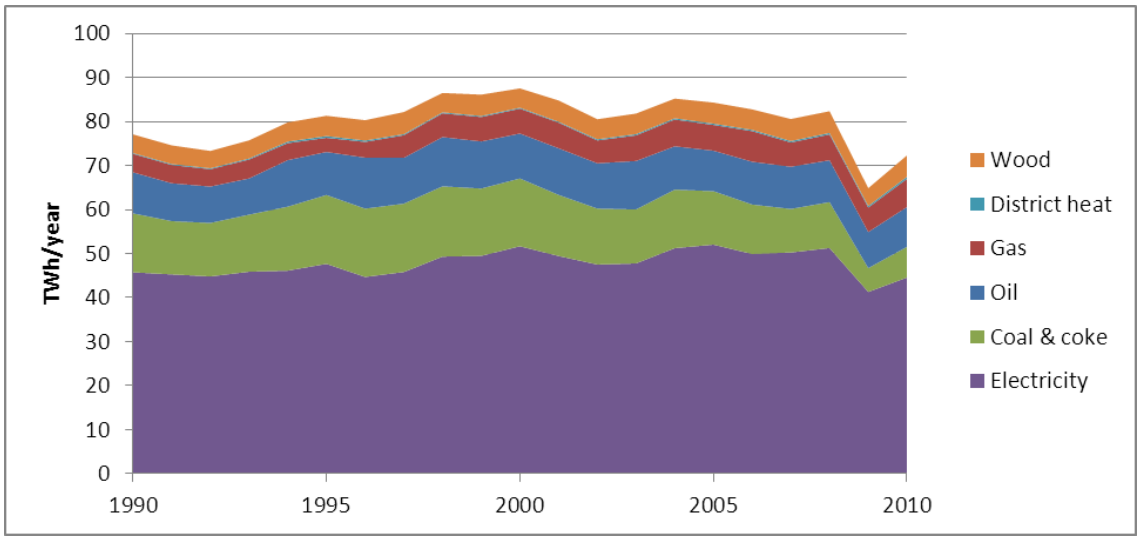


Figure 5 Final energy consumption by energy carrier in industry 1990-2010 (TWh/year)

Energy intensive branches such as metals manufacturing, basic chemicals and pulp & paper production dominates the sector's energy use, using 81 % of total energy use in industry in 2010. The sub-sector with the highest share is the production of non-ferrous metals (mainly aluminium) that used 30 % of total energy use in industry in 2010. The chemical industry had the second highest share (24 % in 2010) followed by the pulp & paper industry and the production of iron, steel and ferro-alloys with a share of respectively 14 % and 13 % in 2010.

Several energy intensive plants have 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 statistics was based on the old standard of classification until 2008 and the statistics of 2009 and 2010 follows the new standard of classification. The consequence of the change of classification is that graphic production, recycling and some industry service is moved from manufacturing industry to the service sector. In overall, the energy use of companies that have changed classification is less than 1 % of the energy used in the industry sector. The macro economic data are based on the new standard of classification back to 1990.

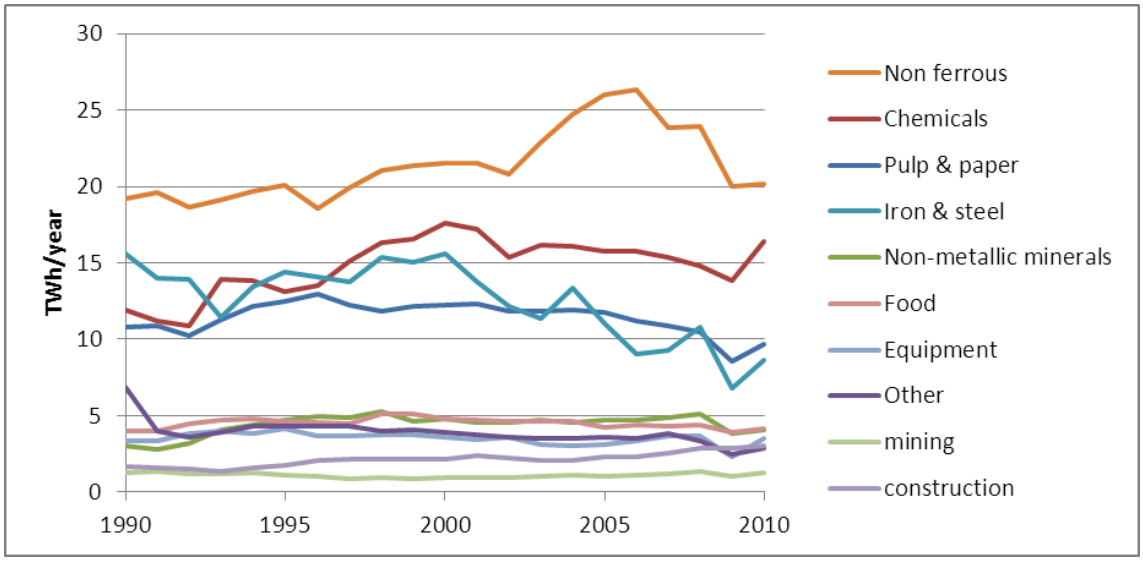


Figure 6 Trends in energy use per sector in industry 1990-2010 (TWh/year)

Non-ferrous metals is the industry sub-sector with the highest energy consumption. It 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 and three more plants were closed down in

2006-2009. 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, increased until 2005 by approximately 50 % and remained at this level until the recession in 2009. In 2009 the production volume decreased by 18 % and further by 2 % in 2010. The energy intensity calculated as energy used per ton aluminium produced has been reduced with 17 %, mainly from 1995 to 2007, see Figure 7. In 2002 the only Norwegian magnesium plant was closed down.

Ferroalloys dominate the sector iron and steel 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 become 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.

The chemical industry includes very different production plants and many of them are energy intensive, such as 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 were 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 a decrease in energy intensity for the chemical industry (caused by structural changes within the sub-sector). The energy use and production index of chemicals slightly decreased in 2009, but in 2010 they were higher than before indicating that the recovery from the recession was faster in this subsector.

The energy intensity of paper, pulp and printing has decreased by 9 % from 1990 to 2009, when energy intensity is calculated as energy use per ton paper produced. In 2010 the specific consumption increased again and was about the same as in 1990, but the energy statistics of 2010 are still preliminary. The production of mechanical pulp is electricity intensive and increased until 2004 by approximately 34 %, but has since

then decreased and was in 2009 and 2010 20 % less than the production in 1990. On the other hand, the chemical pulp production has decreased by 31 % from 1990 to 2009/2010. The paper production in 2010 was 12 % less than in 1990. 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 and a plant producing mechanical pulp and paper was closed down in 2008. In 1996 the electricity price was high and more oil with lower boiler efficiency was used, causing an increase in intensity. The last years the specific energy consumption has increased again, after a positive trend from about 1996 to 2007. The pulp and paper industry have had problems with low earnings and production volumes has been reduced and plants have been shut down.

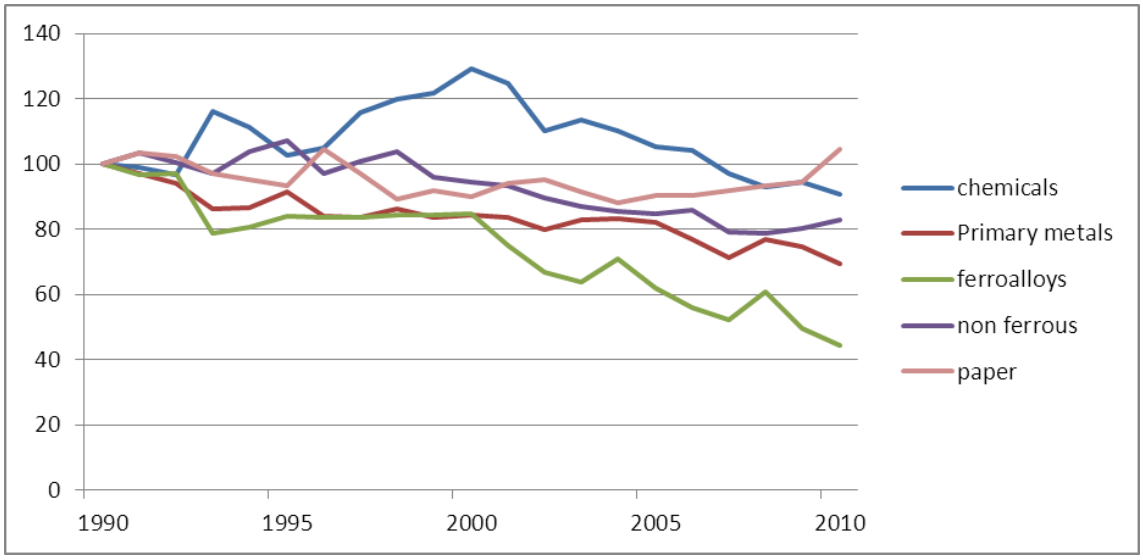


Figure 7 Relative energy intensities in heavy industries. Final energy use/production index; 1990-2010

Production of non-metallic minerals had a high increase in energy intensity in the beginnings of the nineties, see Figure 8. 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 8. This production did not belong to production of machinery before 1993 and hence the energy intensity shows a big increase in 1993, see Figure 8. The energy consumption was the highest in 1995 and has then decreased. During the same time the production index first increased and then slightly decreased again and has after 2005 shown a rapid increase resulting in 59 % higher index in 2010 than in 2000.

The food industry increased the energy intensity from 1990 to 1999 by 17 % and has then slowly reduced the energy intensity with a major drop in 2009, but returning at the same level as before in 2010. One of the most energy intensive products in the food industry is the production of fish meal. In 1998 this production increased considerably, without any increase in the production index, thus causing a great increase in the energy intensity of food industry. The fish industry was one of the sub-sectors with a high decrease in energy use in 2009 and partly recovering in 2010.

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 production index was 15 % less in 2010 than in 2000 and the energy consumption was 13 % less resulting in slightly higher energy intensity, but in overall the energy intensity has been rather constant from 1998 until 2010.

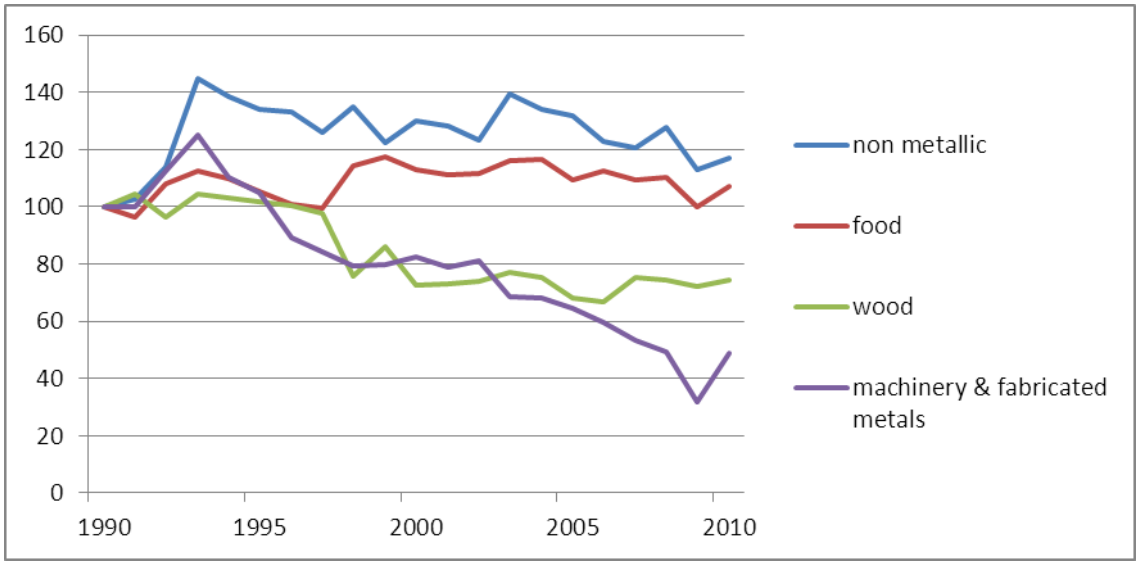


Figure 8 Relative energy intensities in light industries. Final energy use/production index: 1990-2010

The actual energy intensity of industry decreased by 30 % from 2000 to 2010, see Figure 9. If the intensity is kept at the same level as in 2000, the structural changes would have decreased the energy intensity by 14 %. Until 2004/2005, structural changes had less influence on energy intensity, but after that the structural changes have decreased the actual 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 2010 by 14 %. This means that if the intensity had been the same as in 2000, the energy use in 2010 would have been 10 TWh higher.

