Energy Efficiency Policies and Measures in Germany

ODYSSEE- MURE 2010

Monitoring of EU and national energy efficiency targets

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Karlsruhe, November 2012

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1 Executive Summary

Between 1990 and 2011, both primary and final energy consumption in Germany decreased by 12 % and 8 % respectively. The corresponding energy intensities fell significantly by an average of 2.0 % and 1.8 % per year during that period. During the economic crisis between 2008 and 2010, however, an increase of both intensities was observed, i.e. a worsening of energy efficiency. In these years, energy consumption did not completely follow the downward economic development especially in the industrial sector due to a certain part of energy consumption which is independent from the actual production. With the economic recovery in 2011, however, both primary and final energy intensity decreased again at an above-average rate of more than 8 %.

Throughout the 1990s, the share of solid fuels in final energy consumption fell considerably, which can be explained by the drop of lignite as an energy carrier in East Germany. The shares of electricity, gas and renewables in total final consumption increased during the last 20 years, from whereas oil and district heat slightly lost market shares. With regard to the composition of final energy consumption by sector, the most important change between 1990 and 2011 in Germany was the rising share of the transport sector from 25 to 30 %. The share of the industrial sector dropped until the mid 2000s, but due to the relative high industrial growth since 2005 (apart from the recession year 2009) also in some energy-intensive branches, the share of industry in total final energy consumption in 2011 was almost the same as in 1990.

In order to evaluate pure energy efficiency trends in a country and to separate them from other factors like structural changes within the economy, changes in lifestyle, climatic variations or behavioural impacts, an aggregated energy efficiency indicator (ODEX) was developed in the ODYSSEE project. The ODEX summarizes the measured development of energy efficiency in a single indicator, but is calculated on a detailed level of around 30 branches, sub-sectors or application purposes. Between 1991 and 2010, the national ODEX in Germany improved by almost 24 %. On average, this means an energy efficiency improvement of 1.2 %/year for the period 1991-2010, which is a little lower than the decrease in the final energy intensity within that period. Whereas between 1991 and 2000, a continuous efficiency improvement by almost 1.7 %/year could be observed, the improvement slowed down to 0.8 %/year after 2000. During the 1990s, the industrial sector contributed most to this development, whereas the efficiency improvement in the transport and household sectors was smaller than for the whole economy. Since around 2000, this trend was reversed. Whereas the industrial ODEX even showed an increase – i.e. a worsening of energy efficiency - between 2001 and 2004 and again since 2007, the decrease in the household and transport sector sped up at least until 2008. Since then, the energy efficiency improvement in

these sectors remained stagnant, as well as the ODEX for the whole economy, too. For 2011, however, a further improvement of the ODEX is assumed for Germany (as in the case of final energy intensity), but could not be calculated due to a lack of some key data for 2011.

The detailed analysis of energy efficiency measures in Germany based on the MURE database showed that apart from legislative measures, which often go back to EU regulation, financial measures are dominant in Germany, especially in the residential sector. But they also play an important role in the industrial and tertiary sector. Up to now, these measures are mainly financed from the state-budget. In industry, there is also focus on cooperative measures like voluntary agreements and, since a few years, new market based instruments due the start of the European-wide Emissions Trading Scheme. In the transport sector, only a few measures clearly aim at energy efficiency.

During the last year, energy efficiency policy in Germany was especially triggered by two developments: the implementation of the ESD including the submission of two Energy Efficiency Action Plans (NEEAPs) in September 2007 and September 2011 and the decisions of the Federal Government on a transformation of the energy system from 2010 and 2011. In September 2010, the German Government adopted a new Energy Concept aiming at an overall strategy for the period up to 2050. With regard to energy efficiency, the Energy Concept includes ambitious targets both for a reduction of total primary energy consumption and at sectoral level. Among the nine fields of action, energy efficiency was seen as a key issue, besides the further development of renewable energies. Nuclear energy was originally seen as a bridging technology. As a consequence of the nuclear disaster in Fukushima on 11 March 2011, however, the German Government has rethought the planned prolongation of the operation life of nuclear power plants from September 2010 and decided on a phase-out of nuclear energy until end of 2022. With the decisions on an accelerated transformation of the energy system (the so-called “Energiewende”) from mid 2011, important cornerstones for future energy policy as a consequence were laid down.

With regard to energy efficiency, the building sector is regarded as the key to greater energy efficiency. The implementation of the measures announced for this sector is, however, starting slowly. A budget-independent financing of building refurbishment programmes (e.g. by White Certificates) from 2015 is just examined and the planned tax deductibility for energy-efficient building renovation is controversially discussed between the Federal Government and the Federal states.

2 Key messages

A first lesson learnt from the energy efficiency indicators calculated in the ODYSSEE database has been that the economic crisis that struck Germany, the European Union and part of the world since 2008 had a strong impact on energy efficiency progress, slowing considerably the trends observed before. To a large degree this was due to delayed investment in energy efficiency across all sectors and to low capacity use in the industry sector in particular. This hampers the reactivity of Germany and the European countries to the still very high energy prices despite the crisis and puts a burden on the economy once growth will be back and increases the pressure on energy prices. The first energy efficiency indicators available for 2011, which was a year of relatively high growth in Germany, seem to indicate that energy efficiency progressed considerably compared to the years before.

Nevertheless, also for Germany it is true that the economic crisis has enlarged the gap between the large investment needed to further improve energy efficiency, especially in the building sector, and the capacity of public funding. Therefore, there is a need to design stable mixtures of policy instruments, depending only partially on public budgets in order to provide the required long-term stability to investors in energy efficiency investments. This is a crucial point in order to achieve both the ambitious energy efficiency targets which Germany has set at the national level in its Energy Concept from 2010 and the targets set by the European Union for the Member States.

Another key message is that the need for energy efficiency indicators and knowledge on the quantitative impact of energy efficiency policies as developed in the ODYSSEE-MURE project has been increasing a lot at national and EU level with the implementation of ESD and the need to monitor the energy savings in the NEEAP and to evaluate policy impacts. The new Energy Efficiency Directive (EED), which will substitute the ESD, will even increase the need for monitoring by indicators and impact assessment, since according to Article 24, the monitoring demands have been extended compared to the ESD, as a yearly progress report has to be delivered by the Member States. The measure impact assessment at national level is increasingly becoming more sophisticated. In Germany, this is even more important since another monitoring process at the national level has been pushed forward with the “Energiewende” decisions. Both the implementation of the agreed policy measures and the targets themselves are to be examined at regular intervals. The corresponding monitoring process “Energy of the future” was approved by the German government on 19 October 2011. The progress made towards the overall targets and the current state of measure implementation are evaluated in an annual report. These annual reports are supplemented every three

years by a summarised, strategically oriented progress report of the German government.

To sum up, the direction of future energy efficiency policy in Germany will both depend on the further implementation of the policy measures proposed in the Energy Concept and in the “Energiewende” decisions and on the way how the demands of the new Energy Efficiency Directive (EED) of the EU will be implemented at the national level. This mainly concerns Article 7 of the new EED, which asks for the implementation of energy efficiency obligation systems in all Member States but also allows the further development of existing energy policies if the same quantitative target is achieved.

3 The Background to Energy Efficiency

3.1 Overall economic context

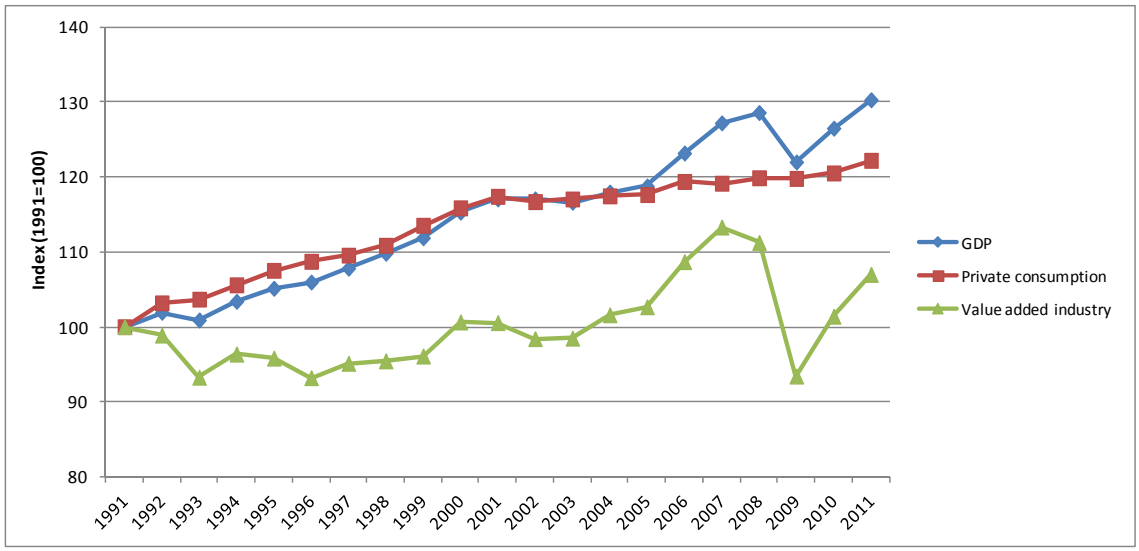
In 2011, total real GDP in Germany amounted to 2452 billion €$_{05}$. After a stagnation between 2001 and 2003, GDP increased again between 2004 and 2008, followed by a strong decline in 2009 due to the financial crisis. Since 2009, however, an above-average growth could be observed again in Germany. The average growth rate of GDP has been around 1.3 % between 1991 and 2011 (see Table 3-1 and Figure 3-1). Whilst the private consumption increased continuously during the 1990s, it has been more or less constant since the beginning of the century. Only in 2011, the growth rate was more pronounced. This means that at least up to 2010, private consumption did not contribute to the rising growth of GDP, which was mainly triggered by exports. Value added of industry also showed a fairly poor development since 1991, which only changed between 2005 and 2007 and especially since 2009, which were periods with a relatively strong industrial growth in Germany. In the course of the financial crisis in 2008, however, industrial value added stronlgy declined by 16 %.

Table 3-1: Real growth of GDP, private consumption and industry value added in Germany since 1991 (in %/year)

	1991-2011	1991-2001	2001-2011	2008-2009	2009-2011
GDP	1.3%	1.6%	0.5%	-5.1%	3.3%
Private consumption	1.0%	1.6%	0.2%	-0.1%	1.0%
Value added industry	0.3%	0.1%	0.3%	-16.0%	7.0%

Source: Federal Statistical Office 2012 (National Accounts)

Figure 3-1: Macro-economic development in Germany, 1991-2011



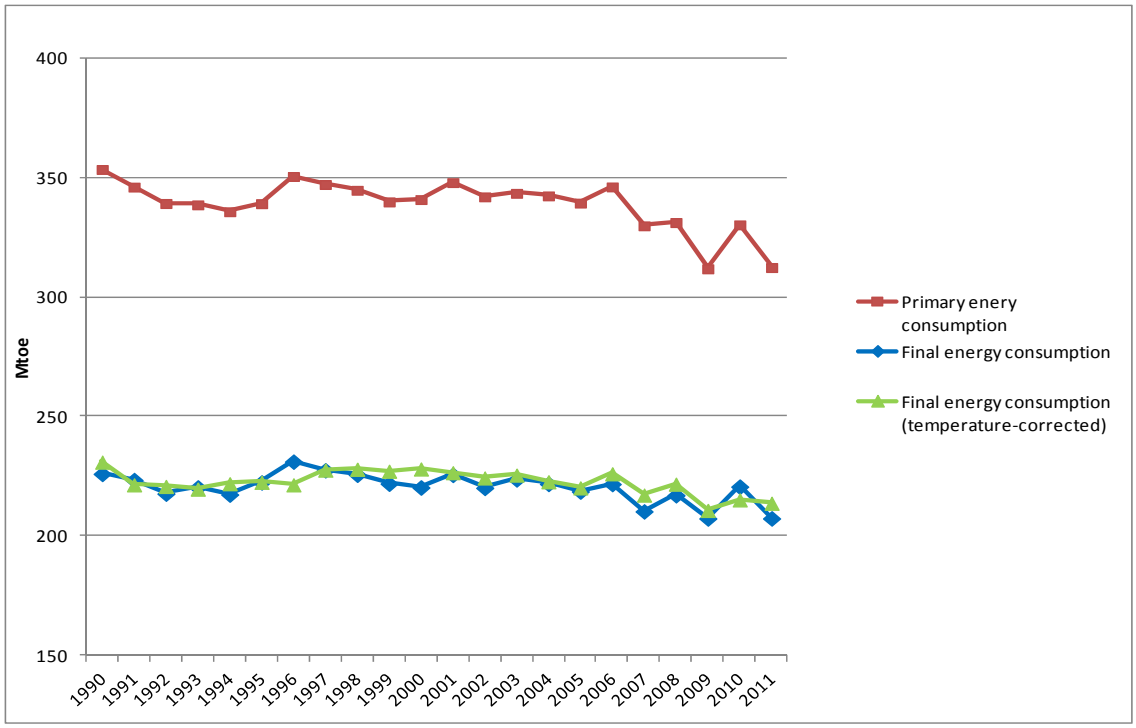
Source: Federal Statistical Office 2012 (National Accounts)

3.2 Energy consumption trends by fuel and by sector

In Germany, primary energy consumption fell from 355 Mtoe in 1990 to 313 Mtoe in 2011, i. e. by almost 12 % or 0.5 %/yr (Figure 3-2). Between 1996 and 2006, primary consumption remained relatively stable, except for a peak in the year 2001, which was, however, partly due to the considerably colder weather. Between 2006 and 2011, primary energy consumption predominantly showed a decreasing trend, which partly reflects the decline in GDP and value added during the financial crisis in 2008 (Figure 3-1). The only exemption of this trend was the year 2010, which was both characterized by an increasing economic growth and a relatively cold weather. The impact of weather fluctuations on energy consumption is also shown by the different development of final energy consumption with and without temperature correction (Figure 3-2). Starting from 1990, most of the years up to 2011 were warmer than the long-term average year (in terms of degree days) with the exception of 1991, 1996 and 2010. As a result it can be seen that the temperature-corrected final energy consumption can be found above the real consumption except the three cold years.

During the last 20 years, the development of final energy consumption was similar to primary energy. In total, final energy consumption fell from 226 Mtoe in 1990 to 208 Mtoe in 2011 (excluding non-energy consumption). With 8.2 % or 0.4 %/yr, the decrease, however, is slightly below primary energy (Figure 3-2).

Figure 3-2: Development of primary and final energy consumption in Germany between 1990 and 2011

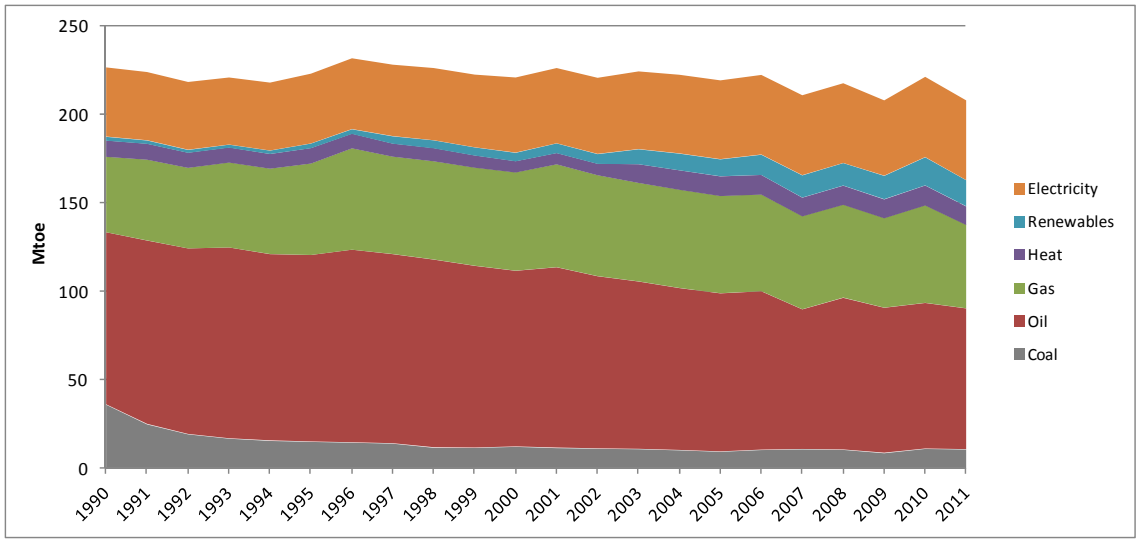


Source: AGEB 2012; calculations Fraunhofer ISI

Throughout the 1990s, the share of solid fuels in final energy consumption fell considerably, which can be explained by the drop of lignite as an energy carrier in East Germany, which used this cheap form of combustion heavily before Germany got reunified. The shares of electricity, gas and renewables in total final consumption increased during the last 20 years, from whereas oil and district heat slightly lost market shares (Figure 3-3 and Figure 3-4).

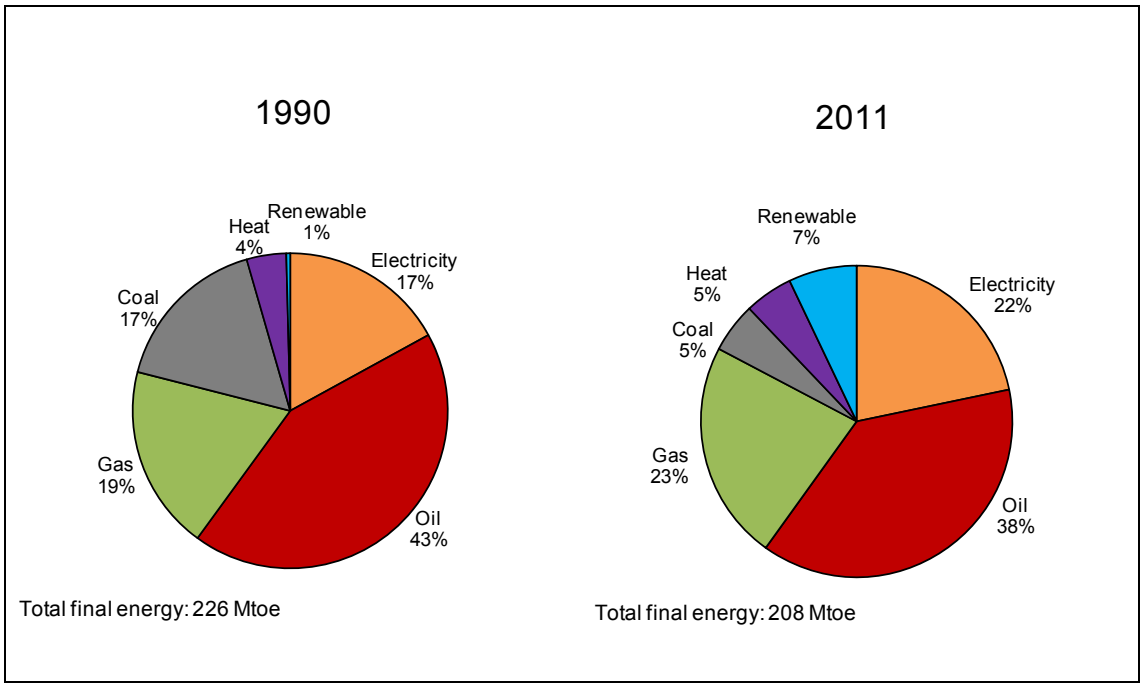
With regard to the composition of final energy consumption by sector, the most important change between 1990 and 2011 in Germany was the rising share of the transport sector (Figure 3-5 and Figure 3-6). The share of the industrial sector dropped until the mid 2000s, but due to the relative high industrial growth since 2005 (apart from the recession year 2009), the share of industry in total final energy consumption in 2011 was almost the same as in 1990.

Figure 3-3: Final energy consumption (excl. non-energy consumption) by energy carrier in Germany, 1990-2011



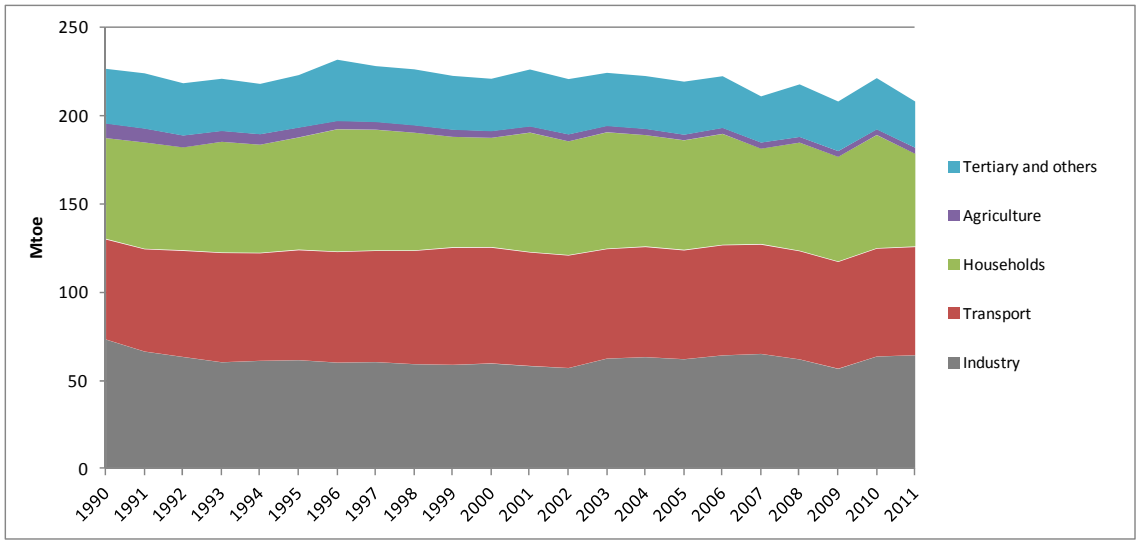
Source: AGEB 2012

Figure 3-4: Shares of energy carriers in total final energy consumption (excl. non-energy consumption), 1990 and 2011



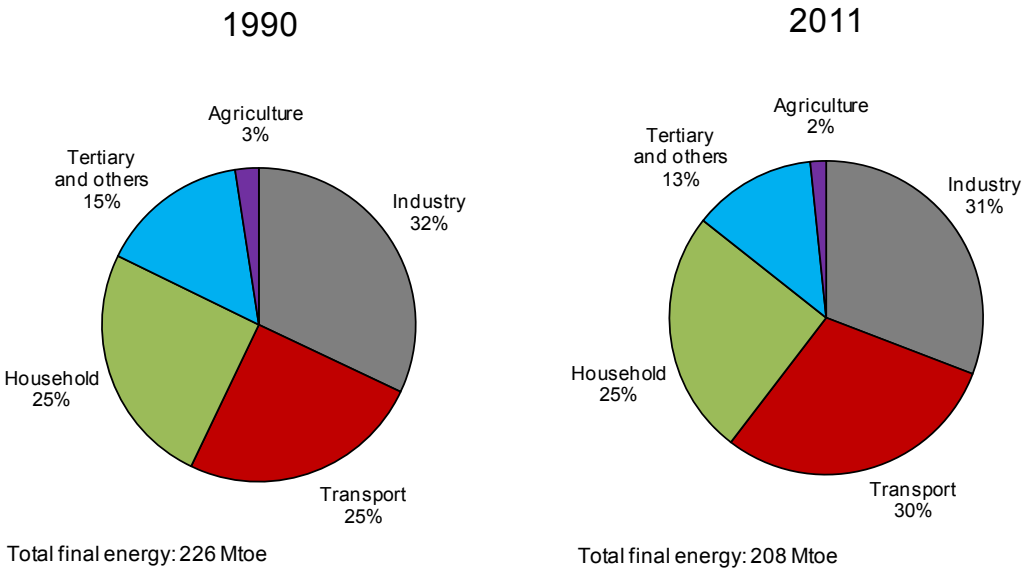
Source: AGEB 2012

Figure 3-5: Final energy consumption (excluding non-energy consumption) by sector in Germany, 1990-2011



Source: AGEB 2012

Figure 3-6: Shares of sectors in total final energy consumption (excluding non-energy consumption) in Germany, 1990 and 2011



Source: AGEB 2012

3.3 The policy background to energy efficiency

In Germany, the main responsibility for most energy policy issues at the Federal level (incl. energy efficiency policy) lies with the Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie; BMWi). The BMWi is also in charge of the national implementation of the EU Directive on energy end-use efficiency and energy services (2006/32/EC; ESD), which became effective on 17 May 2006. The same will apply to the new European Directive on Energy Efficiency (EED), whose entry into force of the EED is expected in November 2012, and which will replace the ESD. The authority which is responsible for the overall control of the framework set up to achieve the ESD (and the new EED) energy saving target in Germany, is the Federal Agency for Energy Efficiency (Bundestelle für Energieeffizienz; BfEE). It was established in January 2009 within the Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle; BAFA), which is a Federal authority subordinated to the BMWi. The responsibility for renewable energies lies with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit; BMU), which is also in charge of climate policy. Energy issues related to transportation are under the responsibility of the Federal Ministry for Transport, Buildings and Housing (BMVBW), which also has an advising function with regard to energy efficiency in buildings. In order to implement the europe-wide greenhouse gas emissions trading system, the Emissions Trading Authority (Deutsche Emissionshandelsstelle; DEHSt) was established within the German Environmental Agency (Umweltbundesamt; UBA). The DEHSt is responsible for the distribution of emissions allowances, the monitoring of the emissions trading system, and the national and the international communication.

An important role with regard to the enforcement of energy efficiency in Germany also plays the German Energy Agency (Deutsche Energie-Agentur; dena)[1]. The German Energy Agency was established in 2000 with its head office in Berlin. Shareholders in dena are the Federal Republic of Germany, KfW Bankengruppe, Allianz SE, Deutsche Bank AG and DZ BANK AG. The German Energy Agency is a performance- and profit-oriented company and was established with a mission to operate at the interface between politics and business. Therefore, its projects are financed with the help of a large number of partners from the public and private sectors. In 2010 total revenue of dena was 20.6 million euros. Between 2005 and 2010, 50 per cent of average revenue came from public grants and 50 per cent from cooperation with private partners.

[1] http://www.dena.de/en.html

During the last year, energy efficiency policy in Germany was especially triggered by two developments: the implementation of the ESD including the submission of two Energy Efficiency Action Plans (NEEAPs) in September 2007 and August 2011 (for more details see Chapter 6) and the decisions of the Federal Government on a transformation of the energy system from 2010 and 2011.

On 28 September 2010, the German Government adopted the "Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply" (BMWi/BMU 2010). The aim was to develop an overall strategy for the period up to 2050. Among the nine fields of action (among others the expansion of renewable energies, grids and storage capacities and the limited extension of the operation live of existing nuclear power plants by an average of 12 years), energy efficiency was seen as a key issue, since the Energy Concept is based on a dual strategy: reduction of energy demand by significantly increasing energy efficiency and covering the remaining energy demand largely by renewables. Nuclear energy was originally seen as a bridging technology. As a consequence of the nuclear disaster in Fukushima on 11 March 2011, however, the German Government has rethought the planned prolongation of the operation life of nuclear power plants and decided on a phase-out of nuclear energy until end of 2022. With the decisions on an accelerated transformation of the energy system (the so-called "Energiewende") of the Federal Government from June 6th, 2011 and the decisions of the Bundesrat from July 8th, 2011, important cornerstones for future energy policy as a consequence of the nuclear disaster in Fukushima were laid down[2].

The Energy Concept from September 2010 already included both relatively ambitious energy efficiency targets and specific policy measures for achieving these targets. These targets were confirmed by the "Energiewende" decisions from 2011 and additional policy measures were announced in order to accerelate the transformation of the energy system (BMU 2012). At the level of the whole economy, primary energy consumption shall be reduced by 20% until 2020 and by 50% until 2050, both compared to 2008. Electricity consumption is planned to be cut by 10 % until 2020 and by 25 % until 2050, again compared with 2008. In addition, the following sectoral energy efficiency targets have been set in the Energy Concept: for buildings a doubling of the building renovation rate from about 1 % to 2 % and a reduction of the heating requirements by 20% until 2020 and by 2050 a reduction of the primary energy demand by 80% for transport a reduction in final consumption by about 10% by 2020 and 40% by 2050, in this case compared to 2005. Some important policy measures laid down in the Energy Concept and the "Energiewende" decisions in order to achieve these targets are presented in Chapter 5.1.

[2] http://www.bmu.de/english/transformation_of_the_energy_system/chronology/doc/48051.php

4 Overall Assessment of Energy Efficiency Trends

The following analysis of energy efficiency trends in Germany since 1990[3] is based on the ODYSSEE database on energy indicators. The ODYSSEE database (www.odyssee-indicators.org) was built-up for the regular monitoring and evaluation of energy efficiency trends and energy-related CO_2 emissions at a yearly basis. The energy indicators are calculated for the years from 1990 onwards (EU-15 countries) or from 1996 onwards (new Member States) using harmonised calculation methods (Enerdata 2008). The input data for the indicators are provided by national energy agencies or institutes[4] according to harmonised definitions and guidelines and mainly based on national statistics and other national data sources. The data sources which are used for Germany are described in detail in Annex 3.

4.1 Overall trends in energy intensity

There are two general indicators which are often used to characterise the overall energy efficiency of an economy: the primary energy intensity and the final energy intensity, i. e. the relationship between primary or final energy consumption and Gross Domestic Product (GDP).