Figure 9 Effect of structure and intensity in manufacturing industry 1995-2010

4.3 Households

Final energy use in households has increased from 41 TWh in 1990 to 51 TWh in 2010, see Figure 10. The energy use has been on the same level from about 1994 with minor variations partly because of different outdoor temperatures. The electricity share has been between 75 % and 79 % in the period 1991-2010, with an exception in 2003 when the share was only 72 % due to high electricity prices. The use of oil has decreased from 5.0 TWh in1990 to 2.1 TWh in 2010. The use of fire wood increased from 5.7 TWh in 1990 to 8.3 TWh in 2010. The use of district heat was 1.1 TWh in 2010 and the gas consumption was 0.05 TWh in 2010. Climate variations explain to a large extent short-term variation in energy use. The climate corrected final energy use [2] has

[2] 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 depend-

been rather constant since about 1995 at approximate 45 TWh, but the last three years there is an increasing trend in residential energy use. The climate corrected energy use increased from 44.5 TWh in 2007 to 48.5 TWh in 2009 and 2010.

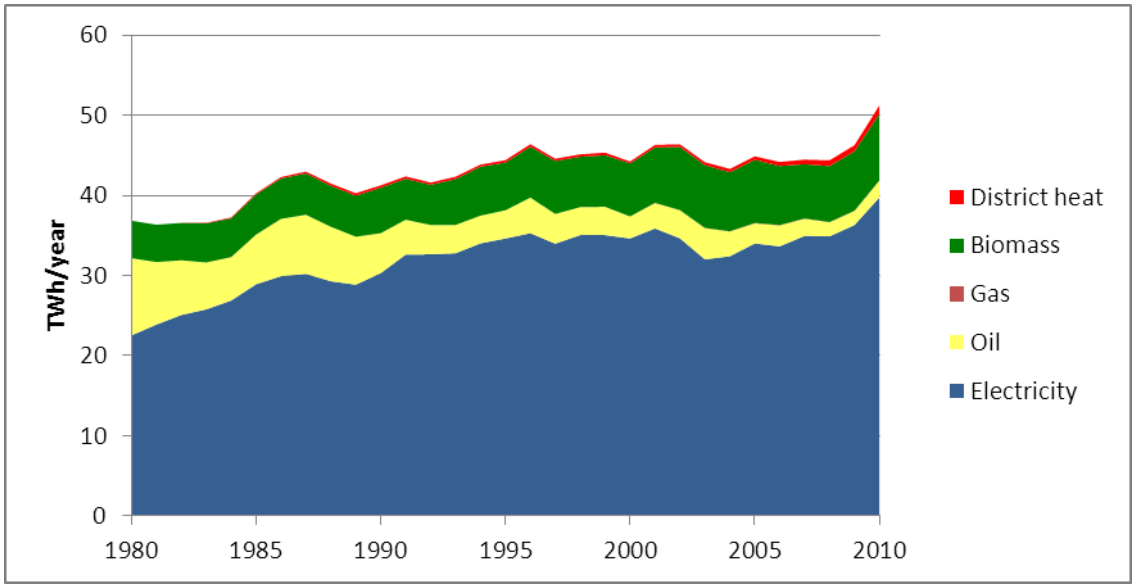


Figure 10 Final residential energy use by fuel (not climate corrected); 1980-2010 (TWh)

Driving forces such as private consumption, number of households and population have increased more than the residential energy use, see Figure 11. Around 1990 there seems to be a decoupling of the energy use from private consumption. Until about 2002 the number of households and the energy use have the same trend, but despite the increased number of households from 2002 to 2010 the energy use did not increase.

ent 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.

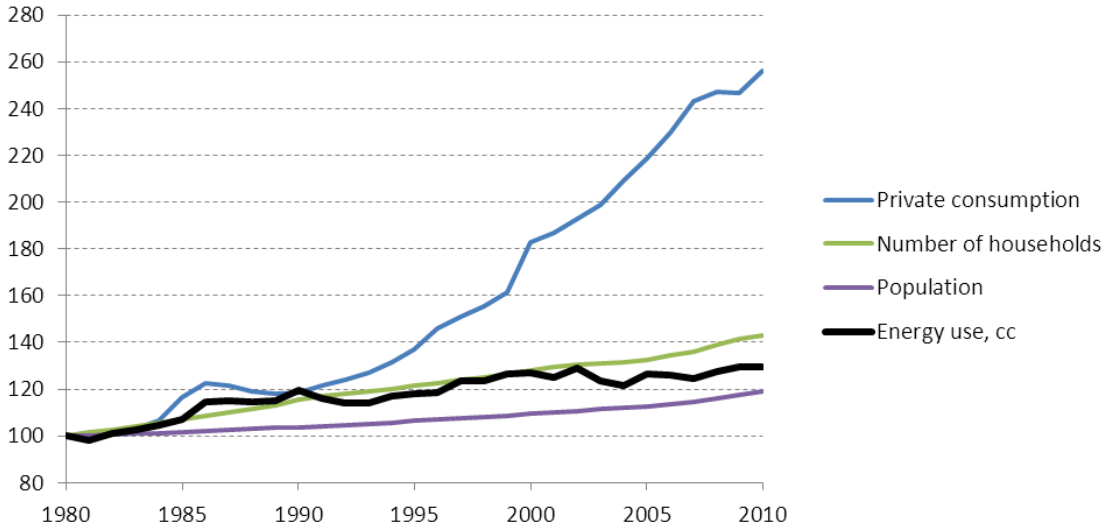


Figure 11 Trends in useful, climate corrected energy, private consumption, area, number of households and resident population 1980-2010

In the first part of the 1990s an increasing residential area can explain the growth in energy use in the residential sector. But since mid-1990's the energy use has stopped growing despite a continued growing area, see Figure 12. A higher share of electricity with higher energy efficiency gives a lower growth in final energy than in useful energy. In 2010 the final energy would have been 1.5 % higher if the share of fuels was as in 1990.

The climate explains a major part of the increased energy use in 2010, but final climate corrected energy use seems to have increased slightly the last years. In order to calculate the influence of temperature on the energy use, it is important to know how much of the total energy that is used for heating. No Norwegian data for each year is available and therefore the calculation is based on estimates. The heating share was recently calculated to be 66 %[3] and in the beginning of 1990's it was calculated to be approximately 55 %. Based on these two studies, an estimate of climate corrected final energy use is calculated, as shown in Figure 12. In average the households used 22 325 kWh/dwelling and 172 kWh/m² in 2010 of final energy (not climate corrected).

[3] NVE report 30/2012 "Energibruksrapporten 2012 – Energibruk i husholdningene"

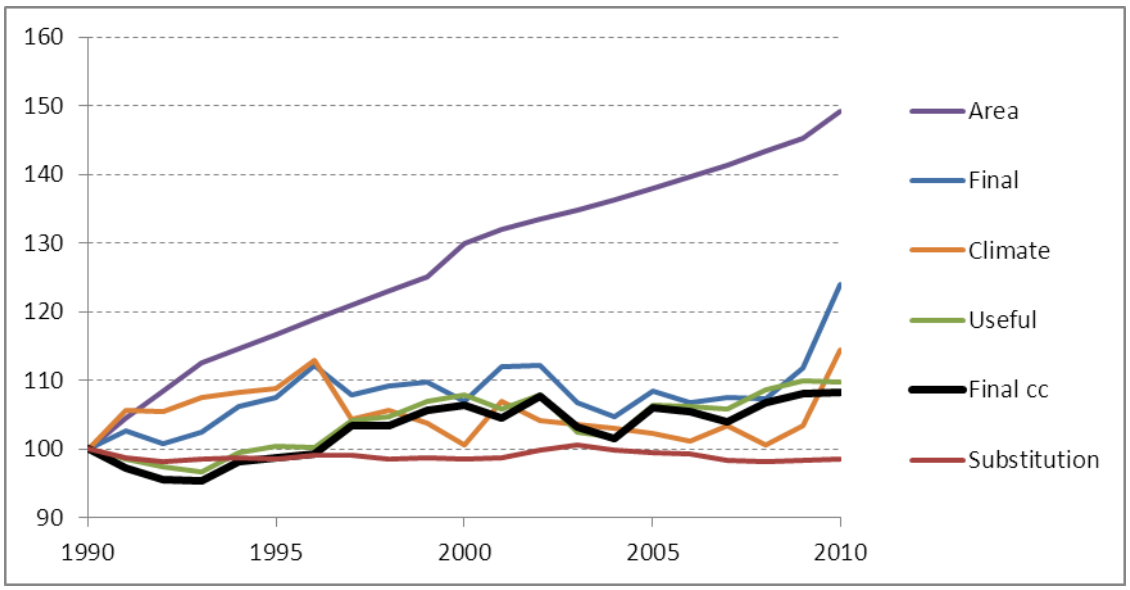


Figure 12 Effect of fuel substitution, climate and heated area on final energy use, 1990-2010

Climate corrected energy use per capita has decreased annually by 0.27 % from 1990 to 2010, see Figure 13. Climate corrected energy use per household has decreased annually by 0.6 % and per private consumption by 2.5 %. Climate corrected energy per heated area is used as energy intensity indicator in the residential sector in ODYSSEE, and a decrease of 26 % indicates an annual saving of 11 TWh.

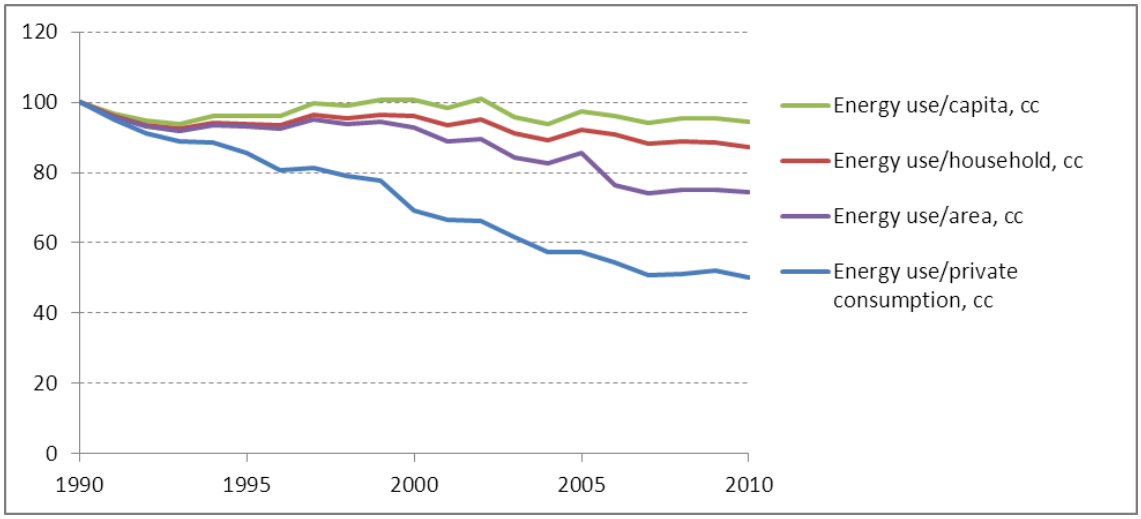


Figure 13 Trends in energy use per capita, household and private consumption, climate corrected; 1990-2010 (1990=100)

The area per capita has increased by 0.9 % annually from 1990 to 2010. At the same time the number of persons per household has decreased by 0.4 % annually, see Figure 14. Both these factors have an increasing impact on the energy consumption.