In Germany, primary energy intensity fell by 34 % or 2.0 % per year between 1990 and 2011. During the 2000s, the decrease was slightly more pronounced than during the 1990s (Table 4-1). Over the whole period, the decrease went relatively continuously, but was interrupted by short periods of stagnation and a few years showing the reverse development (Figure 4-1). All years showing an increasing trend in energy intensity, i.e. 1993, 1996 and 2009/2010, were years with a downward trend of industrial value added and a stagnation or decrease in GDP (Figure 3-1). In these years, energy consumption did not completely follow the economic development especially in the industrial sector due to a certain part of energy consumption which is independent from the actual production. The development of final energy intensity since 1990 was very similar to the primary intensity, only the rate of the decrease was slightly smaller (Table 4-1 and Figure 4-1). Only in the period from 2008 to 2011, which was characterized by strong fluctuations in the economic development in Germany (Figure 3-1), the differences between both intensities were more pronounced or even showed a reversal (as in 2008; see Table 4-1).

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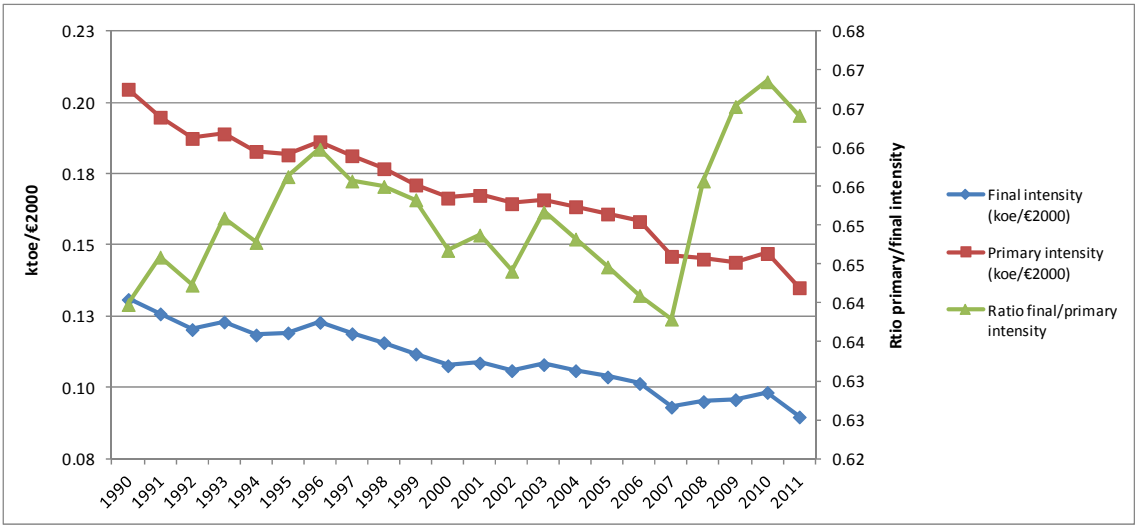
3 For Germany, many indicators can only be calculated from 1991, since due the unification in 1989, most of the official statistics only started in 1991 for Germany as a whole.

4 The national partner for Germany is the Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI) in Karlsruhe, Germany (www.isi.fraunhofer.de).

Table 4-1: Variations in final and primary energy intensity in Germany (in %/year)

	1990-2011	1990-2001	2001-2011	2008-2009	2009-2010	2010-2011
Primary intensity	-2.0%	-1.8%	-2.1%	-0.7%	2.1%	-8.2%
Final intensity	-1.8%	-1.7%	-1.9%	0.7%	2.6%	-8.7%

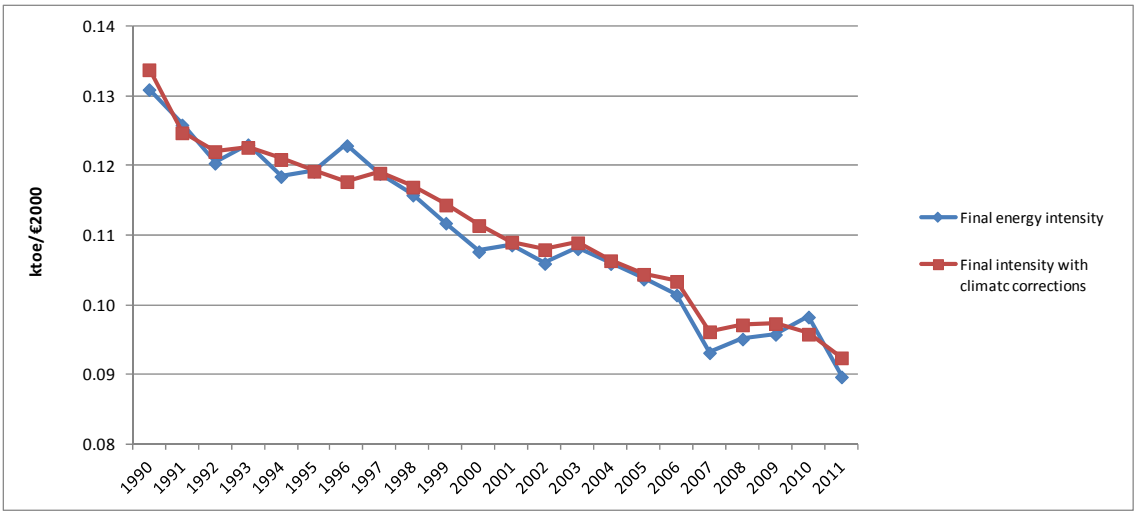
Figure 4-1: Development of primary and final energy intensity in Germany between 1990 and 2011



The predominantly similar trends in the development of final and primary energy intensity are also shown by another indicator, which is the relationship between these two intensities. In Germany, this ratio increased during the first half of the 1990s and again between 2007 and 2010 (Figure 4-1). This reflects the stronger decrease in primary energy intensity than in final energy intensity during these periods.

The development of primary or final energy intensity over time is often used as an indicator for the overall energy efficiency of all final consumers. Given that the focus lies upon short-term variations, these indicators are prone to be distorted by climatic variations from year to year. The influence of climatic variations on the development of final energy intensity in Germany is shown in Figure 4-2. Starting from 1990 most of the years up to 2011 (with the exception of 1991, 1996 and 2010) were warmer than the long-term average year (in terms of degree days). As a result it can be seen that the climate corrected final energy intensity can be found above the real intensity in most of the years. Regarding the total period from 1990 to 2011, the decrease in final energy with climatic corrections was a little smaller than the uncorrected decrease.

Figure 4-2: Final energy intensity in Germany and the role of climatic variations, 1990-2011



Apart from short-term fluctuations, the expressiveness of aggregate energy intensities is also limited by many structural effects within or across the different energy consumption sectors (e.g. sector or product structure in the industrial and tertiary sectors) and economic rebound effect, i.e. additional quantity effects, which are mainly dependent on income (e.g. larger living area per household, higher room temperature, larger energy-using appliances). These effects can at least partly be corrected at the sectoral level in order to enhance the meaningfulness of economic energy intensities or specific energy consumption values in a more technical sense. This will be described in the following Chapters. In addition, an alternative aggregated energy efficiency indicator ODEX is presented which - unlike the primary or final energy intensity - takes into account short-term fluctuations as well as some structural and economic rebound effects and separates them from changes primarly attributable to changes of energy efficiency in a technical sense.

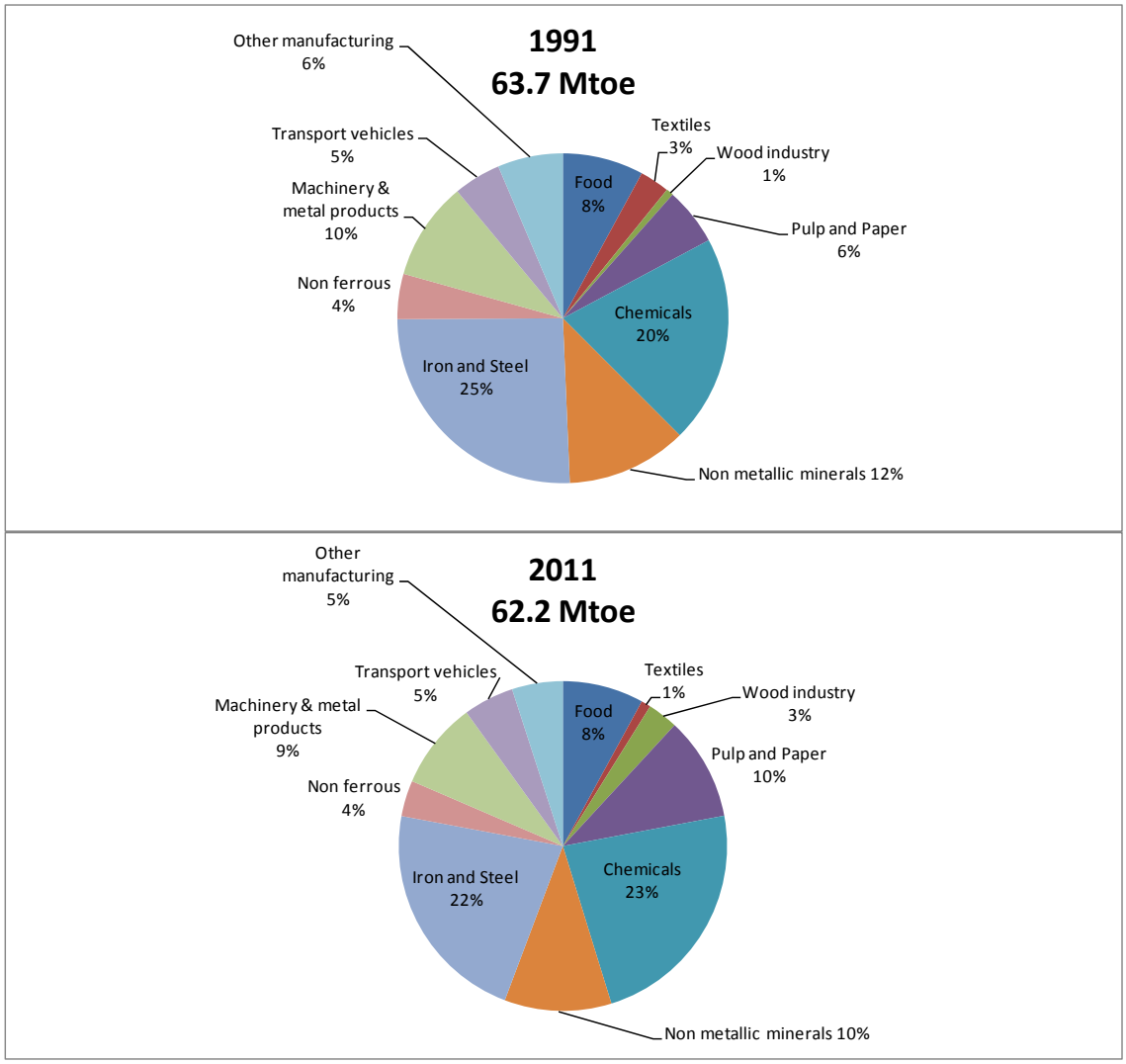
4.2 Industry

In 2010, final energy consumption of industry (incl. construction industry) in Germany amounted to 62.2 Mtoe, which is only slightly below the level of 1991 (Figure 4-3). Until the beginning of the 2000s, industrial energy consumption had fallen to around 55 Mtoe, which was mainly due to the strong decline in industrial production in East Germany. But from 2003, it increased again to the present level, only interrupted by a decline in 2009 because of the economic recession.

Energy consumption by branches did not change significantly in Germany during the last 20 years (Figure 4-3). The most important energy consumer is the iron and steel

industry, whose share only slightly fell from one quarter of manufacturing energy consumption to 22 % in 2011. This is due to the regained strength of the steel industry in Germany from the beginning of the new century. The share of the other very energy-intensive branches (non-ferrous metals, non-metallic minerals, chemicals, pulp and paper) in total energy consumption of manufacturing amounted to 44 % in 2011, which even means a slight increase compared to 1991 (42 %).

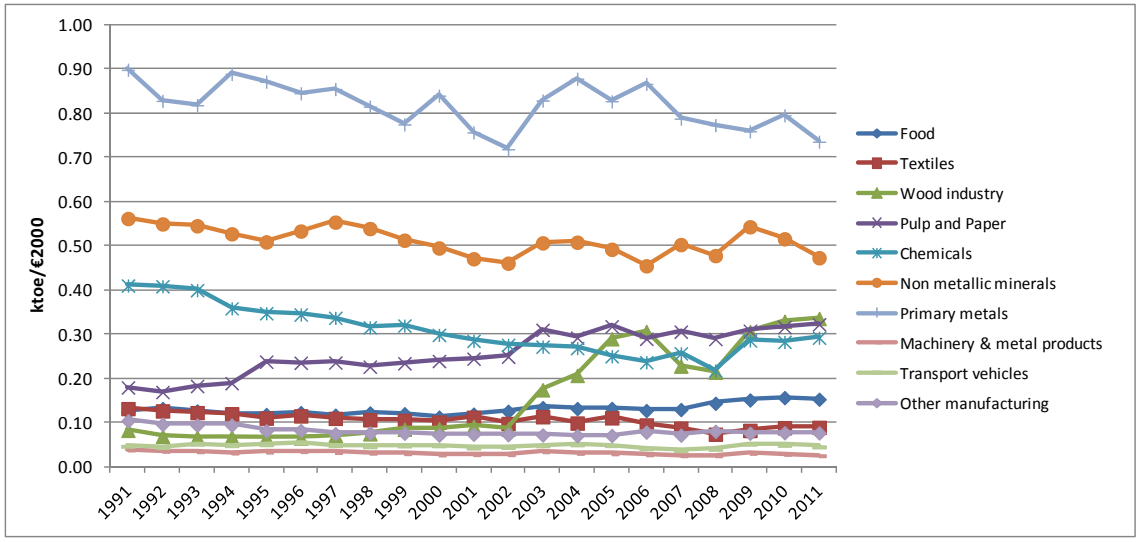
Figure 4-3: Energy consumption in the industrial sector by branches, 1991 and 2011



The highest energy intensity within manufacturing industry is shown by the iron and steel industry, though it fell considerably since 1991 (Figure 4-4). Energy intensity of the other energy-intensive branches also decreased continuously since then. In 2003 and 2004, a rising trend seemed to start, which was dampened by the chemicals and non-metallic minerals industry. Thus the index floated only moderately since then. The

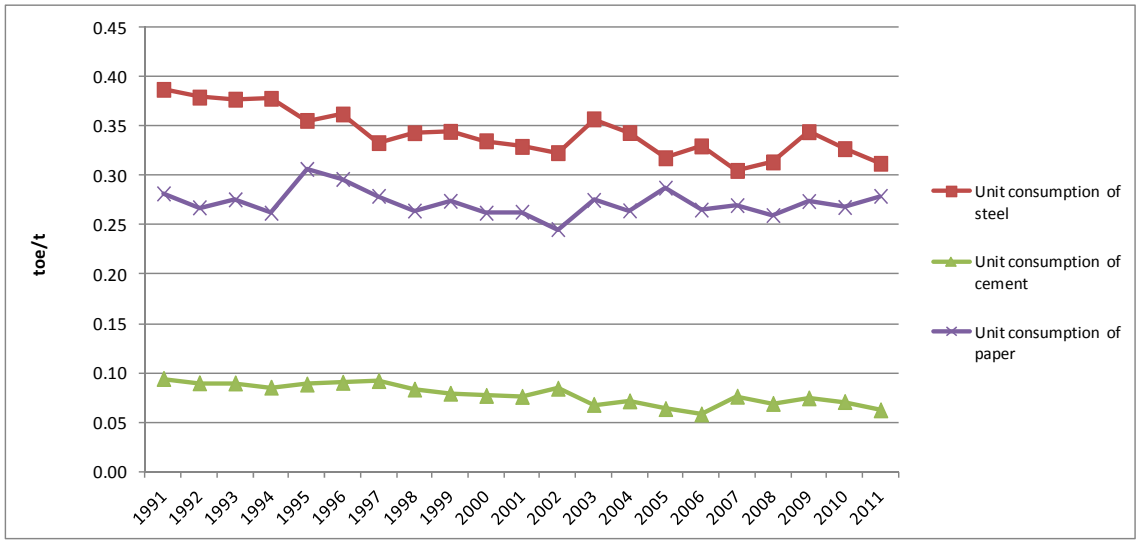
world wide increase in demand for steel products might have led to an increase intensity of steel products. With regard to the branches with a relatively lower energy intensity (food, machinery and equipment goods, textiles), the development was rather balanced.

Figure 4-4: Energy intensity within manufacturing industry 1991-2011



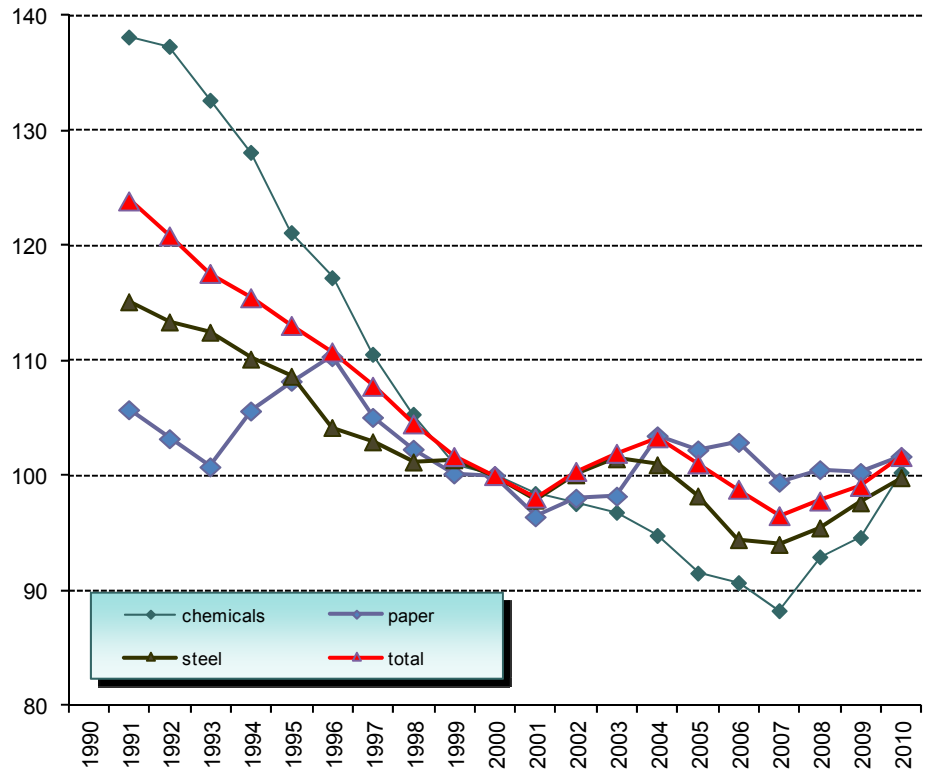
Unit consumption (energy consumption per ton) of most of the selected energy-intensive products (crude steel, pulp and paper, cement) showed a falling trend since 1991 (Figure 4-5). Since the beginning of the 2000s, however, the unit consumption decrease slowed down and there also were more periods with a rising trend, especially in the case of steel.

Figure 4-5: Unit consumption of selected energy intensive products 1991-2011



The efficiency progress in the industrial sector is also measured by an energy efficiency index (ODEX), which measures the efficiency development at the level of 10 industrial branches (in terms of energy used per production index or per ton) and aggregates this development to the whole sector (Figure 4-6 which only shows selected branches). During the 1990s, energy efficiency in industry, as measured by the industrial ODEX, improved by about 24 %, which was at least partly due to the breakdown of industry in Eastern Germany in the first half of the 1990s. Since 2001, however, energy efficiency progress slowed down or even turned back in some branches, especially in the energy-intensive steel and paper industries. After a phase of further energy efficiency improvement between 2004 and 2007, the following years were again characterized by an increase of the ODEX in manufacturing, i.e. a worsening of energy efficiency, both at the level of the energy-intensive branches and for manufacturing industry as a whole.

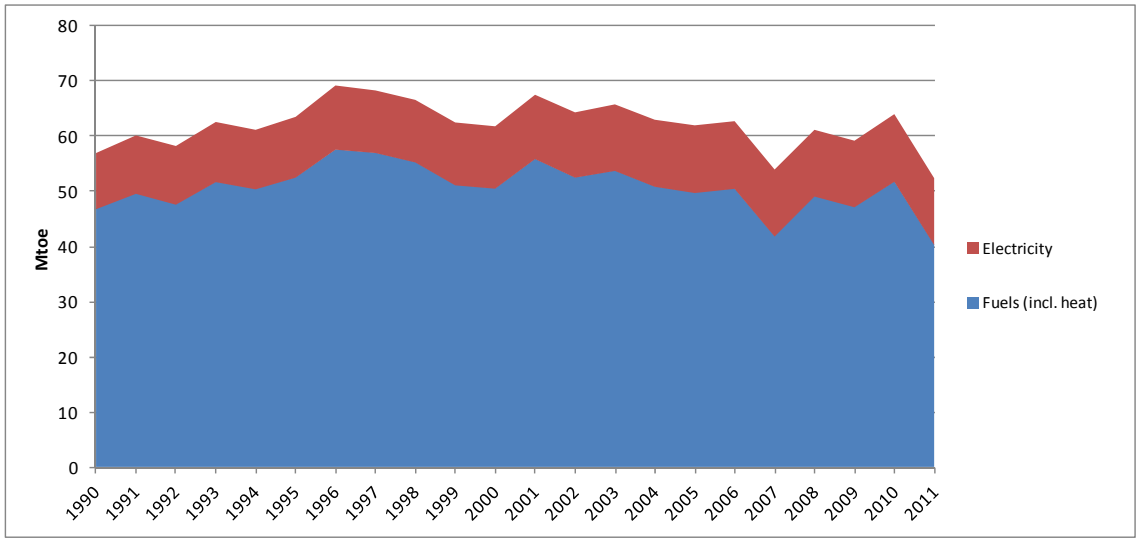
Figure 4-6: Energy efficiency trends in manufacturing 1991-2011 measured with the ODEX



4.3 Private households

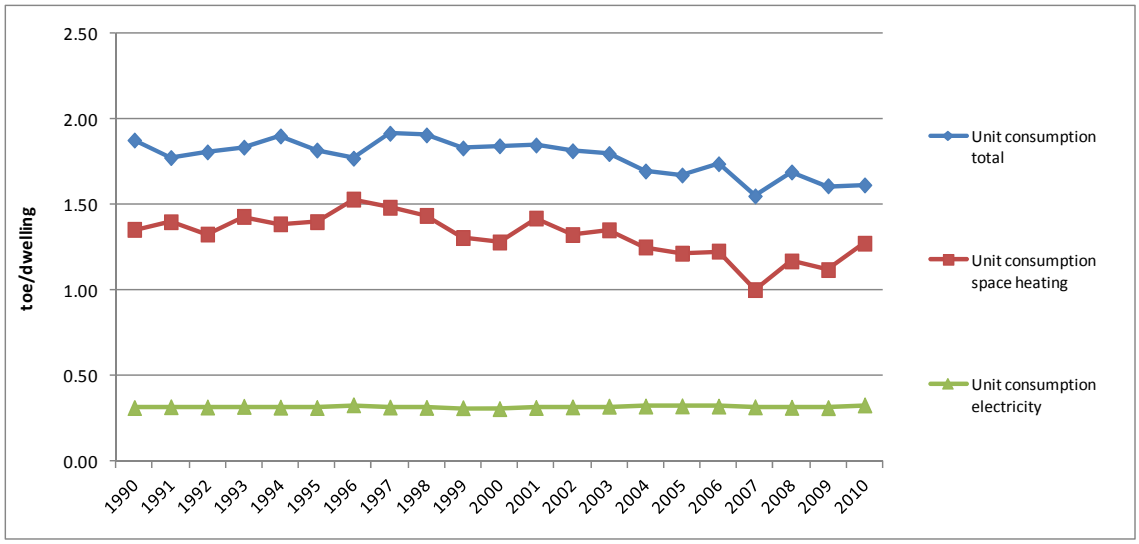
Between 1990 and 2011, energy consumption in the household sector (not climate-corrected) fell from 57 to 52 Mtoe, i.e. by around 8 % (Figure 4-7). The decrease was caused by a strong decline in fossil fuels/heat consumption (-14 % since 1990). Electricity consumption however continued to rise until 2003, from then, it remained relatively stable at around 12 Mtoe. In 2011, the share of electricity in total household energy consumption amounted to 23 %.

Figure 4-7: Fuel and electricity consumption in households (not climate-corrected), 1990-2011



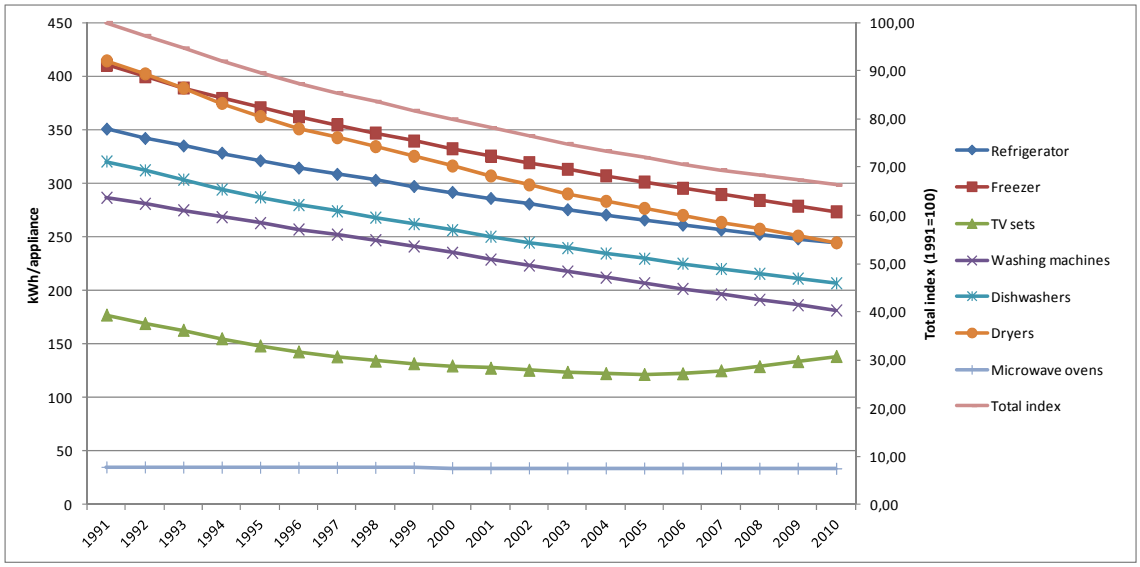
The average unit consumption per dwelling showed a non-uniform development, which is dominated by the development for space heating, which is responsible for more than three quarters of total consumption (see Figure 4-8). Between 2002 and 2007, a continuous decrease has started both for space heating and total unit consumption per dwelling (figures are climate-corrected). From 2007, however, unit consumption increased again. Electricity consumption per dwelling only slightly changed over the whole period. The non-uniform development of unit consumption per dwelling is due to the fact that it is influenced by several determinants, which partly compensate each other: fuel substitution, higher energy efficiencies due to thermal regulations, changes in dwelling size or heating system (trend to central heating), changes in the share of single and multi-family dwellings and not least behavioural factors as e. g. a trend to higher indoor temperature or a more intensive use of electrical appliances or lamps.

Figure 4-8: Unit consumption of private households in toe/dwelling (total and space heating climate-corrected), 1990-2010



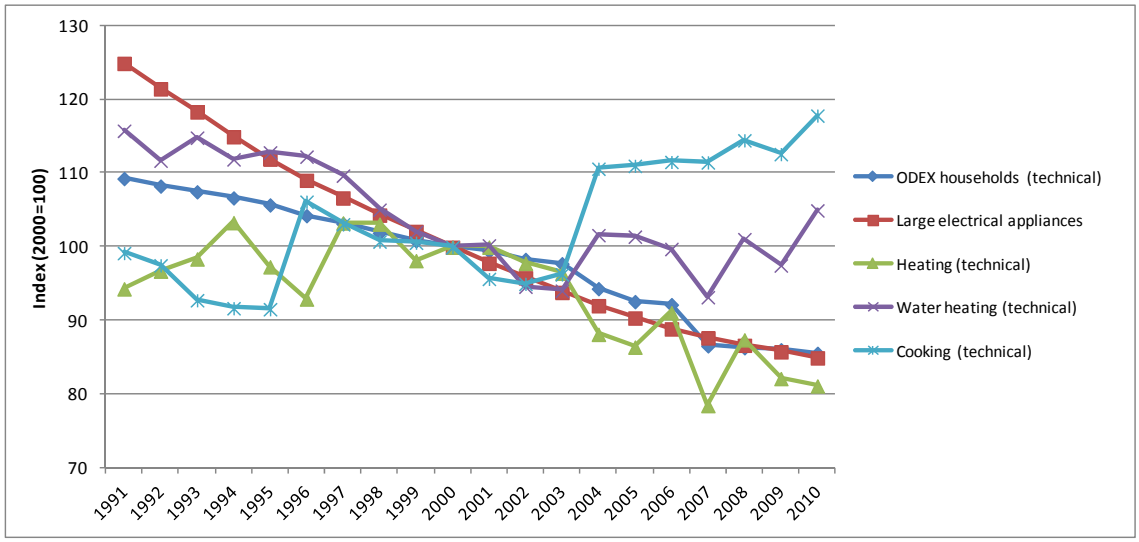
The specific electricity consumption of most of the major household appliances in Germany decreased considerably between 1991 and 2011, thus improving the energy efficiency considerably (Figure 4-9). Only for TV sets, an increasing trend was observed since 2006, which was mainly due to the increasing size of TV screens. It must, however, be noted that these data are not available from yearly statistics or surveys, but had to be taken from modelling calulations (Prognos 2010; also see Annex 3) and therefore may not fully reflect the yearly status of the appliance stock.