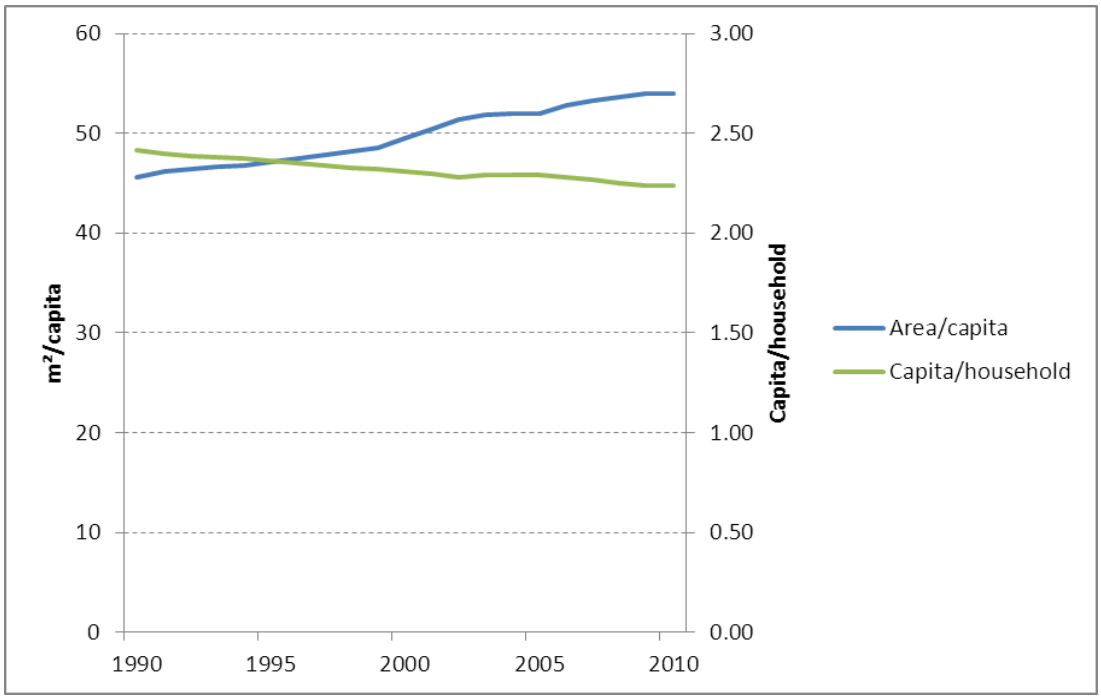


Figure 14 Area per capita and persons per households 1990-2010

The share of multi-family houses is increasing, see Figure 15. In 2000, 27 % of new dwellings were flats, while the share has increased to 47 % in 2009 and 39 % in 2010. In 1990, 80 % of all dwellings were single-family houses and in 2010 this share was about 73 %. An increasing share of flats will contribute to a decrease of energy consumption, since the energy intensity is less for flats compared to single-family houses.

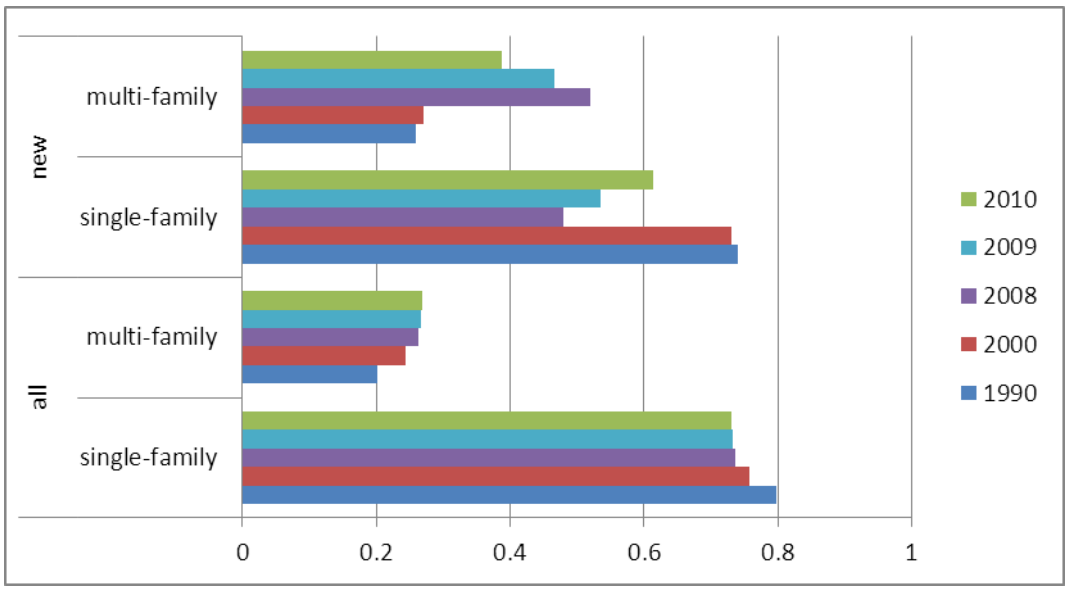


Figure 15 Share of flats and single family houses of total dwellings and of new dwellings 1990, 2000 and 2010

4.4 Services

Final energy use in the service sector has increased from 23.5 TWh in 1990 to 33.1 TWh in 2010, corresponding to an annual increase of 2 %, see Figure 16 (not climate corrected). From 1996 to 2006 there were a stabilisation, but from 2006 to 2010 the annual increase has been 6 %. The energy statistics of 2009 and 2010 is based on the new standard of classification of branches while the years before are data with the old standard of classification. More activity is included in the service sector in the new classification and this can explain part of the increased use of energy but not all.

The share of electricity varies between 78 % (in 2003 with high electricity prices) and 85 %. The share is slowly decreasing due increased use of district heating. District heating has increased from 0.4 TWh in 1990 to 2.9 TWh in 2010. The increase has been 19 % per year from 2000 to 2010. The share of fuel oil was 10 % in 2010 and the consumption has been about 3-4 TWh the past 20 years. The use of gas also shows a rapid increase, but it is still very small and in 2010 the consumption was 0.4 TWh or 1 % of total energy use. Direct use of biomass has also increased lately and the consumption was 0.3 TWh in 2010. The increase in electricity use from 2006 to 2010 is slightly less than the increase of total energy use in the service sector; respectively 5.7 % electricity and 6.2 % total.

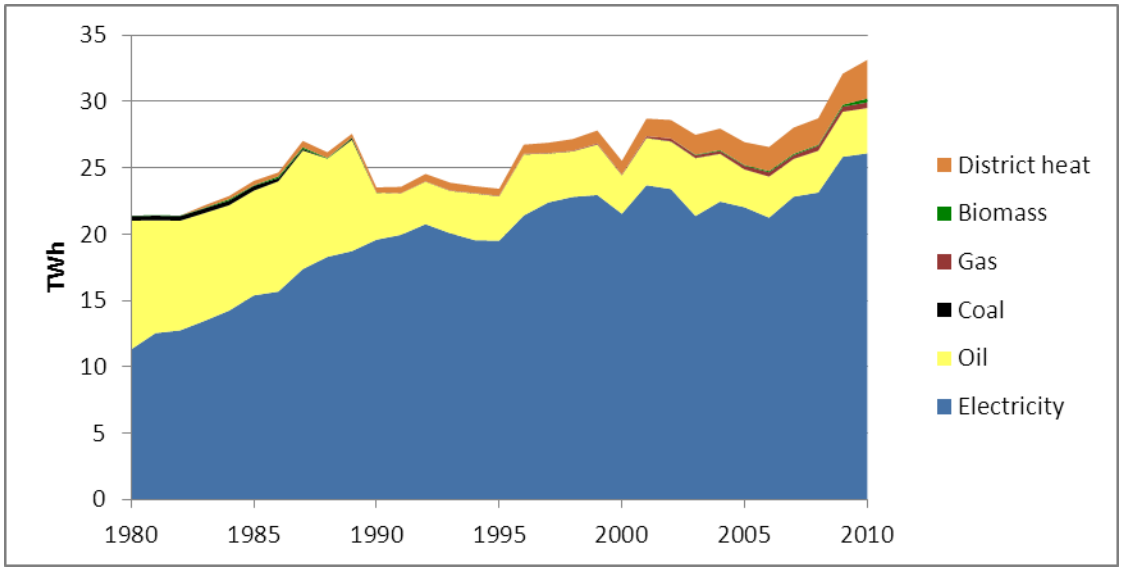


Figure 16 Final energy use by fuel in the service sector (not climate corrected); 1990-2010

Value added of the service sector was 1.8 times higher in 2010 than in 1990, see Figure 17. The energy intensity calculated as energy use per value added has therefore decreased considerably. The trends in building area and number of employees have a more similar development as final energy use, especially from 1990 to 2002.

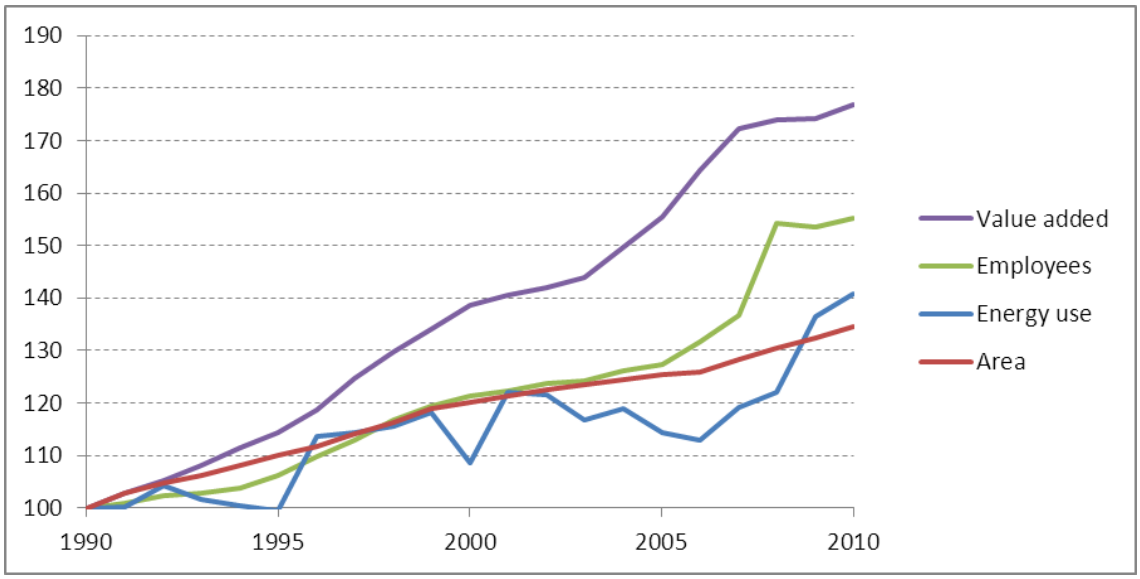


Figure 17 Trends in final energy use, value added, area and number of employees in the service sector 1990-2010

Final energy per employee is 10 % less in 2010 compared to in 1990, see Figure 18. Most of the decrease was from 2001 to 2006 and in 2009/2010 there has been a small

increase. Final energy per building area is 5 % higher in 2010 than in 1990, but the statistics of building area is uncertain. The final energy per value added decreased from 1990 to 2006 by 31 % and has increased afterwards, resulting in a decrease of 20 % from 1990 to 2010. From 2006 to 2010 the annual increase in energy per value added has been 2.7 %.

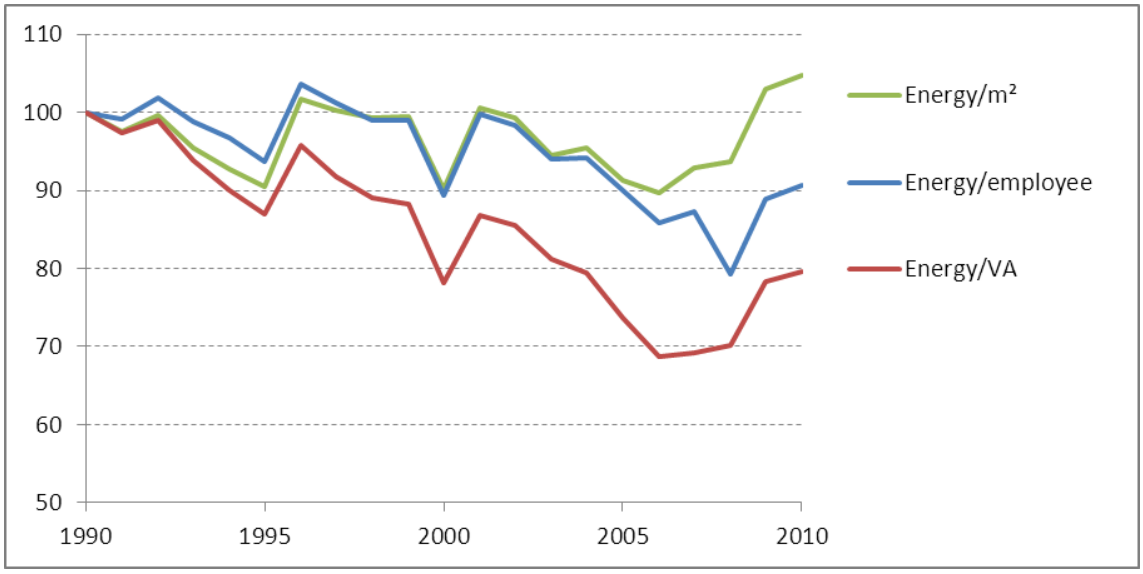


Figure 18 Trends in energy use per area, employee and value added in the service sector 1990-2010

Figure 19 shows energy use for some sub-sectors of the service sector. The sub-sector "other" has now become the one using most energy, 7.0 TWh in 2010, followed by wholesale and retail trade, 6.6 TWh in 2010.

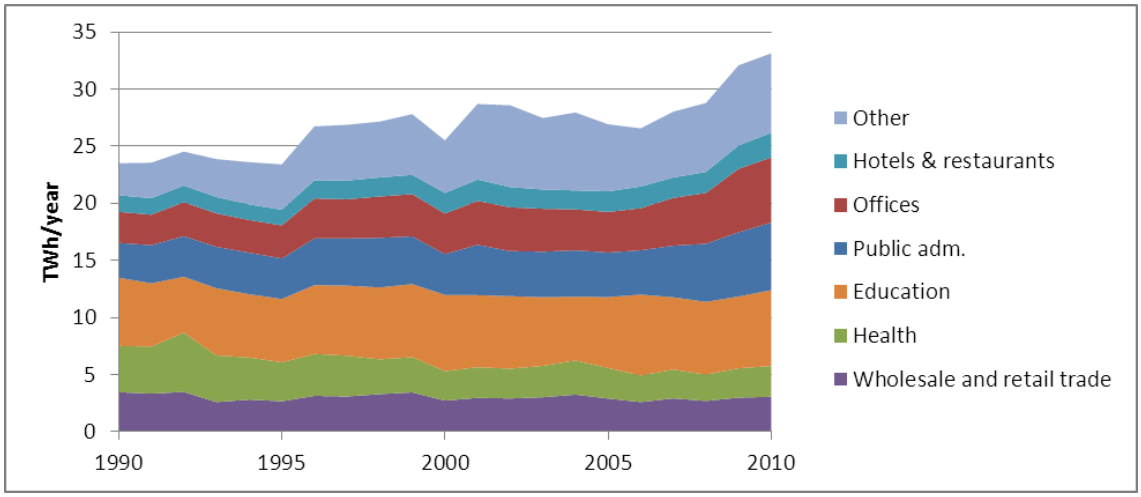


Figure 19 Energy consumption in sub-sectors in the service sector 1990-2010

The trend in energy use is decreasing in health and education, see Figure 20. Wholesale and retail trade has a rather constant use of energy from 1990 to 2010. From 2006 to 2010 the sub-sectors “offices” and “public administration” is increasing the most, with an annual increase of 13-14 %. The sub-sector “other” has increase 9 % per year from 2006 to 2010 and is in total 2.5 times higher in 2010 compared to in 1990. Part of this increase can be due to the change of classification of branches, but it doesn’t explain all of the increase.

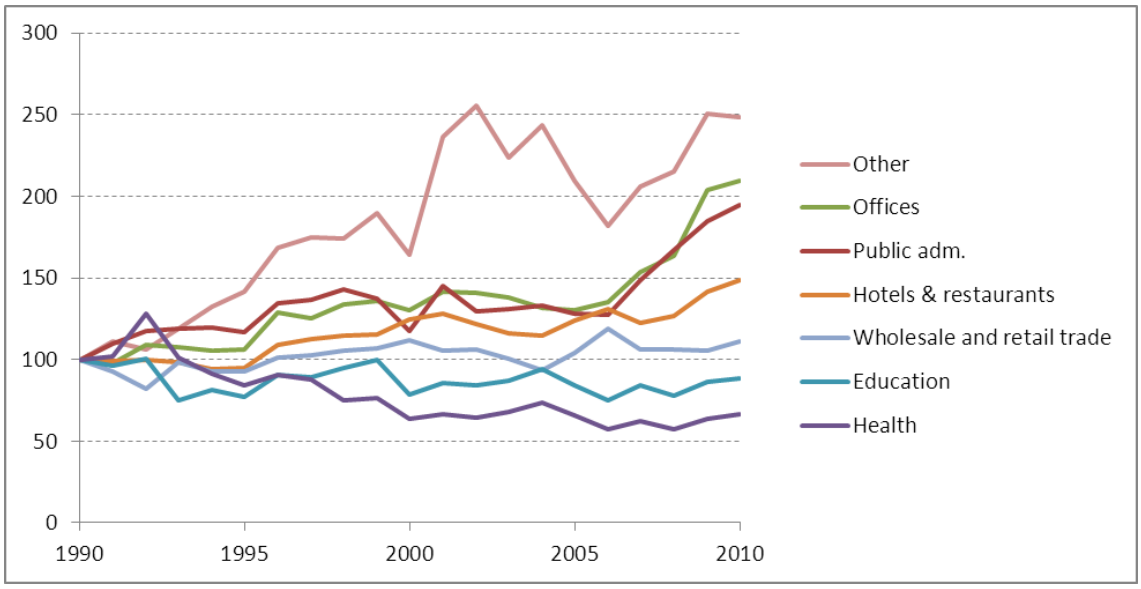


Figure 20 Trends in energy use in service sub-sectors; 1990-2010

4.5 Transport

The total energy consumption in the transport sector has increased from 45 TWh in 1990 to 62 TWh in 2010, an annual increase of 1.9 %, see Figure 21. The use of diesel oil is more than doubled from 1990 to 2010, while the use of gasoline has decreased by 1.7 % per year. Jet fuel has an annual increase of 2.7 % in this period.

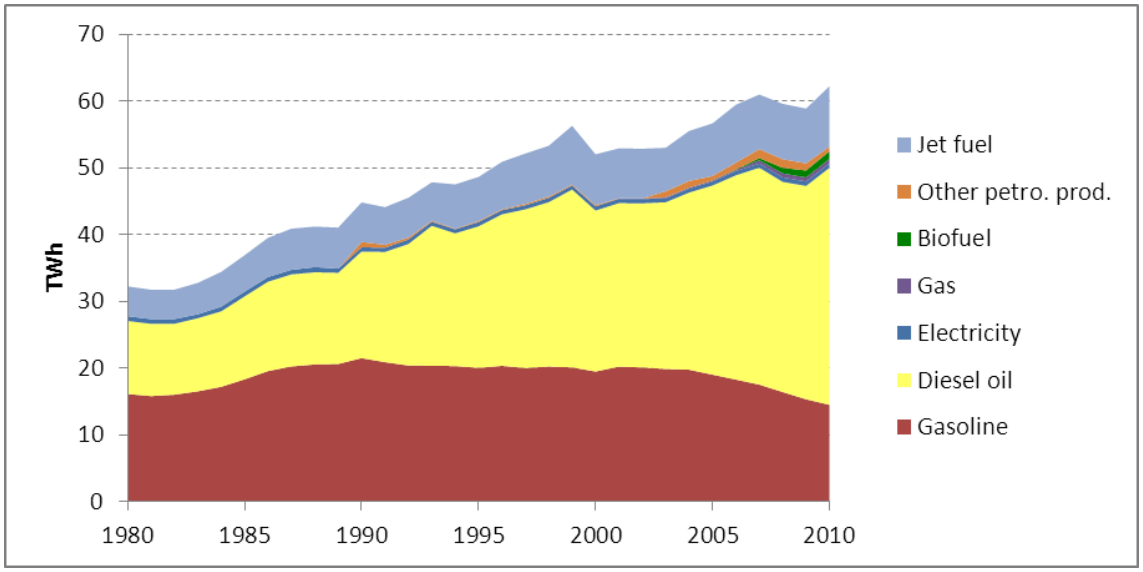


Figure 21 Energy use by fuel type in the transport sector 1980-2010

In person transport, cars are dominating with a share of 80.7 % in 1990 and 79.4 % in 2010, Figure 22. Domestic air transport has increased most, from 4.9 % in 1990 to 6.2 % in 2010. Buses have decreased from 7.2 % in 1990 to 6.1 % in 2010. Motorcycles have also increased, from 1.3 % in 1990 to 1.8 % in 2010. Transport by railway (train and tram) has increased from 4.5 % to 4.9 % and water transport from 1.3 % to 1.6 %.

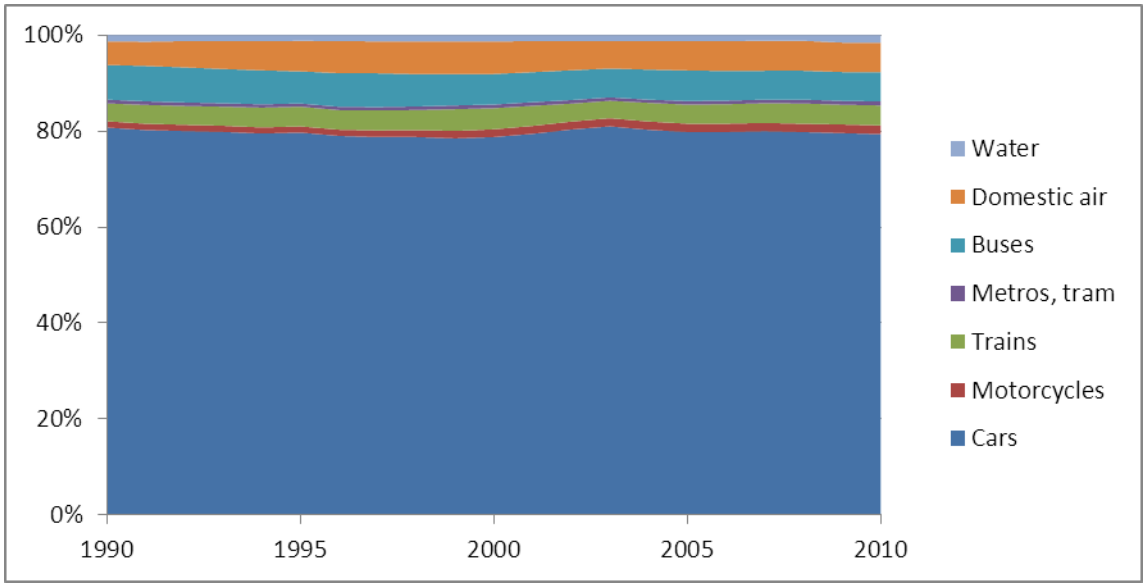


Figure 22 Travel by mode, % of passenger kilometers, 1990-2010

The stock of diesel cars is 16 times higher in 2010 than it was in 1990, see Figure 23. In 1990 the share of diesel cars was only 3 % and in 2010 it has increased to 35 %. 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. The number of electric battery cars was 2068 in 2010 and the number of other cars was 27.

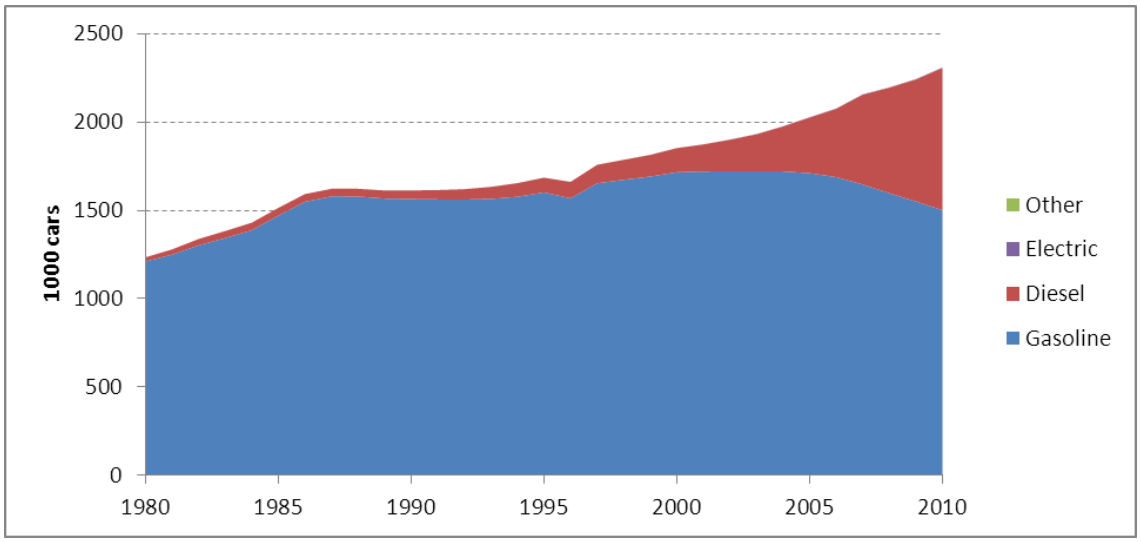


Figure 23 Stock of gasoline and diesel cars 1990-2010

The calculation of energy use per transport mode is partly based on uncertain data and the indicator is therefore also uncertain. Figure 24 presents energy use as toe/passenger km for transport by car, buses, train and air. All the calculated modes have improved their efficiency from 1990 to 2010. Energy use by car is calculated to be reduced from 38 toe/Mp-km[4] in 1990 to 30 toe/Mp-km in 2010 an annual reduction of 1.1 %. A higher share of diesel cars with a higher efficiency and general efficiency improvements of all cars contribute to the improvement. Travel by bus is calculated to 28 toe/p-km in 1990 to 24 toe/Mp-km in 2010, an annual reduction of 0.8 %. Travel by air has the highest energy use per passenger-km, 190 toe/Mp-km in 1990 and 169 toe/Mp-km in 2010, an annual reduction of 0.5 %. The calculation of energy use per ton-km and passenger-km by train is based on a common norm of distribution of ODYSSEE. The calculated trend of passenger traffic by train is then a decreased use of 2.3 % per year, from approximately 16 toe/Mp-km in 1990 to approximately 9 toe/Mp-km in 2010.