Figure 4-9: Specific consumption of electrical household appliances, 1991-2010



For the residential sector, the bottom-up energy efficiency index (ODEX) is calculated at the level of eight end-uses or appliances: heating, water heating, cooking and five large appliances (refrigerators, freezers, washing machines, dishwashers, TV). The main methodological problem of the household ODEX is to clean the indicator from behavioural factors, which play an important role in the household sector and often compensate energy efficiency gains (as e. g. a higher indoor temperature, increasing use and number of lamps, increasing use of TV, increasing use of hot water). In order to solve this problem, the calculation of the household ODEX was revised in 2006 and a so-called "technical ODEX" was calculated, which separates technical and behavioural trends by assuming that technical energy efficiency cannot be reverse. Between 1991 and 2010, the technical ODEX in the household sector as a whole decreased by about 23 %, which represents an average energy efficiency improvement of 1.3 %/year (Figure 4-10). Especially the efficiency of the five large appliances considerably improved. The development of the household ODEX is strongly influenced by the heating sector. Here, the improvement accarelated between 2002 and 2008, which was also reflected in the total household ODEX Since 2009, however, a stagnation can be observed.

Figure 4-10: Energy efficiency trends in the household sector measured by the ODEX, 1991-2010



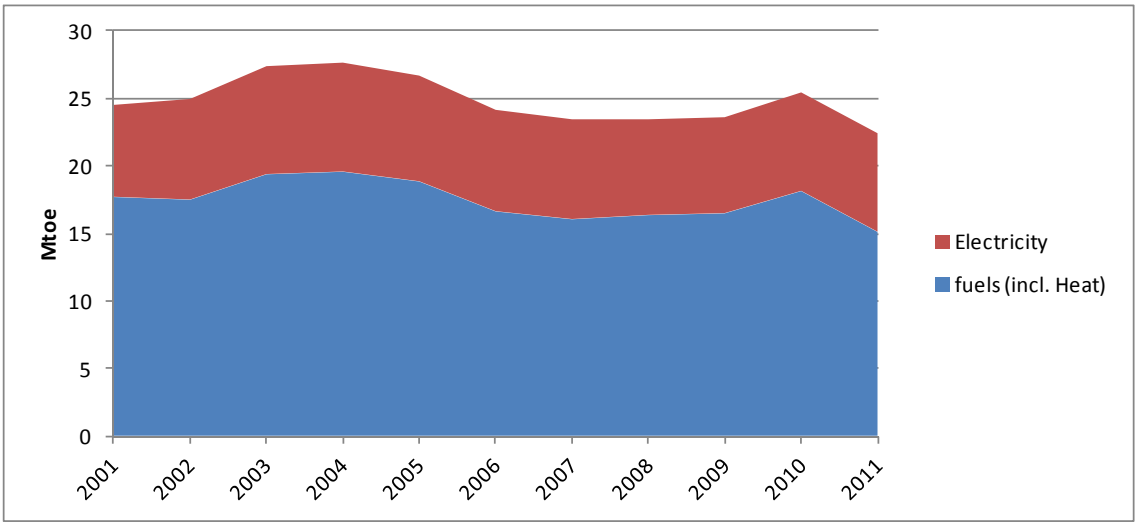
4.4 Services

The German energy balance (AGEB 2012) only shows energy consumption of the total tertiary sector, broadly defined as private and public services, agriculture, construction industries and military. In 2011, energy consumption of this aggregate amounted to

31 Mtoe. This is around 15 % of total final energy consumption in Germany and a decrease by 25 % compared to 1990. The energy consumption of the service sector only, including private and public services, was estimated based on the data of a regular survey of energy consumption in the tertiary sector in Germany, which distinguishes several branches (Table 4-2). These data are available from 2001 (see Annex 3).

Between 2001 and 2011, energy consumption in the service sector fell by almost 9 % from 25 to 22 Mtoe (Figure 4-11). Between 2002 and 2004 and again in 2010, a consumption increase was observed. In 2011, around 32 % of final energy consumption in the tertiary sector can be ascribed to electricity which remained relatively stable since 2006.

Figure 4-11: Electricity and fuel consumption in the service sector in Germany (not climate-corrected), 2001-2011



Especially between 2004 and 2008, the energy intensity per value added and unit consumption per employee in the service sector (i.e. only private and public services) showed a sharp decrease, which slowed down afterwards (Figure 4-12).

For the tertiary sector, a re-aggregated energy efficiency index (ODEX) cannot be calculated in ODYSSEE due to the poor data situation at the level of end-uses and subsectors in most of the countries. For Germany, the data situation has improved due to regular energy consumption surveys in more than 2000 companies, which have now been conducted every 2 years starting in 2001 (see Annex 3). The survey results were extrapolated to Germany as a whole. The data for the years without an original survey were interpolated (Table 4-2).

Figure 4-12: Energy Intensity and Unit Consumption in the service sector (private and public services) 2001-2010

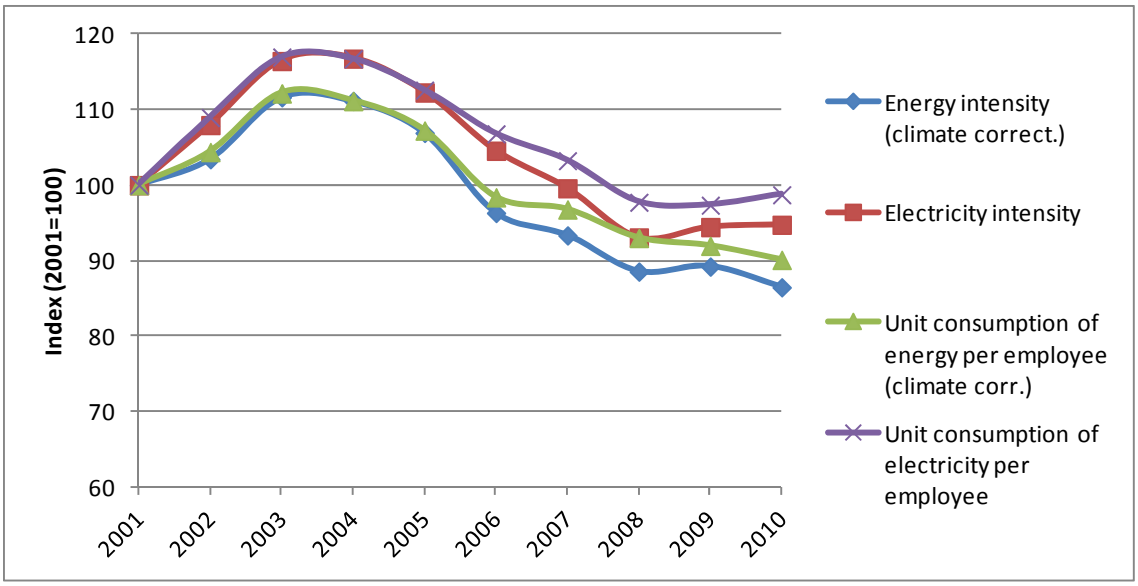


Table 4-2: Energy consumption in the tertiary sector in Germany by branches (in PJ), 2006 to 2010

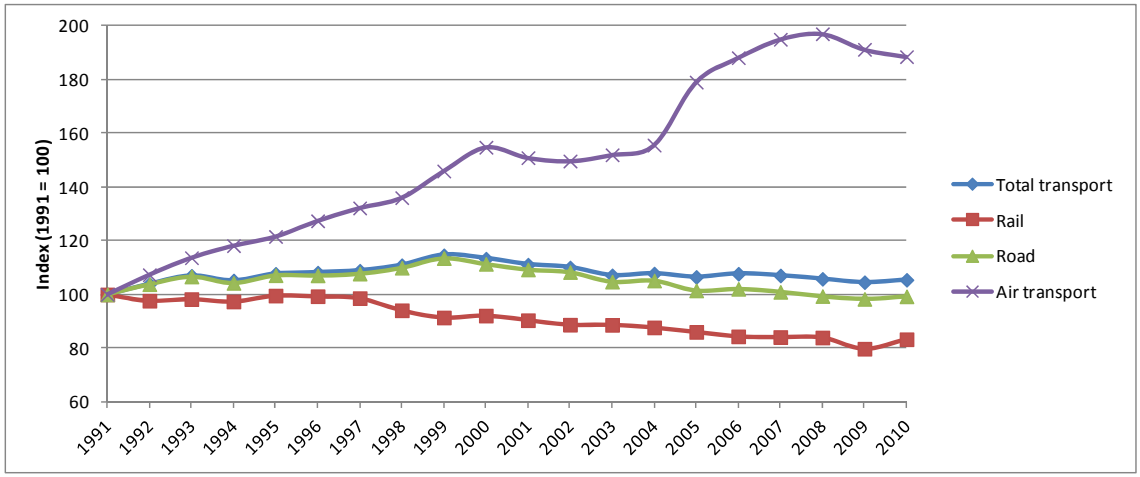
Energy unit: PJ	2006			2007			2008			2009 (prel.)			2010 (prel.)		
Definition	Electricity	Fuels	Total	Electricity	Fuels	Total	Electricity	Fuels	Total	Electricity	Fuels	Total	Electricity	Fuels	Total
Construction industry	13,3	48,6	62,3	13,0	43,2	56,2	11,9	40,7	52,6	11,9	41,0	52,9	12,6	43,6	56,2
Office-like enterprises	103,3	248,8	352,4	108,4	242,3	350,6	109,1	245,5	355,0	108,0	244,1	352,4	113,0	277,9	391,0
Manufacturing enterprises	16,6	22,7	39,6	15,1	25,6	40,7	12,6	27,4	40,3	12,2	26,6	39,2	13,0	29,2	42,1
Retail trade	101,2	141,8	243,0	95,0	137,2	232,6	85,0	139,3	224,3	85,3	140,8	226,1	86,4	152,6	239,0
Hospitals	25,9	46,4	72,4	23,8	40,3	64,1	22,0	38,9	60,8	22,0	38,9	60,8	22,0	41,8	64,1
Schools	13,7	69,8	83,9	13,0	67,0	79,9	12,2	71,3	83,5	12,2	71,3	83,5	12,6	79,6	92,5
Public baths	6,8	15,1	22,0	7,2	17,6	24,5	7,2	20,2	27,4	7,2	20,2	27,4	7,2	20,2	27,4
Hotels, restaurants, homes	57,2	166,3	223,6	55,8	157,3	213,5	54,7	159,8	214,9	56,9	166,3	222,8	57,6	177,1	234,7
Bakers	2,2	5,0	7,2	2,2	4,7	6,8	1,8	4,7	6,5	1,8	4,7	6,5	1,8	4,7	6,5
Butchers	2,2	2,2	4,3	2,2	2,2	4,3	1,8	2,2	4,0	1,8	2,2	4,0	2,2	2,2	4,3
Other food	0,4	0,7	1,4	0,7	0,7	1,4	0,7	0,7	1,4	0,7	0,7	1,4	0,7	1,1	1,8
Laundries	1,8	1,8	3,6	1,4	2,2	3,2	1,1	2,2	3,2	1,1	2,2	3,2	1,1	2,2	3,2
Agriculture	18,0	139,3	157,3	17,3	139,3	156,6	17,6	136,1	154,1	17,6	136,4	154,1	17,3	138,6	155,9
Horticulture	1,1	15,5	16,2	1,1	17,6	18,7	1,4	16,9	18,7	1,4	17,3	18,7	1,4	18,4	19,8
Airports	5,0	7,2	12,6	5,4	7,6	13,0	5,8	7,6	13,3	5,4	7,2	12,6	5,8	8,3	14,0
Textile, clothing, leather	2,5	7,6	10,1	5,4	10,1	15,5	5,4	10,4	16,2	5,8	10,4	16,2	5,8	11,5	17,3
Remaining groups (not covered by questionnaire)	5,8	1,1	6,8	5,8	1,1	6,8	5,4	1,1	6,5	5,4	1,1	6,5	5,8	1,1	6,8
Others	59,0	26,3	85,3	59,0	25,6	84,6	59,0	25,9	85,3	59,0	26,3	85,3	59,0	28,4	87,5
Total tertiary from extrapolation	436,7	966,2	1402,9	431,3	941,4	1372,3	415,4	951,1	1366,6	416,2	957,2	1373,4	425,5	1038,6	1464,1
Total tertiary from energy balance	479,9	961,6	1441,4	479,9	823,3	1303,2	488,5	954,0	1442,5	505,1	867,4	1372,5	529,5	888,7	1418,2

Source: Fraunhofer ISI et al. 2011

4.5 Transport

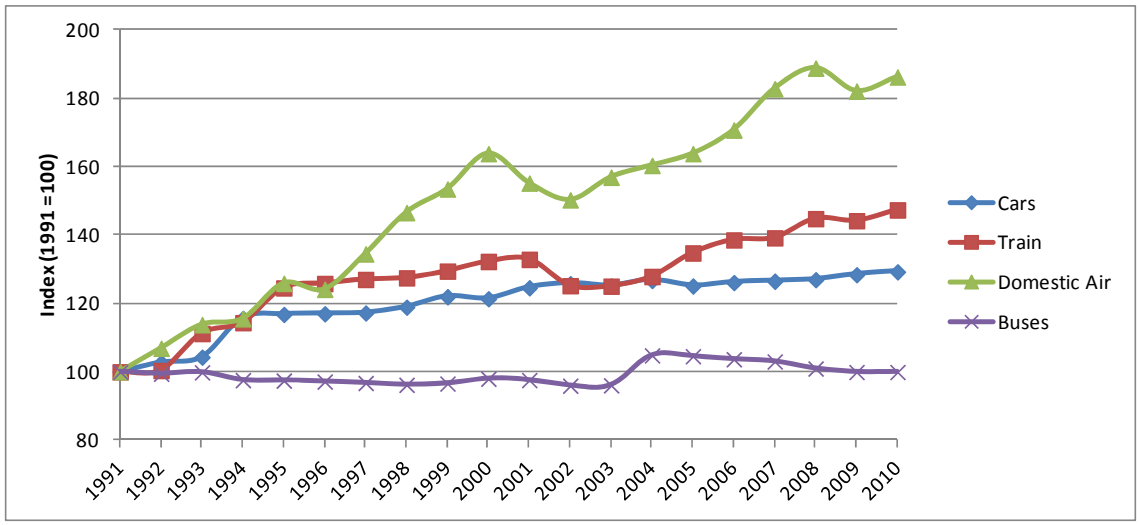
Between 1991 and 2010, total energy consumption in the transport sector grew by about 5.5 % from 58 to 61 Mtoe. Whereas during the 1990s, a continuous increase could be observed (to 66.4 Mtoe in 1999), a slight decrease in transport energy consumption has occured from 2000 onwards, which stabilized since 2005 (Figure 4-13). Energy consumption in the transport sector is dominated by road transport, with a share of more than 80 %. Therefore, in the following special emphasis is put on this transport mode. Due to the considerably above-average growth of air transport (international and domestic), its share in total consumption increased from 8 % in 1991 to 14 % in 2010. With a share of about 3 %, the role of rail transport for transport energy consumption is rather small and further lost importance during the last 15 years. The share of inland navigation is insignificant.