[4] Million passenger-km

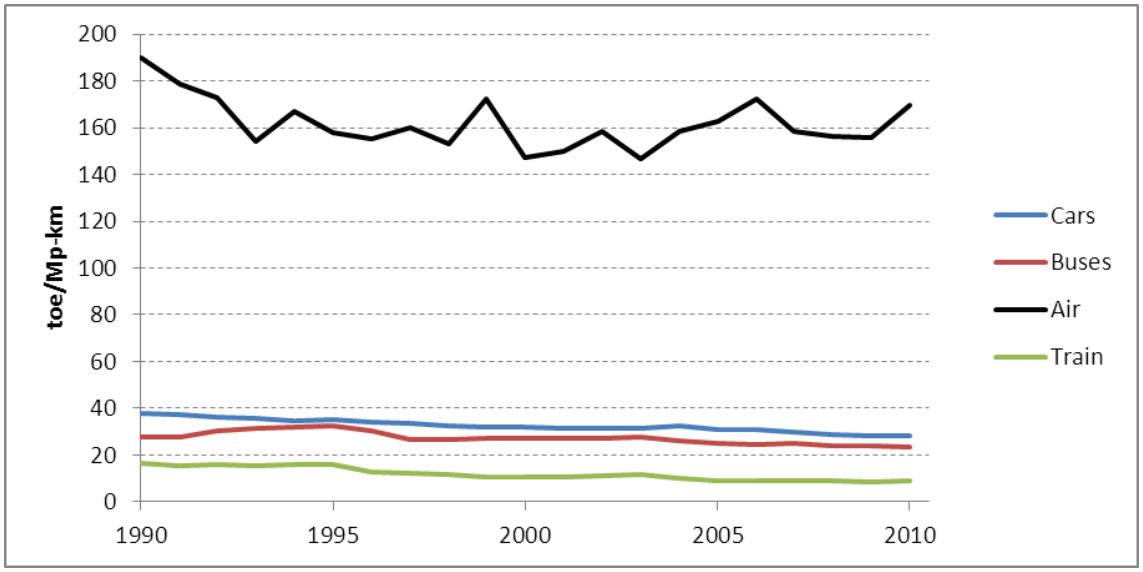


Figure 24 Energy use per passenger-km for transport by car, bus, train and air , 1990-2010 (toe/Mp-km)

The calculated use of energy in freight road transport as toe/ton-km of freight was the same in 1990 as in 2010 and thus no improvement can be calculated. Freight transport by train has a much lower energy intensity, and the trend is an annual decrease of 2.3 %, see Figure 25.

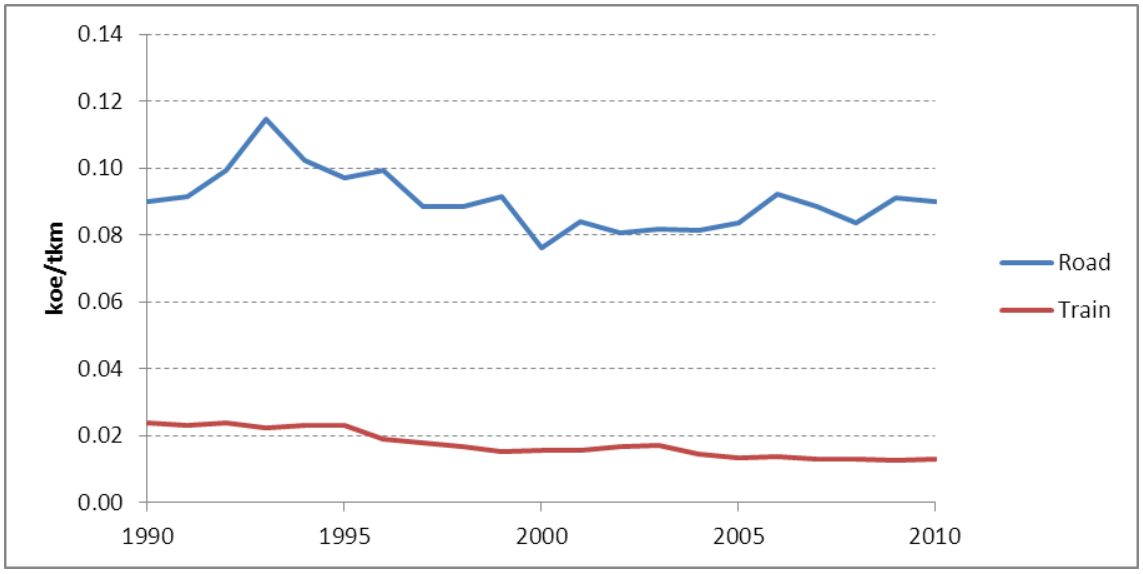


Figure 25 Unit consumption for freight modes (toe/tkm) 1990-2010

4.6 Assessment of energy efficiency/savings through ODEX

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 26 %, or 1.3 % per year, see Figure 26. This means that if these policies and measures would not have been implemented, the final energy consumption would have been 26 % higher in 2010 (approximately 59 TWh).

The development has been positive for all sectors, according to the selected indicators. The energy efficiency index in industry has the highest decrease, especially from 2000 to 2010 with an annual improvement of 1.5 %. The transport sector has in overall improved the energy efficiency index, but at the end of the period the index is slightly increasing. The household sector has a rather constant improvement after 1992 and in total the annual improvement has been 1.2 %.

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.

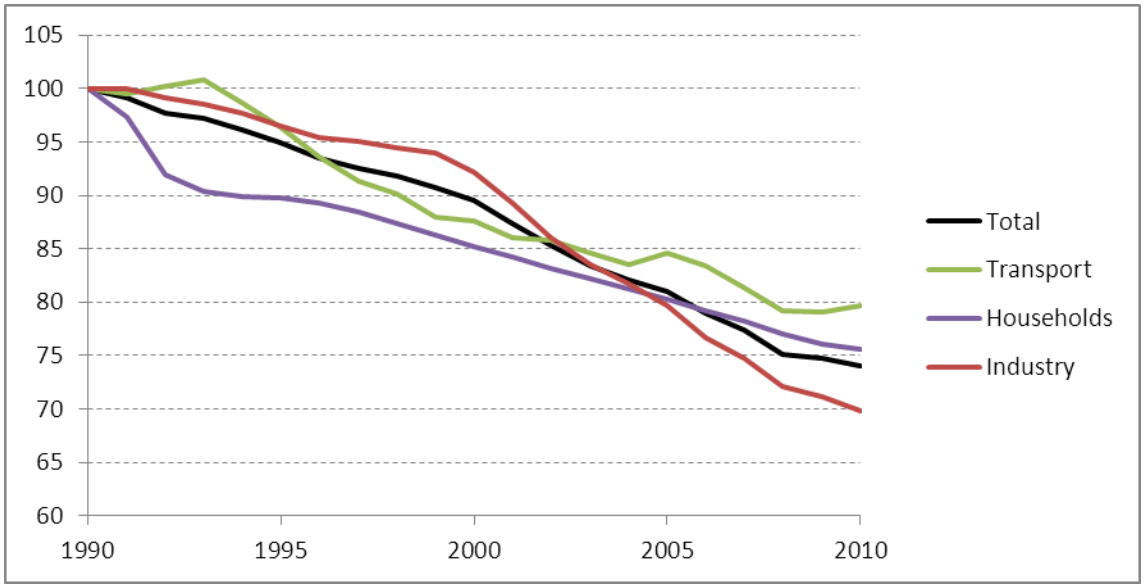


Figure 26 Energy efficiency progress (at normal climate), ODEX total, industry, transport and households, 1990-2010

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.

5 Energy efficiency measures

5.1 Recent Energy Efficiency Measures

Residential 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 current law entered into force for the first time 1 July 1986 and was amended in 1997, 2007, 2008 and 2010. In February 2008 the regulation was changed to partly implement EU directive 2002/91/EC concerning energy efficiency and energy use in buildings. The building regulation 2010 is valid for the whole country without differences between regions. The scope and extent of the regulation is all types of constructions and products for constructions. Construction works with installations shall be carried out in such manner as to promote a low demand for energy and power. The building has to be as energy efficient as the requirements described in the law or fulfill the requirements of a total net energy demand (frame demand) as specified in the regulations. The minimum requirement described in are the same anyway.

It is not allowed to install a fossil fuel oil boiler as base load. Buildings with an area less than 500 m² have to be constructed in a way to be able to cover at least 40 % of useful heating demand with other energy sources than direct electricity heating or fossil fuel, unless the heating demand is less than 15 000 kWh per year. Buildings with an area of more than 500 m² have to be constructed in a way to be able to cover at least 60 % of useful heating demand with other energy sources than direct electricity heating or fossil fuel.

Norwegian standard: Criteria for passive houses and low energy houses - residential buildings

In 2010, a new Norwegian standard for passive and low energy houses was implemented. It includes definitions and requirements regarding heat loss, heating demand and energy supply and requirements for building components and leakage figures. It gives further requirements to test procedures, measurement methods and reporting of energy performance on completion for residential buildings that can be defined as passive house and low-energy houses in the Norwegian climate. The standard specifies three levels of energy efficient residential buildings:

- Passive house
- Low energy house class 1
- Low energy house class 2

Enova Recommends

This is a program designed to promote the products in a mature market which have the most favourable energy and climate qualities. The purpose is to influence the purchase decisions made in households towards choosing the best product in terms of energy. Enova has a label used for advertising at relevant sales outlets and supported by PR and marketing campaigns. Windows was the first product targeted under Enova Recommends. The main criterion for earning the Enova Recommends label was that windows has to have a U-value lower than the current building regulations requirement. The second product of Enova Recommends was insulation.

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. The purchase tax is correlated to CO_2-emissions.

Transnova

In 2009, the Ministry of Transport and Communications established a pilot scheme in order to reduce the CO2-emissions from the transport sector. 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. Private enterprises, various organisations, research institutes and local and regional authorities can apply for funding to projects that will make a fast contribution to the adoption of new and more environmentally friendly technologies or practices. Transnova budget was 50 million NOK yearly in 2009 and 2010. In addition, in 2009 Transnova also administered a one year funding programme for establishing charging points for electric vehicles, with a broad scope of applicants. This programme had a 50 million NOK budget, which by 2010 has yielded almost 2000 new charge points. For 2012 Transnova's budget will be 74.8 million NOK (approximately 10 million €).

Introduction of battery electric vehicles

Battery electric vehicles (BEV) have been introduced faster in Norway than in most other countries. This has been driven by several policies, introduced since 2001, such as the exemption from nonrecurring tax for vehicles, free parking and charging on public parking places, free drive in lanes for public transport and exemption from road toll. In addition there have been a research and development scheme on battery technology administered by the Norwegian Research Council, and a demonstration scheme administered by Transnova.

Industrial Sector

Energy end-use – industry programme

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 onshore industry. Via the programme "Energy consumption – 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 grant has to be a triggering factor.

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/).

Heating plants – industry programme

In 2011, a designated programme aimed at the industry's heating plants came in place, with the goal of triggering conversion to renewable energy in smaller industry companies.

Tertiary Sector

One of the most important measures in the tertiary sector is the buildings regulation, described under the “residential sector”.

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 one 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.

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.

5.2 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 1991-2000. 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 sub-section 5.4. The graphs only show the number of measures that are started in the two periods. Measures started before the actual period and still on-going are not included. The abbreviations used in the graphs are explained in a box below.

In all sectors the number of financial measures 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.

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

Residential Sector

In the residential sector, most of the measures after 2000 are financial, see Figure 27. Before 2001, the measures were more of the type information and legislative. After 2000 a total of 12 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 18. The last five years, no financial measures have been introduced.