Figure 4-13: Development of transport energy consumption by mode 1991-2010



With regard to passenger traffic by means of transportation, the number of passenger kilometres for cars considerably increased in the first half 1990s. Afterwards, there was only a moderate growth and even a slight decrease in the mid of the 2000s, which however did not continue in the following years (Figure 4-14). The highest increase was again observed for air traffic (here: only domestic), both during the 1990s and again since 2004 (only interrupted by a decrease during the economic recession in 2009). The transport by train also showed an increasing trend, whereas traffic by buses lost shares in passenger transport.

Figure 4-14: Passenger traffic by means of transportation, 1991-2010



Road transport

In road transport, 69 % of energy consumption is caused by cars and further 29 % by trucks and light vehicles. Compared to 1991, the importance of trucks increased until 2010. Other vehicle types (motor cycles, buses) are not important (Figure 4-15).

The slightly decreasing trend of energy consumption in road transport since 2000 is mainly driven by petrol-driven cars whose number of vehicle kilometres has decreased since 2000, whereas diesel-driven cars show a continuous increase since then (Figure 4-16). This means that the trend to diesel-driven cars, which was rather moderate during the 1990s, considerably strengthened since the beginning of the new century. Between 2000 and 2010, the share of diesel cars in the total car stock more than doubled and correspondingly its share in road transport grew from 17 to almost 40 %. Domestic truck transport has almost remained constant since the end of the 1990s, whereas the number of foreign trucks crossing Germany has increased considerably.

Another influencing factor which contributed to the decreasing energy consumption in road transport was the decreasing fuel consumption per vehicle (in l/100 km). For cars, the decrease was fairly strong especially since 2001. The average consumption for diesel-driven cars was almost constant during that period, apart from a slump during the recession year 2009 (Figure 4-17).

Figure 4-15: Road transport energy consumption by vehicle type, 1991 & 2010

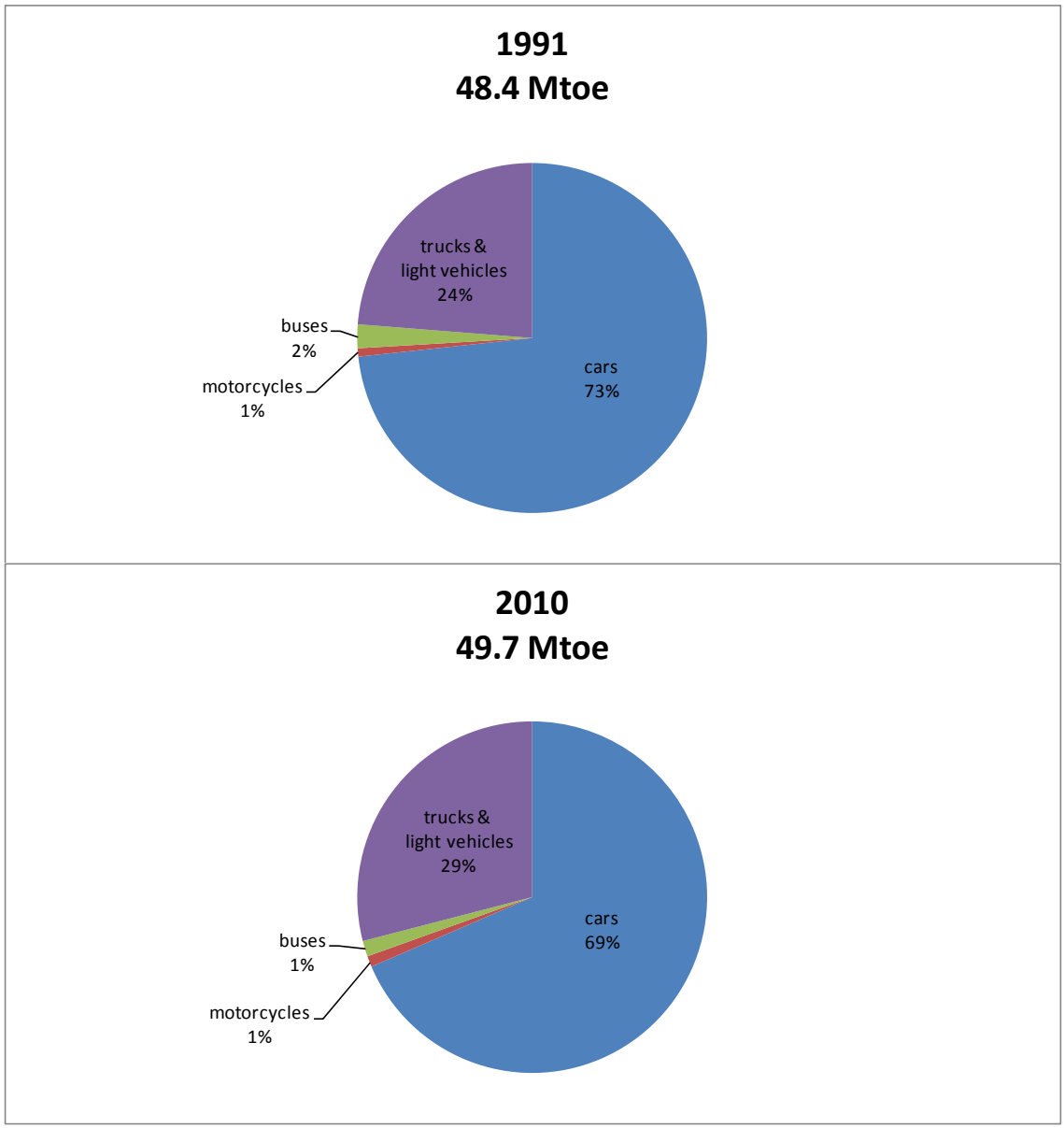


Figure 4-16: Development of vehicle kilometers in road transport by type of vehicles, 1991-2010

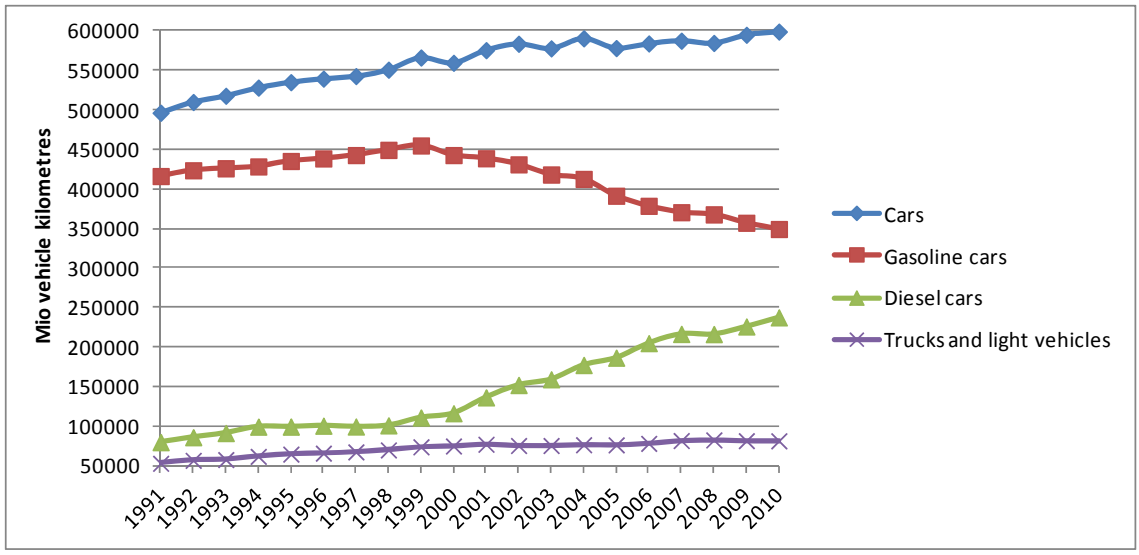
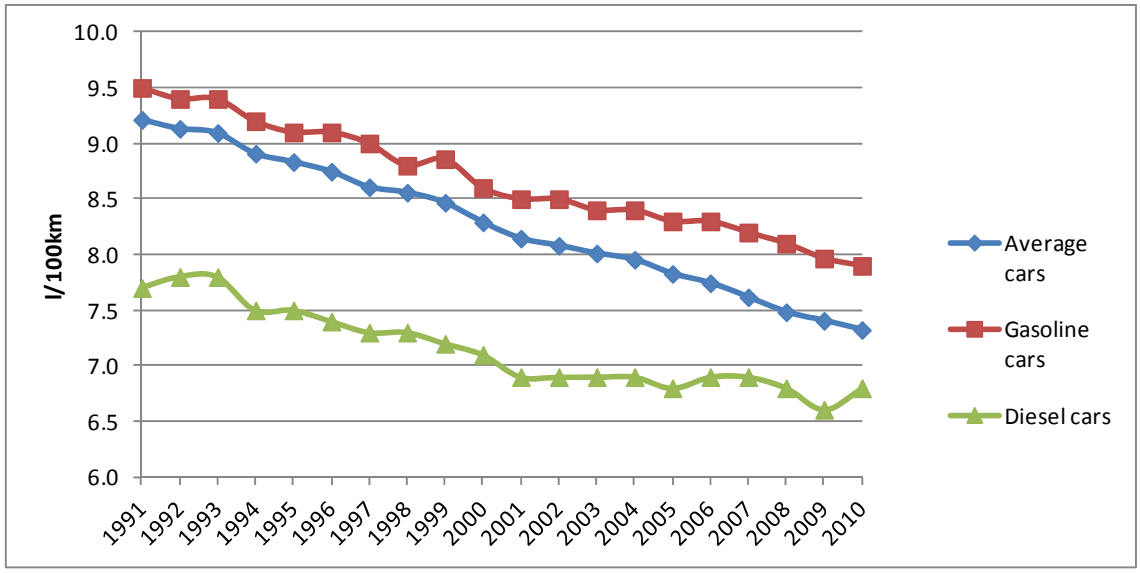


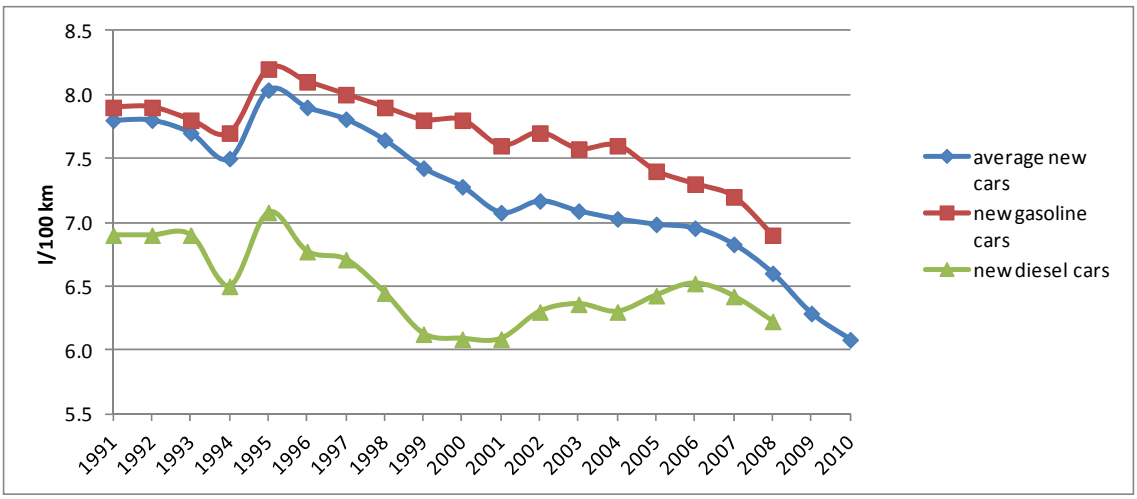
Figure 4-17: Specific fuel consumption of cars (stock), 1991-2010



The decrease of total average fuel consumption for cars was also driven by the increasing share of diesel cars in Germany, showing a considerably lower average fuel consumption than gasoline-driven cars. Since the beginning of the 2000s, however, the difference became smaller for new cars (Figure 4-18), which is also reflected in the average consumption of the stock (Figure 4-17). The slowing-down in fuel efficiency especially of diesel cars suggests that the purchasing trend towards large cars did outweigh the efficiency benefits of engine improvements. The average power of new cars in Germany is still above the EU-average and there is also an increasing share of new

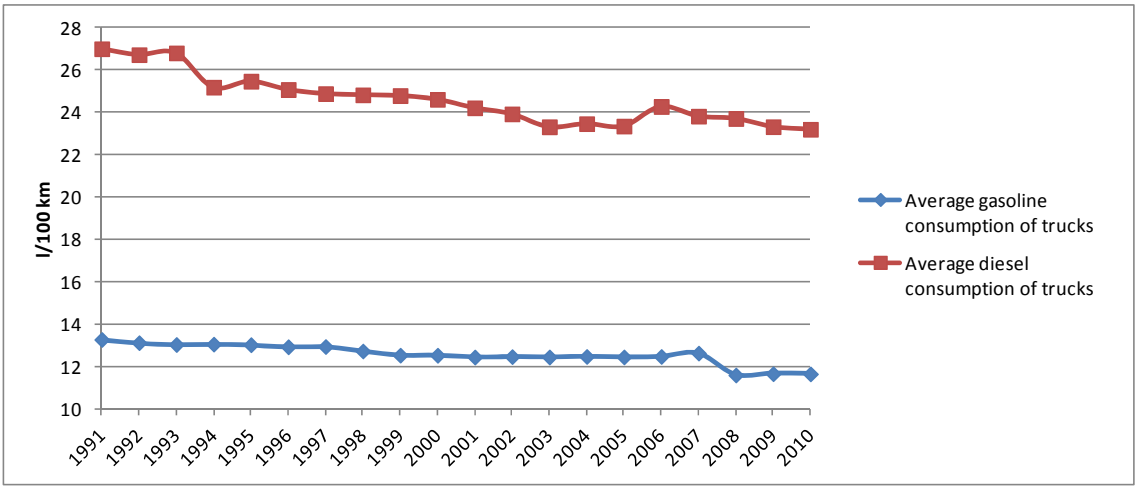
cars with 4-wheel-drive. Since 2006, however, this trend seems to turn back and the improvement in the specific consumption of cars sped up again.