Even if the numbers of legislative measures are lower after 2000, the importance is high. There have been three legislative measures after 2000; two building regulations and in addition the EU directive on energy performance of buildings. Before 2000 there were two 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.

The information types of measures are the educational awareness program for children called “Regnmakerne”, the energy guidance label “Enova Recommends” and the national standard of passive houses and low energy houses.

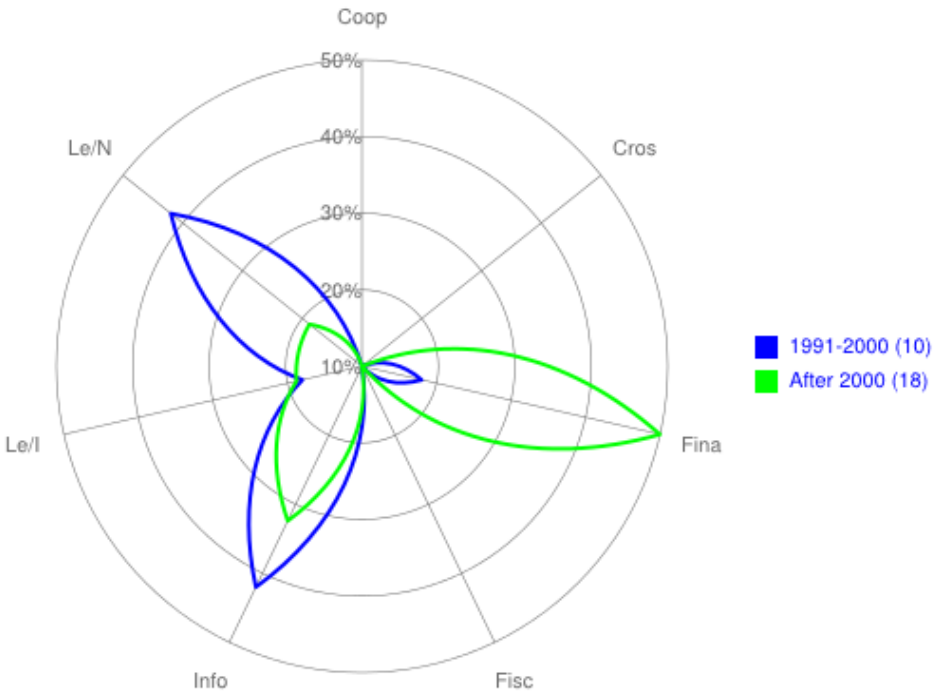


Figure 27 Energy efficiency measure patterns residential sector: development of measure by type over time

Transport Sector

The types of measures in the transport sector were mostly of legislative and infrastructure type before 2001, see Figure 28. After 2000, there are four measures; passenger car labelling, the establishment of Transnova, the reward scheme for better public transportation and reduced use of cars in cities and the promotion of biofuels or other renewable fuels for transport. Since Transnova is linked to four types of measures and renewable fuels are linked to two, the total of measures increase to 11 after 2000. The focus on information, fiscal and financial measures increases at the same time as the legislative/normative measures decrease.

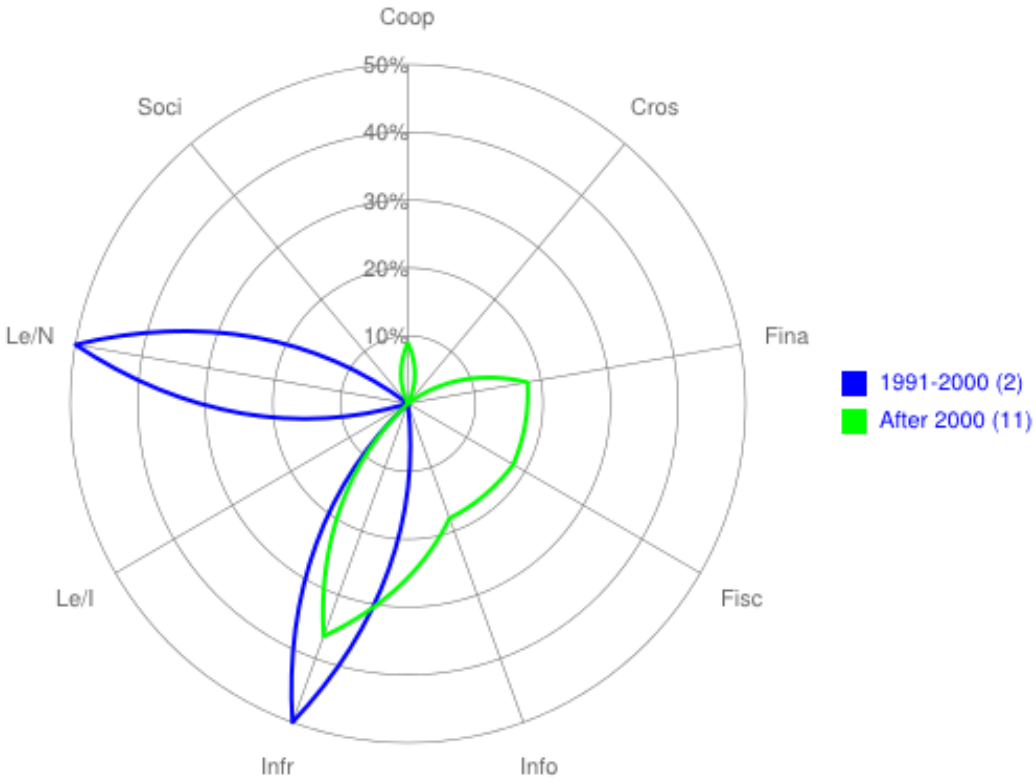


Figure 28 Energy efficiency measure patterns transport sector: development of measure by type over time

Industrial Sector

The types of measures in the industry sector are dominated by financial measures, both before and after 2000, see Figure 29. In the period 1991-2000 most of the measures introduced are of the financial type, while also other measures are introduced after 2000. Examples of this are the emission trading system (new market-based instrument), the energy information helpline (information/education/training) and the program for energy efficiency in industry for the pulp and paper industry (co-operative/fiscal/tariff).

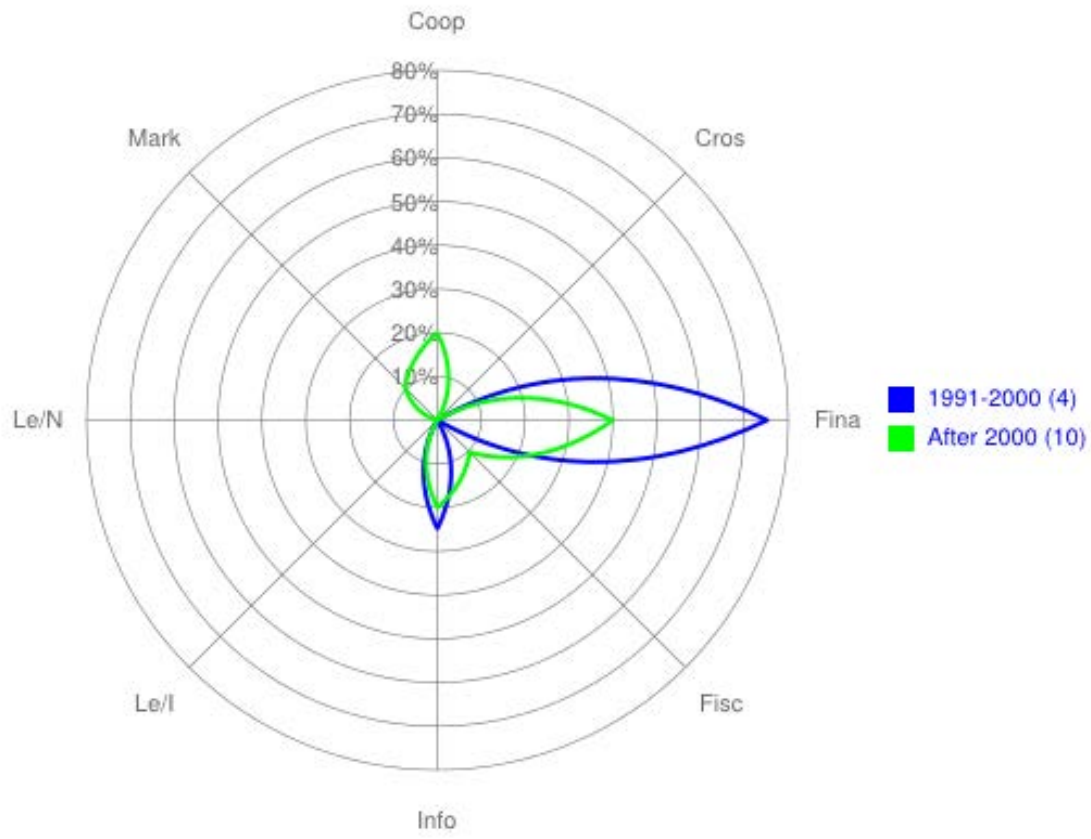


Figure 29 Energy efficiency measure patterns industry sector: development of measure by type over time

Tertiary Sector

In the tertiary sector, measures of different types are implemented, both before and after 2000. Most frequent are the financial type followed by informative, legislative/informative and legislative/normative measures, see Figure 30. Before 2001, cross-cutting and cooperative measures were also introduced.

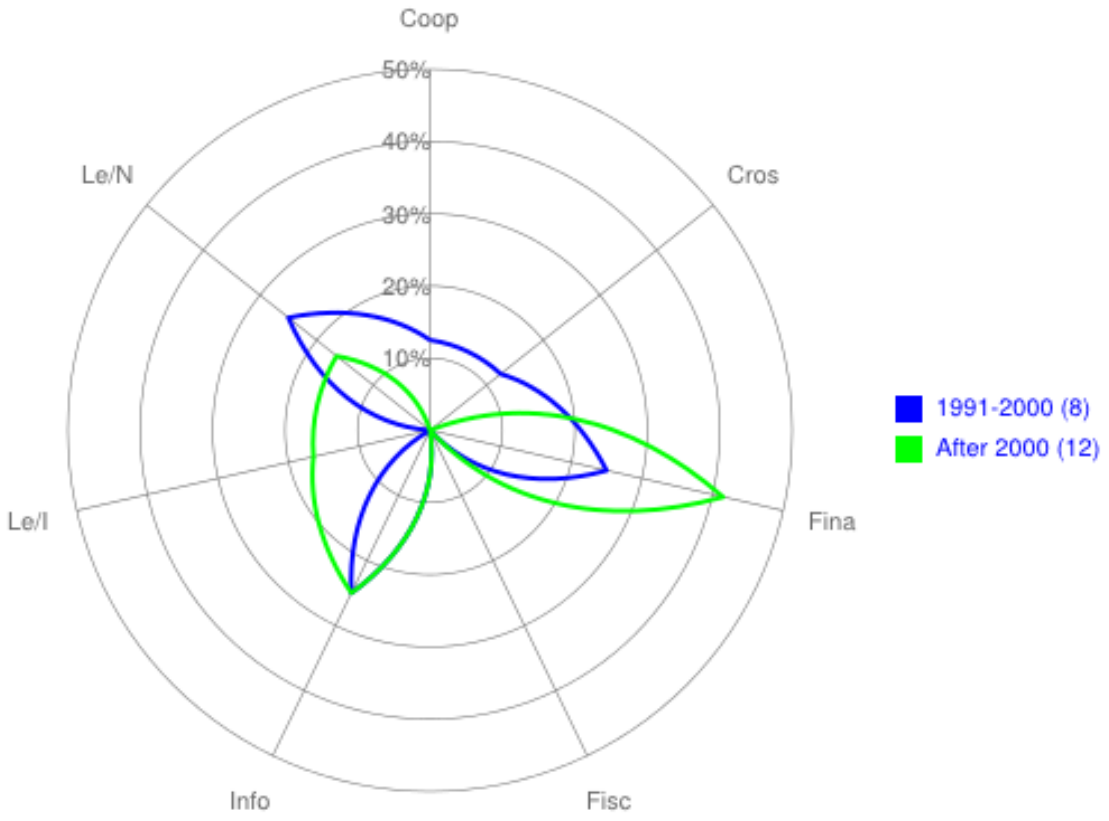


Figure 30 Energy efficiency measure patterns tertiary sector: development of measure by type over time

General cross-cutting measures

There are only five Norwegian general cross-cutting measures in the MURE database. The measure in the period 1992-2000 is the Norwegian energy policy as described in the white paper of 1999. The four measures of the last period are the Energy fund, Local energy studies, new technology support and the Ecodesign directive.

The Energy Fund is funding many of the measures in the different sectors and is of high importance.

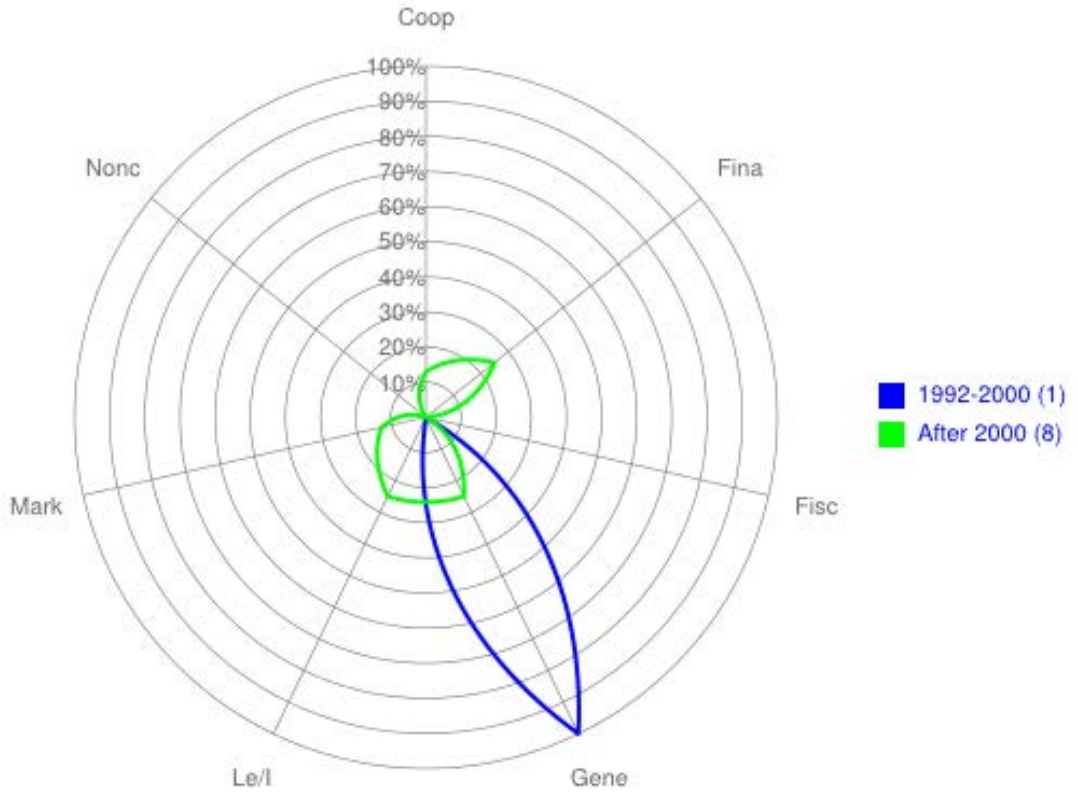


Figure 31 Energy efficiency measure patterns general cross-cutting sector: development of measure by type over time

5.3 Innovative Energy Efficiency Measures

Enova

In 2002 the government established an agency to support energy efficiency and renewable energy. The new agency, Enova, was given a defined target (in TWh), a stable financing and a high degree of flexibility in how to deliver. While the previous obligation scheme had a focus on activities, the combination of ambitious, specific and measurable targets and flexibility in measures gave a strong incentive to focus on outcomes. Placing the responsibility for supporting renewable energy and energy efficiency in one agency instead of several utilities gave a harmonization of the measures provided across the country. It also meant that measures which couldn't show direct results through increased production of renewable energy or energy efficiency, to a large extend were disbanded.

Besides specific targets, a key feature of the new agency was that the financing was to a large extent not linked to annual allocations under the state budget. This gave both a high degree of flexibility and a high degree of predictability. Until 2008, Enova was financed partly by a levy on the transmission tariff, and partly by allocations under the state budget. From 2008, the funding also included the return on a fund set aside for financing for the purpose. As the results have been achieved, both targets and funding have increased. By the end of 2011, Enova supported a variety of projects in renewable energy (power and heat) and energy efficiency in Norway equivalent to 16,6 TWh. To have an idea, the final energy consumption (excluding transportation) in 2011 was 156 TWh.

The Enova model was renewed in 2012, setting new targets for 2015 and expanding the scope to include reduction of greenhouse gas emissions.

Policies drive the electrification of transports in Norway

Battery electric vehicles (BEV) have been introduced faster in Norway than in other European countries. In 2011 approximately 18% of the total sales of BEV's in Europe were in Norway. One important reason behind this development is that Norway has implemented policies which contribute to the transition to a more environmentally friendly car fleet. From 2001 strong market pull policies have been in place in Norway, and the most important policies are:

- exemption from nonrecurring tax for vehicles
- free parking and charging on public parking places

- free drive in lanes for public transport
- exemption from road toll

Technology policies have been focused on research and development schemes on battery technology administered by the Norwegian Research Council, and a demonstration scheme administered by Transnova.

It seems like the possibility to avoid traffic tailback and the easy access to parking and charging have a huge impact on people's willingness to buy a BEV. Many Norwegian households have two cars, and the share is slightly increasing. Families with two cars have the opportunity to use a BEV for the daily driving; to and from work, shop, leisure activities etc. The larger fossil fuelled car is used for longer travels or when there is a need for two cars at the same time.

Approximately 7.000 BEV are running on Norwegian roads by May, 2012. The monthly sales rate of BEVs is about 300. However, this is a low number compared to the average monthly sales rate of conventional private cars at 10.000.

This is described in the Norwegian white paper on Climate policy (2011-12): "To be able to reduce emissions from transport, new and more environmentally friendly vehicles and fuels must be deployed, and new infrastructure needs to be built to make public transport and bicycling more accessible. Communities have an obligation to reduce the transport demand through coordinated planning of land use and transport".

On June 7, 2012 all political parties in the Parliament with exception of one signed a new climate agreement. The agreement implies a continuation to 2017 of tax advantages related to purchase and use of zero emission vehicles, as long as the number of vehicles is less than 50.000. This agreement gives the needed predictability for auto buyers and auto dealers. It also gives framework conditions which makes it possible to build the needed recharging infrastructure.

The climate agreement has a goal of an average emission from new private cars in 2020 to be 85 g CO_2/km. The average CO_2 emissions from conventional gasoline and diesel cars are in the range of 130-135 g CO_2/km (May 2012). Thus, parts of the vehicle stock must be zero emission vehicles like BEV or FCEV, or the efficiency of conventional cars must increase.

An important premise for the deployment of BEVs in Norway has been the availability of renewable electricity in years with the average hydro inflow, and an electricity grid with sufficient capacity from producer to end user.

In addition, the former car manufacturer Think did strongly contribute to the interest of developing policies to promote the deployment of BEVs. Thus the policies were in place when the larger international car manufacturers had their vehicles introduced in the Norwegian market.

5.4 Energy efficiency measure evaluations

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 on-going measures in the Norwegian household sector. It is a total of 15 measures and two of the measures are regarded as of high importance, three of medium importance and seven of low importance. The new building regulations and energy performance of buildings are the two measures with high importance.

Table 3 Impact of on-going measures in the household sector

Title	Type	Semi-quantitative Impact
Building regulations 2010 (Byggeforskrift 2010)	Legislative/ Normative	High
Energy Performance of Buildings (Directive 2002/91/EC) - Bygningsenergidirektivet	Legislative/ Informative	High
Ecodesign Directive for Energy-using Products (Directive 2005/32/EC)	Legislative/ Normative	Medium
Energy and environmental taxes	Cross-cutting	Medium
Enova - Grants for energy savings in the built environment (Bygg, bolig og anlegg)	Financial	Medium
Energy Labelling of Household Appliances (Directive 92/75/EC) - (Energimerking av hvitevarer)	Legislative/ Informative	Low
Energy saving loans (Husbanken)	Financial	Low
Enova - Educational awareness program for children about energy use and environmental impacts (Regnmakerne)	Information/ Education	Low
Enova - Energy information helpline (Enovas svartjeneste)	Information/ Education	Low
Enova - Grants for electricity savings in households (Tilskuddsordningen i husholdningene)	Financial	Low
Local energy efficiency fund in Oslo (Enøkfondet i Oslo)	Financial	Low
Performance of Heat Generators for Space Heating/Hot Water (Directive 92/42/EEC)	Legislative/ Normative	Low
Enova - Energy guidance label "Enova Recommends" (Enova anbefaler)	Information/ Education	Unknown
Enova - Information activities (media campaigns, magazine, exhibition material)	Information/ Education	Unknown
National standard: Passive and low energy residential buildings	Information/ Education	Unknown

The list of on-going 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.

Promotion of biofuels and other renewable fuels and speed limits are regarded as the measures 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 on-going measures in the transport sector

Title	Type	Semi-quantitative Impact
Promotion of Biofuels or other Renewable Fuels for Transport (Directive 2003/30/EC)	Financial, Fiscal	High
Speed limits	Legislative/Normative	High
Purchase tax on vehicles (Engangsavgift på motorvogner)	Fiscal	Medium
Taxes on gasoline and auto diesel oil	Fiscal	Medium
New passenger car labelling on fuel economy rating (Energimerking av nye personbiler)	Legislative/Informative	Low
Reward scheme for better public transportation and reduced use of cars in cities (Belønningsordningen)	Infrastructure	Low
Semiannual technical inspection of vehicles	Legislative/Normative	Low
Transnova	Co-operative Measures, Financial, Information/ Education/ Training, Infrastructure	Low

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

Table 5 Impact of on-going measures in the industrial sector

Title	Type	Semi-quantitative Impact
Enova - Energy Consumption - Industry (Energibruk - industri)	Financial	High
Energy and environmental taxes	Cross-cutting	Medium
Energy efficiency in industry (Program for energieffektivisering i energiintensiv indust-ri)	Co-operative Measures, Fiscal/Tariffs	Medium
Enova - Grants to renewable heat produc-tion and distribution – district heating and local heating plants (Program for fjernvarme og lokale energisentraler)	Financial	Medium
EU Emission Trading Scheme (2003/87/EC) - Klimakvoteloven	New Market-based In-struments	Medium
Enova - Energy information helpline (Eno-vas svartjeneste)	Information/ Education/ Training	Low

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

Table 6 Impact of on-going measures in the tertiary sector

Title	Type	Semi-quantitative Impact
Building regulations 2010 (Byggeforskrift 2010)	Legislative/ Normative	High
Energy Performance of Buildings (Directive 2002/91/EC) - Bygningsenergidirektivet	Legislative/ Informative	High
Energy and environmental taxes	Cross-cutting	Medium
Enova - Grants for energy savings in the built environment (Bygg, bolig og anlegg)	Financial	Medium
Enova - Grants to renewable heat production and distribution - district heating and local heating plants (Program for fjernvarme og lokale energisentraler)	Financial	Medium
Energy Labelling Office Equipment (Energy Star) - Energimerking av kontorutstyr	Information/ Education/ Training	Low
Enova - Energy statistics of the Norwegian Building Network (Bygningsnettverkets energistatistikk)	Information/ Education/ Training	Low
Local energy efficiency fund in Oslo (Enøkfondet i Oslo)	Financial	Low
Mandatory climate and energy plans in municipalities (Kommunale klima- og energiplaner)	Legislative/ Informative	Low
Minimum energy efficiency standards for boilers	Legislative/ Normative	Low
Enova - Energy information helpline (Enovas svartjeneste)	Information/ Education/ Training	Unknown

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

The long-term frames of the energy policy were studied by a government committee in 2011-2012. Central topics were production, consumption, grid development and import and export of electric energy and how it is affecting the Norwegian energy and power balance. An objective was to create a better understanding of the balancing of interests in the energy policy. The work was reported to the department of petroleum and energy on 5 March 2012 (NOU 2012:9). The report describes different paths towards 2030 and 2050 and can be a base for further political decisions.

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. Norway's target is to be carbon neutral in 2050 or in 2030 if international climate agreement.

The directives of energy labels (Directive 2010/31/EC), eco-design (Directive 2009/125/EC) and the energy performance of buildings (Directive 2002/91/EC) are implemented in Norway, while the energy service directive (Directive 2006/32/EC) still not is included in the EEA Agreement[5].

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 today, investments in new energy production capacity and investments in energy savings are equal.

The EU Renewables Directive (RES) was implemented into the EEA agreement at the end of 2011 and in 2012 Norway implemented the directive. The Norwegian goal for the share of renewable energy in 2020 is 67.5%, an increase from 60.1% in 2005.