Figure 4-18: Specific fuel consumption of cars (new cars), 1991-2010



With regard to trucks (for Germany incl. light vehicles), the average diesel consumption has decreased from 27.0 to 23.2 l/100 km, i. e. by 14 % (Figure 4-19). As in the case of cars, this development stagnated between 2002 and 2005 and in 2006 even an increase could be observed. But since then, the decreasing trend seems to continue again. Average consumption of gasoline trucks has remained constant over the whole period, apart from a break in 2007. Since only 6 % of all trucks are gasoline-driven, this is only of minor importance for the development of energy consumption in road transport.

Figure 4-19: Specific fuel consumption of trucks and light duty vehicles, 1991-2010

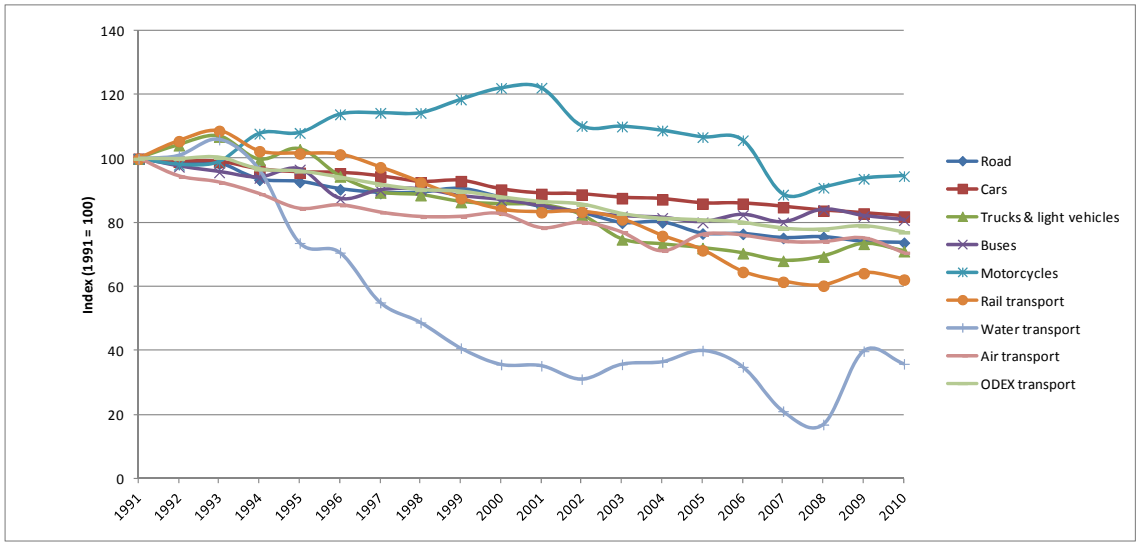


Energy efficiency trends in transport

The energy efficiency progress in the transport sector is measured by an aggregated energy efficiency index (ODEX), which is calculated at the level of seven transport modes or vehicle types: cars, trucks/light duty vehicles, motorcycles, buses, rail, water and domestic air transport (Figure 4-20).

In 2010, the energy efficiency index of transport improved by 25 % compared to 1991. Efficiency improvements in the car stock as a consequence of the penetration of new, more efficient cars (measured by a specific consumption in l/km) and a continuous trend to diesel cars, contributed steadily to this development. The energy efficiency index for trucks and light duty vehicles increased until the mid 1990s, but afterwards, it also contributed to energy efficiency gains in transport, especially over 2001-2006. From 2007, however, the ODEX for trucks increased again. The contribution of the other transport modes (air, train, buses, motor cycles) is less important due to their small shares in consumption. Therefore, the development of the total transport ODEX strongly follows the car and truck ODEX. Modal shift had a comparatively small impact on transport energy consumption.

Figure 4-20: Energy efficiency progress in the transport sector measured by the ODEX, 1991-2010



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

The development of the final energy intensity over time is often used as an indicator for the overall energy efficiency of all final consumers (see Chapter 4.1). The meaningful-

ness of this indicator however is limited by the fact that variations in the final energy intensity of a country can be caused by many different factors: apart from technical improvements in the use of energy these are climatic variations from year to year, structural changes in the composition of GDP by branches, changes in lifestyle (e. g. trend to more and bigger cars or larger dwellings) or other structural changes. These factors have to be separated in order to get a more meaningful indicator for the energy efficiency on the end-use level.

In order to evaluate pure energy efficiency trends, an aggregated energy efficiency indicator (ODEX) was developed in the ODYSSEE database. This index allows cutting a clear line to other factors and summarizes the measured development of energy efficiency in a single indicator. Its calculation is based on a detailed analysis of around 30 branches, sub-sectors or application purposes. The ODEX is calculated for both, individual final consumption sectors and for the economy as a whole. So as to be as precise as possible it is corrected for structural changes, temperature influences and similar factors which are not to be ascribed to energy efficiency. Furthermore it contains the autonomous and price-driven progress in energy technology as well as behaviourally-related influences on energy consumption which cannot be corrected due to the data situation or only by making additional assumptions.

In the year 2010, the national ODEX in Germany amounted to 92.5 %, which represents an 7.5 % increase in efficiency since the base year 2000 and an improvement of 23.6 % compared to the starting year 1991 (Figure 4-21). On average, this means an energy efficiency improvement of 1.2 %/year for the period 1991-2010, which is a little lower than the decrease in the final energy intensity within that period (1.3 %/yr.; see Chapter 4.1). Whereas between 1991 and 2000, a continuous efficiency improvement by almost 1.7 %/year could be observed, the improvement slowed down to 0.8%/year after 2000. During the 1990s, the industrial sector contributed most to this development, whereas the efficiency improvement in the transport and household sectors was smaller than for the whole economy. Since around 2000, this trend was reversed. Whereas the industrial ODEX even showed an increase – i.e. a worsening of energy efficiency - between 2001 and 2004 and again since 2007, the decrease in the household and transport sector sped up at least until 2008. Since then, the energy efficiency improvement in these sectors remained stagnant, as well as the ODEX for the whole economy, too.

In Figure 4-22, the development of the ODEX for the whole economy and within the sectors is summarized again. It was already described for the sectors in the preceding Chapters.

Figure 4-21: Development of the ODEX in Germany, 1991-2010

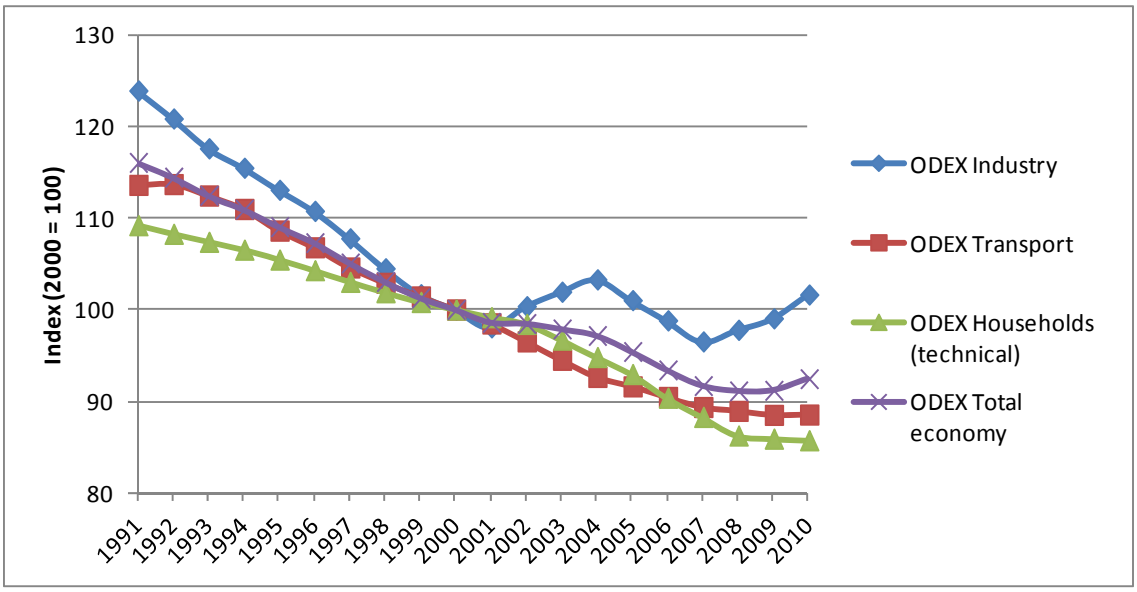
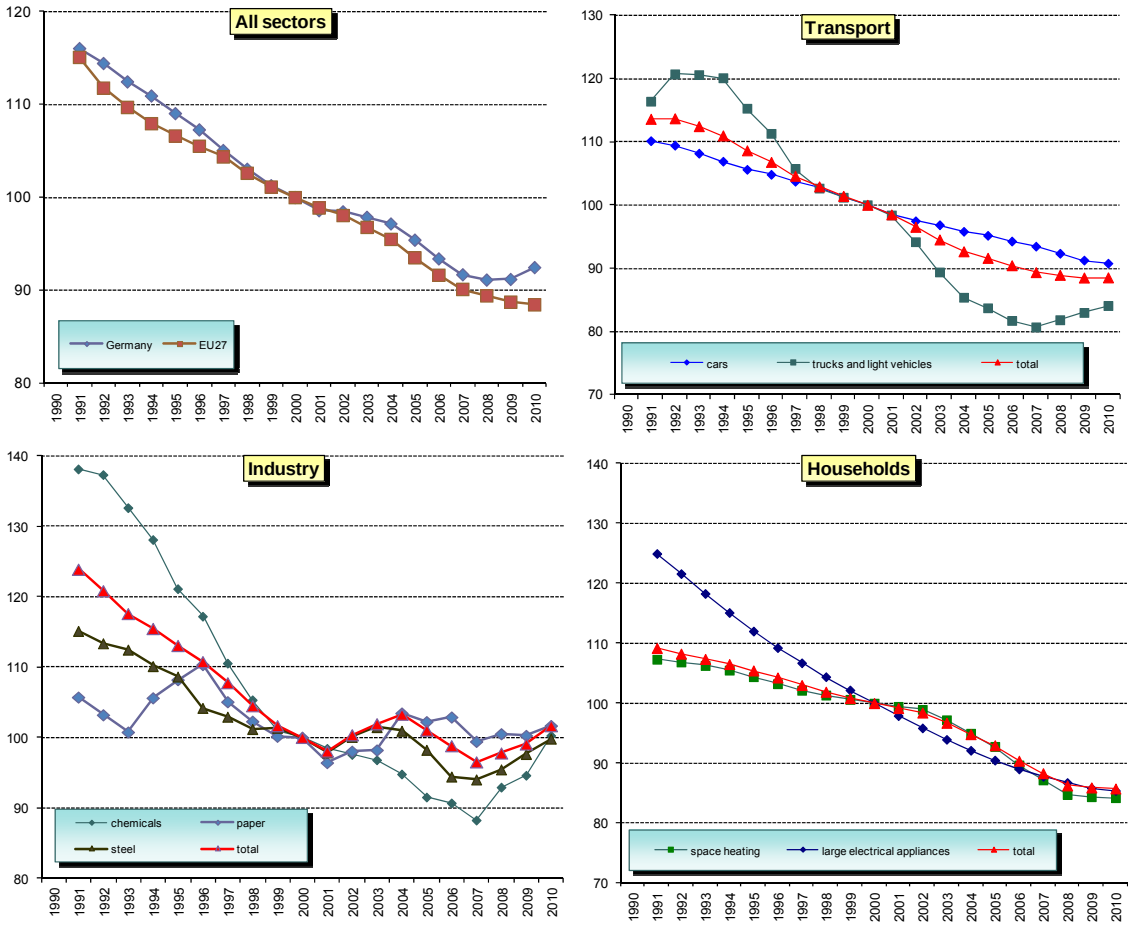


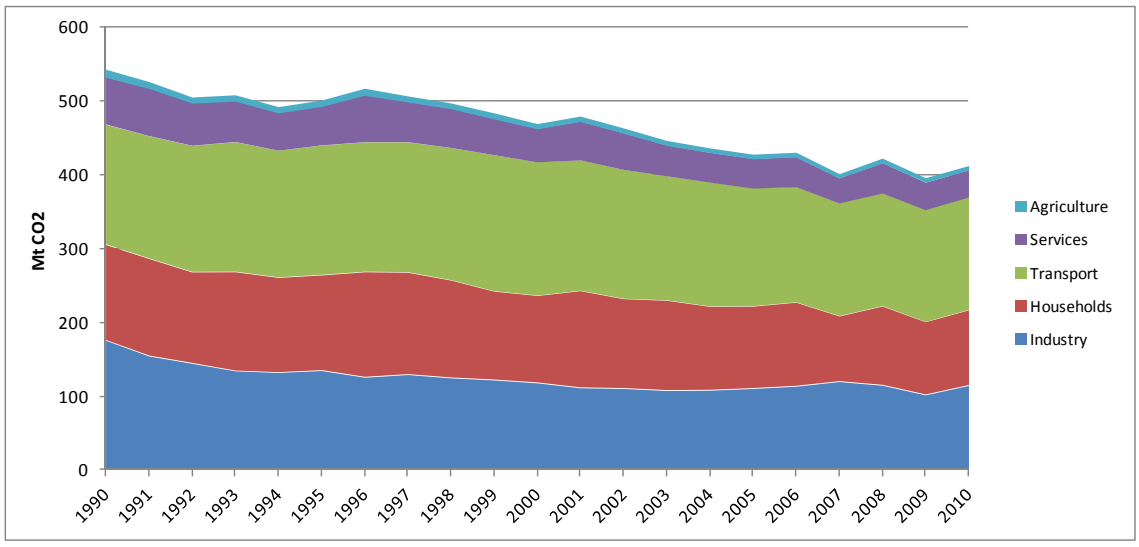
Figure 4-22: Development of the ODEX in Germany by sector, 1991-2010



4.7 CO_2 emission trends

The total direct CO_2 emissions of all final customers (i.e. without the indirect emissions from electricity production) were cut down from 542 Mt CO_2 in 1990 to 412 Mt CO_2 in 2010, i.e. by almost 25 % during the last 20 years[5] (Figure 4-23). Regarding the indices for different sectors it seems evident that all major sectors successfully reduced their emissions, though to a different extent (Figure 4-24). Whereas the emission decrease in the transport sector only amounted to 6 % over the whole period, the contributions of the other sectors were considerably larger: services/agriculture -40%, industry -35%, households – 21%. In industry, however, a rising trend could be observed since 2003, apart from the recession year 2009.