The governments of Sweden and Norway have agreed on a common market for green certificates (GCM) in order to promote new renewable energy projects until 2020. The new market mechanism is expected to annually generate 26.4 TWh electricity by 2020, where each country is financing 13.2 TWh. The system is neutral regarding renewable technologies, and the two countries share the same level of ambition regarding production increases of the common market.

[5] the European Economic Area (EEA) that unites the 27 EU Member States and Iceland, Liechtenstein and Norway into an Internal Market governed by the same basic rules

Annex 1

Energy Efficiency Measure Summary

Table 7 On-going Norwegian measures in the household sector of MURE

Code	Title	Type	Starting Year	Semi-quantitative Impact
NOR1	EU-related: Energy Labelling of Household Appliances (Directive 92/75/EC) - (Energimerking av hvitevarer)	Legislative/ Informative	1996	Low
NOR2	Local energy efficiency fund in Oslo (Enøkfondet i Oslo)	Financial	1981	Low
NOR6	Energy information helpline (Enovas svartjeneste)	Information/ Education	2003	Low
NOR10	Energy and environmental taxes	Cross-cutting	1975	Medium
NOR12	Energy saving loans (Husbanken)	Financial	1996	Low
NOR19	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Bygningsenergidirektivet	Legislative/ Informative	2010	High
NOR20	EU-related: Ecodesign Directive for Energy-using Products (Directive 2005/32/EC) - Energy efficiency requirement on new refrigerators, freezers and their combinations (Energieffektivitetskrav til kjøleskap, frysere og kombinasjoner av disse)	Legislative/ Normative	1999	Medium
NOR22	Grants for electricity savings in households (Tilskuddsordningen i husholdningene)	Financial	2006	Low
NOR23	Grants for energy savings in the built environment (Bygg, bolig og anlegg)	Financial	2005	Medium
NOR25	Educational awareness program for children about energy use and environmental impacts (Regnmakerne)	Information/ Education	2003	Low
NOR26	EU-related: Performance of Heat Generators for Space Heating/Hot Water (Directive 92/42/EEC) - Performance of Heat Generators for Space Heating and the Produciton of Hot Water (92/42/EEC) - Minimum energy efficiency standards for boilers	Legislative/ Normative	1998	Low
NOR28	Building regulations 2010 (Byggeforskrift 2010)	Legislative/ Normative	2011	High
NOR29	Information activities (media campaigns, magazine, exhibition material)	Information/ Education	2002	Unknown
NOR30	Energy guidance label "Enova Recommends" (Enova anbefaler)	Information/ Education	2008	Unknown

NOR31	National standard: Passive and low energy residential buildings	Information/ Education	2010	Unknown

Table 8 On-going Norwegian measures in the transport sector of MURE

Code	Title	Type	Starting Year	Semi-quantitative Impact
NOR1	Purchase tax on vehicles (Engangsavgift på motorvogner)	Fiscal	1959	Medium
NOR2	EU-related: Passenger Car Labelling on fuel economy rating (Directive 1999/94/EC) - New passenger car labelling on fuel economy rating (Energimerking av nye personbiler)	Legislative/ Informative	2001	Low
NOR3	Taxes on gasoline and auto diesel oil	Fiscal	1986	Medium
NOR4	Speed limits	Legislative/ Normative	1965	High
NOR5	Semiannual technical inspection of vehicles	Legislative/ Normative	1998	Low
NOR6	Reward scheme for better public transportation and reduced use of cars in cities (Belønning-sordningen)	Infrastructure	2004	Low
NOR8	Transnova	Co-operative Measures , Financial, Information/ Education/ Training, Infrastructure	2009	Low
NOR9	EU-related: Promotion of Biofuels or other Re-newable Fuels for Transport (Directive 2003/30/EC) - Promotion of the use of bio fuels or other renewable fuels for transport (2003/30/EC)	Financial, Fiscal	2009	High

Table 9 On-going Norwegian measures in the industry sector of MURE

Code	Title	Type	Starting Year	Semi-quantitative Impact
NOR1	Energy and environmental taxes	Cross-cutting	1975	Medium

NOR8	Energy efficiency in industry (Program for energieffektivisering i energiintensiv industri)	Co-operative Measures, Fiscal/ Tariffs	2005	Medium
NOR13	EU-related: EU Emission Trading Scheme (2003/87/EC) - Klimakvoteloven	New Market-based Instruments	2005	Medium
NOR15	Energy Consumption - Industry (Energibruk - industri)	Financial	2003	High
NOR16	Grants to renewable heat production and distribution – district heating and local heating plants (Program for fjernvarme og lokale energisentraler)	Financial	2008	Medium
NOR17	Energy information helpline (Enovas svartjeneste)	Information/ Education/ Training	2003	Low

Table 10 On-going Norwegian measures in the tertiary sector of MURE

Code	Title	Type	Starting Year	Semi-quantitative Impact
NOR4	Energy and environmental taxes	Cross-cutting	1975	Medium
NOR6	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Energy Performance of Buildings (2002/91/EC) - Bygningsenergidirektivet	Legislative/ Informative	2010	High
NOR14	Grants for energy savings in the built environment (Bygg, bolig og anlegg)	Financial	2005	Medium
NOR15	Local energy efficiency fund in Oslo (Enøkfondet i Oslo)	Financial	1981	Low
NOR16	Energy statistics of the Norwegian Building Network (Bygningsnettverkets energistatistikk)	Information/ Education/ Training	1997	Low
NOR17	Grants to renewable heat production and distribution - district heating and local heating plants (Program for fjernvarme og lokale energisentraler)	Financial	2008	Medium
NOR20	Minimum energy efficiency standards for boilers	Legislative/ Normative	1999	Low
NOR22	EU-related: Energy Labelling Office Equipment (Energy Star) - Energimerking av kontorutstyr	Information/ Education/ Training	2005	Low
NOR23	Building regulations 2010 (Byggeforskrift	Legislative/	2011	High

	2010)	Normative		
NOR24	Energy information helpline (Enovas svartjeneste)	Information/ Education/ Training	2003	Unknown
NOR25	Mandatory climate and energy plans in municipalities (Kommunale klima- og energiplaner)	Legislative/ Informative	2010	Low

Table 11 On-going Norwegian measures in the general cross-cutting sector of MURE

Code	Title	Type	Starting Year	Semi-quantitative Impact
NOR4	Energy policy	General Energy Efficiency / Climate Change / Renewable Programmes	2000	Low
NOR1	Energy Fund	Financial Measures	2002	High
NOR2	Local energy studies (Lokale energiutredninger)	Legislative/ Normative Measures	2003	Low
NOR6	New technology support: Technology verification (piloting) and technology qualification (demonstration)	Financial Measures, General Energy Efficiency / Climate Change / Renewable Programmes, Market-based Instruments	2005	Low

Annex 2

Country Profile

Energy Efficiency Profile : Norway

Energy Efficiency Trends

September 2012

Overview

In the period 2000-2010 the energy efficiency bottom-up index for the whole economy (ODEX) decreased by 17 %. The sector with the greatest improvement was industry in the period from 2000 to 2010.

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 24 % from 2000 to 2010, while the improvement from 1990 to 2000 was only 9 %. Norway had a strong growth in chemical industry in the 1990s, 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. Most industries were affected by the financial crises the last years, resulting in lower production and reduced energy efficiency. In pulp & paper industry this negative trend is observed since 2005, while the production of primary aluminium only shows a negative trend in energy efficiency in 2009-2010. In the chemical industry the energy efficiency index has continued to be improved also these last years.

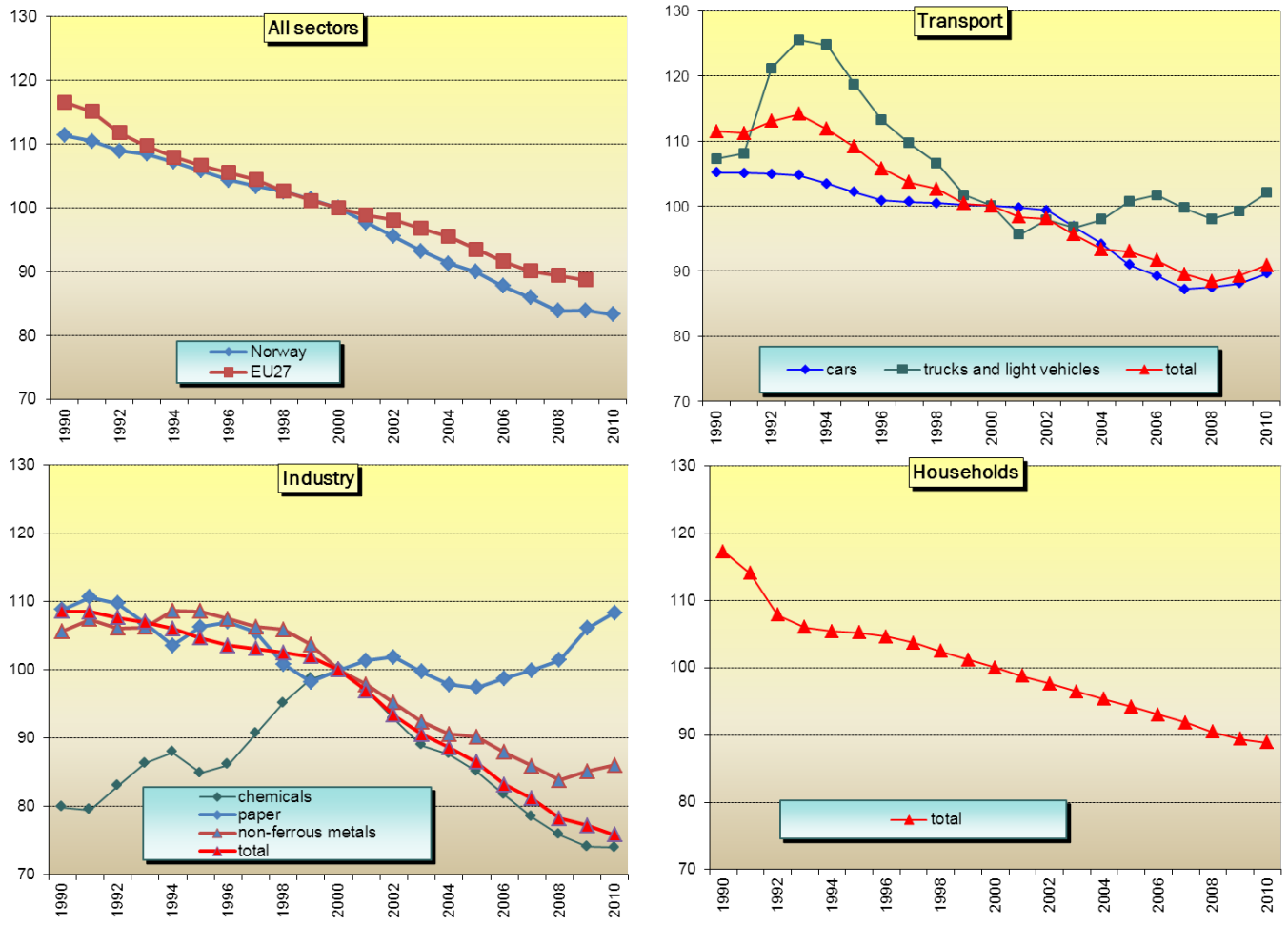
Households

Between 2000 and 2010, the household sector as a whole had an improvement of energy efficiency by 11 %. 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

The energy efficiency index of the transportation sector has improved by 9 % from 2000 to 2010. 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.

Energy efficiency index (base 100=2000)



Energy Efficiency Policy measures

Institutions and programmes

The alteration to a more environmental friendly production and use of energy in Norway is 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 income of the energy fund comes from a levy of NOK 0.01/kWh to the distribution tariffs and from allocation from the state budget.

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 0.1 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 grant has to be a triggering factor.
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 9 to 12 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.
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. Transnova was established in 2009 and is operating as a trial funding programme supporting projects making a fast contribution to the adoption of new and more environmentally friendly technologies or practices.

Energy prices and taxes

The electricity tax in Norway has been very low in a European perspective (14 €/MWh in 2011) 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	2001	16.6 TWh
Households	Grants for electricity savings in households	2006	1.4 TWh
Households	"Regnmakerne"	2003	
Industry	Energy end-use - Industry	2003	4.6 TWh
Buildings	Grants for energy savings in buildings	2002	3.3 TWh
Transport	Transnova	2009	

Institute for Energy Technology

Institute for Energy Technology
P.O. Box 40
NO-2027 Kjeller, Norway
Telephone: (+47) 63 80 60 00
Telefax: (+47) 63 81 63 56
www.ife.no