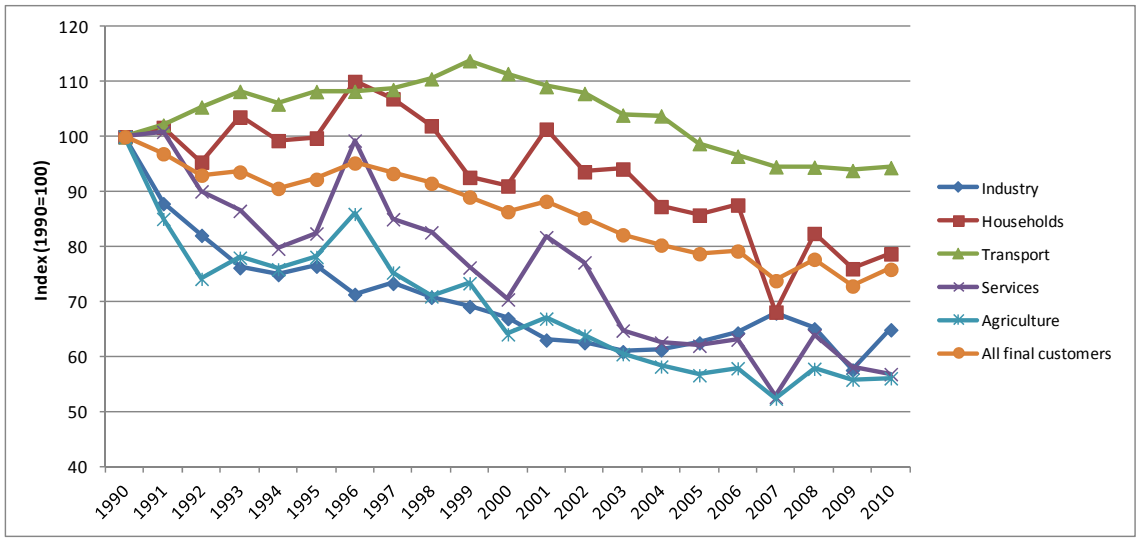
Figure 4-23: CO_2 emissions by sector (direct emissions), 1990-2010



Source: ODYSSEE database (taken from EEA inventories)

5 The direct CO_2 emissions from final customers in the ODYSSEE database are taken from the EEA inventories.

Figure 4-24: Development of CO_2 emissions by sector (direct emission), 1990-2010



5 Energy efficiency measures in Germany

The following analysis of energy efficiency policies and measures in Germany is based on the MURE database for energy-efficiency measures available on the internet (www.muredatabase.org). The database provides comprehensive, up-to-date information on energy-efficiency policies in the four demand sectors (households, transport, industry, tertiary) and on policy measures across the sectors in the EU-27 countries, Norway, Croatia and for the EU itself. The measures can be retrieved according to various criteria (e. g. type of measure, enforcement year, target audience, technologies affected, impact evaluation etc.). Summary tables and graphs by different criteria can also be created by the user of the MURE database. Recently, two new features have been added to the MURE database in order to better reflect the strong connections between ntional and European energy efficiency policies:

- If a measure is included in the National Energy Efficiency Action Plan under the EU Energy Efficiency and Service Directive ESD (2006/32/EC), it is classified as "NEEAP measure" in the MURE database. This allows an easy identification of policy measures reported in the NEEAPs and a specific analysis of these policies.
- In order to separate of EU-wide measures which are common to all EU Member States (mainly EU Directives) from pure national measures, a set of "EU measures" was also defined in the MURE database.

The description of the energy efficiency policies at the national level in MURE is provided by national energy agencies or institutes[6] according to harmonised guidelines (Schlomann & Eichhammer 2011). An overview of all policy measures which are included in the MURE database for Germany is given in Annex 1.

5.1 Recent Energy Efficiency Measures in Germany

As already stated above, recent energy efficiency policy in Germany was mainly pushed by the EU Directive on Energy End-use Efficiency and Energy Services (ESD) and the national Energy Concept from 2010 as well as the decisions on an accelerated transformation of the energy system from June and July 2011 (see Chapter 3.3).

In the following, the important policy measures referring to an enhancement of energy efficiency in the final energy consumption sectors are shortly described by sector for the period 2008 to 2012. These both include the national transposition of EU legislation and new national policy measures. In addition, some planned measures from the "En-

6 The national partner for Germany is the Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI) in Karlsruhe, Germany (www.isi.fraunhofer.de).

ergiewende" process are mentioned, too. The policy measures which were reported in the 2nd NEEAP (BMWi 2011) are described in Chapter 6.

Residential Sector

The building sector, i.e. mainly residential buildings (though non-residential buildings are mostly addressed by the same measures), is regarded as the key to greater energy efficiency in the German Energy Concept from 2010. In this field, the following measures are planned:

- Inclusion of the climate neutral building standard, to be met by new buildings by 2020, in the revised Energy Saving Ordinance of 2012
- Developing of a renovation roadmap for existing buildings which starts in 2020
- Ensuring better funding for the CO_2 building rehabilitation programme to support efficiency measures and assessment whether a budget-independent financing of building refurbishment programmes (e.g. by White Certificates) from 2015 is possible
- Increasing the market incentive programme for the use of renewable energies for heat generation in buildings
- Launching a new support scheme "performance-enhancing urban rehabilitation".

The planned tax deductibility of energy-efficient building renovation is controversially discussed between the Federal Government and the Federal states.

With regard to electricity consumption, most of the measures adopted during the last years were based on EU regulation.

In 2009, the EU-Directive on **Eco-Design of Energy-using Products** (EuP Directive, 2005/32/EC) was revised and extended to all energy-related products. The revised version (2009/125/EC) became effective on 20 November 2009. The transposition into German law by a revision of the "Law on eco-design requirements for energy-using products" (EBPG) was conducted through the Energy-related Products Act enacted on 25 November 2011. Energy-relevant products covered by the eco-design requirements may only be placed on the market if they comply with the relevant requirements. Furthermore they need to obtain the CE-Label. This is valid for all products regardless of their origin. The implementing measures usually intend that manufacturers themselves verify compliance. In case, that compliance is requested to be verified by a third party, the Länder (German Federal States) designate the responsible authorities. Market surveillance shall be incumbent upon the competent Länder authorities and penalties are raised. Market surveillance measures shall be reported to the Federal Institute for Ma-

terials Research and Testing (BAM), an agency of the Federal Ministry of Economics and Technology.

Energy labels are thought as a complementary instrument for minimum energy efficiency requirements. Whereas efficiency standards shall remove the less energy-efficient products from the market, energy labels shall help consumers choosing the most energy-efficient products and also to provide incentives for the industry to develop and invest in these products. In 2010, the EU Directive 92/75/EEC on appliance labelling was revised and extended to energy-related products (Directive 2010/30/EC, which came into force on 19 June 2010). The revised EU Labelling Directive was transposed into German by a new Energy Labelling Law from17 May 2012 (Energieverbrauchskennzeichnungsgesetz - EnVKG). With this law, the extension of the energy label to energy-related products was transposed into national law.

Transport Sector

In 2009 the **environment bonus for car scrapping** ("*Umweltprämie*") provided 2,500 Euro to people who "scrap" a car that's at least nine years old and buy a new car instead before end of the year 2009. The car has to belong at least one year to the owner, who applied for the scheme. This scheme was aimed to fight against the effects of the global downturn on domestic car sales, preserve factory jobs, and encourage people to replace older, inefficient cars, with the latest engine technology. Due to the high demand the budget was raised from 1.5 billion to 5 billion Euro. The measure provided financial funding to approximately 2 million new car-owners.

A **levy on air traffic** has become valid from 1 January 2011 for all flights from German airports. The levy has to be paid by the airline and depends on the distance of the flight. It ranges between 8 EUR for short-haul flight, 25 EUR for medium-haul flights, and 45 EUR for long-haul flights.

In the transport sector, a strong focus is on Germany's **electric mobility strategy**, which aims to have 1 million electric vehicles on road by 2020 and 6 million by 2030.

At the EU level, the German Government is advocating for ambitious CO_2 limit values for all classes of vehicles. The German Government is also taking steps to foster a higher share of vehicles that run on natural gases and to increase the share of sustainably produced biofuels. A further developing of the emission-based vehicle tax and the heavy goods vehicle (HGV) toll charge in order to achieve a greater reduction of greenhouse gases is foreseen in the Energy Concept, too.

Industry and tertiary sector

Starting in February 2008, the Federal Ministry for Economics and Technology (BMWi) together with the KfW promotional bank offer a **special fund for energy efficiency in SMEs** in order to promote energy efficiency in small and medium enterprises. On the one hand, the fund supports the advice on potential energy savings in SMEs providing a grant of up to 80 % for an independent energy advice. On the other hand, financial support is given for investments (in case replacement investments lead to an energy saving of a minimum of 20% compared to the average consumption of the last three years and new investments cause energy savings at least of 15% compared to the branch average) for exploiting the saving potentials by means of low-interest loans within the ERP Energy Saving Programme. Both of those components can be taken advantage of separately.

One measure in the Energy Concept from 2010 was the creation of an “Energy and Climate Fund” by law, out of which both a special **energy efficiency fund** was established and the financing for the existing National Climate Initiative was increased. Both initiatives shall initiate important efficiency measures at all levels - municipalities, industry, SMEs and consumers. The funding provided for the energy efficiency fund was around €100m for 2011 and 2012 and an increase to a maximum of €300m in 2015. From 2012, the whole Energy and Climate Fund should be financed only by revenues from ETS. Due to the very low prices for CO_2 at the moment, the financing of this fund is not stable.

With regard to product labeling and standards, Germany is advocating ambitious standards at EU level and a transparent labeling for cars, products and buildings. In order to save electricity, the advisory service for private consumers was considerably extended, esp. for poor households. In industry, a wider spread of energy management systems and energy audits is supported in order to help industry to better identify and tap its efficiency potential. In the course of reorganization of the eco-tax relief to energy-intensive companies, this requirement is to be linked to the operation of energy management systems in accordance with international standards (EN 16001, ISO 50001) from 2013. In addition, successful financial support programmes especially for small and medium-sized companies shall be extended, as e.g. the special energy efficiency fund for SMEs.

Cross-cutting measures

In the framework of the Integrated Energy and Climate Programme, the German government has elaborated a **Renewable Energy Sources Act for Heat** (EEG-H). The objective is to increase the share of renewables in heat generation from currently 6% to 14% in 2020. The overall strategy is to reduce the dependence on imports, reduce the exploitation of fossil resources, be in line with the climate protection programme and induce a sustainable development of energy supply and technology for generation of heat from renewable sources. The new act will force new residence owners to use an increasing share of renewables for the energy and heat use in buildings. Using solar energy, the surface of the solar collectors has to correspond at least to 0.04 sqm per sqm floor space. Using geothermal, environmental and biomass, their share for heating has to be predominant to the fossil sources' share. Alternatively other climate protecting measures such as insulation of walls, co-production of heat and power as well as the use of waste heat can be applied. The market incentive programme will provide the corresponding financial support for residential owners. The Heat Act's amendments, which came into force on May 1st 2011, arose from the "Act Implementing European Renewable Energies Legislation" (implementing Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources). It was extended to existing public buildings undergoing major renovations. Also the public sector has to fulfil an exemplary role in using renewable energy sources for heat and cold.

5.2 Patterns and Dynamics of Energy Efficiency Measures

The patterns of energy policies and measures in Germany, i.e. the predominant measure type in a sector, are illustrated by diagrams in the form of a spider's web with the measure types on the spokes of the web. The greater a country's preference for a certain measure type, the more the pattern will resemble the hands of a watch indicating the preference. The broader the policy in the sector, the more equally spread the measures on the different axes so that the pattern resembles a pentagon or other polygons depending on the number of categories (see Figure 5-1 to Figure 5-5)[7].

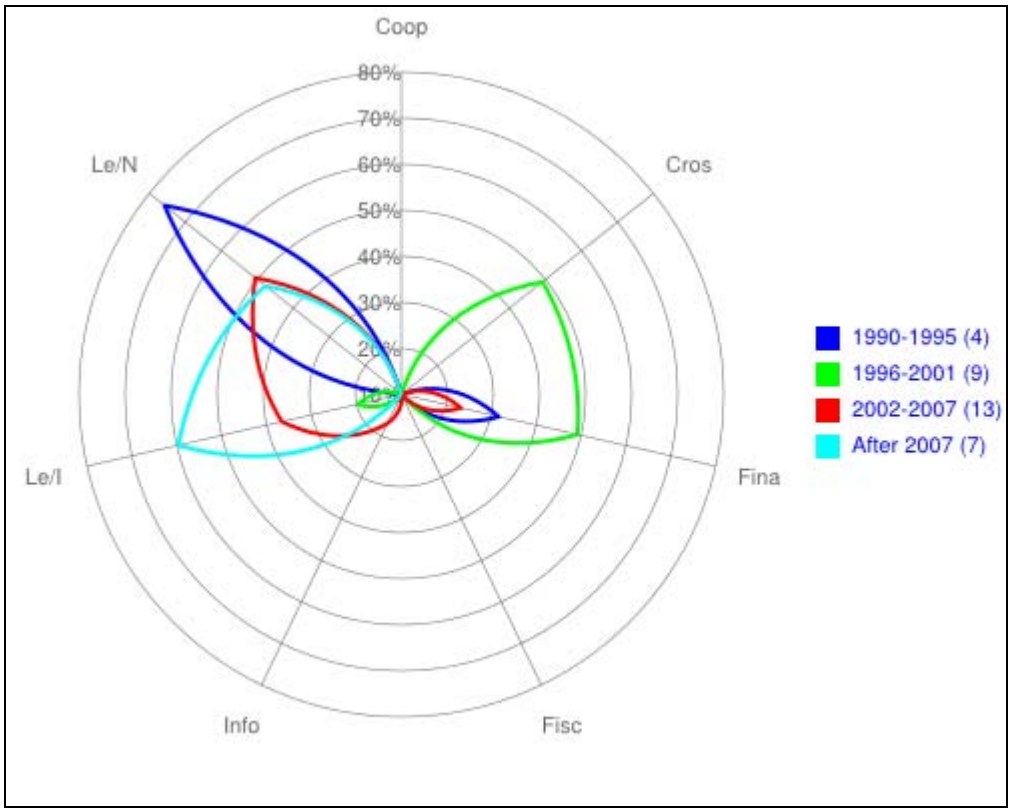
[7] Abbreviations used in graphs:

Coop: Co-operative Measures; *Cros*: Cross-cutting with sector-specific characteristics; *Fina*: Financial; *Fisc*: Fiscal/Tariffs; *Info*: Information/Education; *Le/I*: Legislative/Informative; *Le/N*: Legislative/Normative; *Mark*: New Market-based instruments; *Soci*: SocialPlanning/Organisational; *Gene*: General Efficiency/Climate Change/Renewable Programmes; *Nonc*: Non-classified measure types

Household Sector

In the houshold sector in Germany, financial and cross-cutting measures are dominant, especially the several housing modernisation programmes of the KfW promotional bank. Especially since 2007, legislative measures became even more important, both legislative/normative measures (especially building regulations) and legislative/informative measures (especially due to measures which are triggered by the EU as labelling and minimum efficiency standards). All other measure types are at the lower end of preference in the residential sector (Figure 5-1).

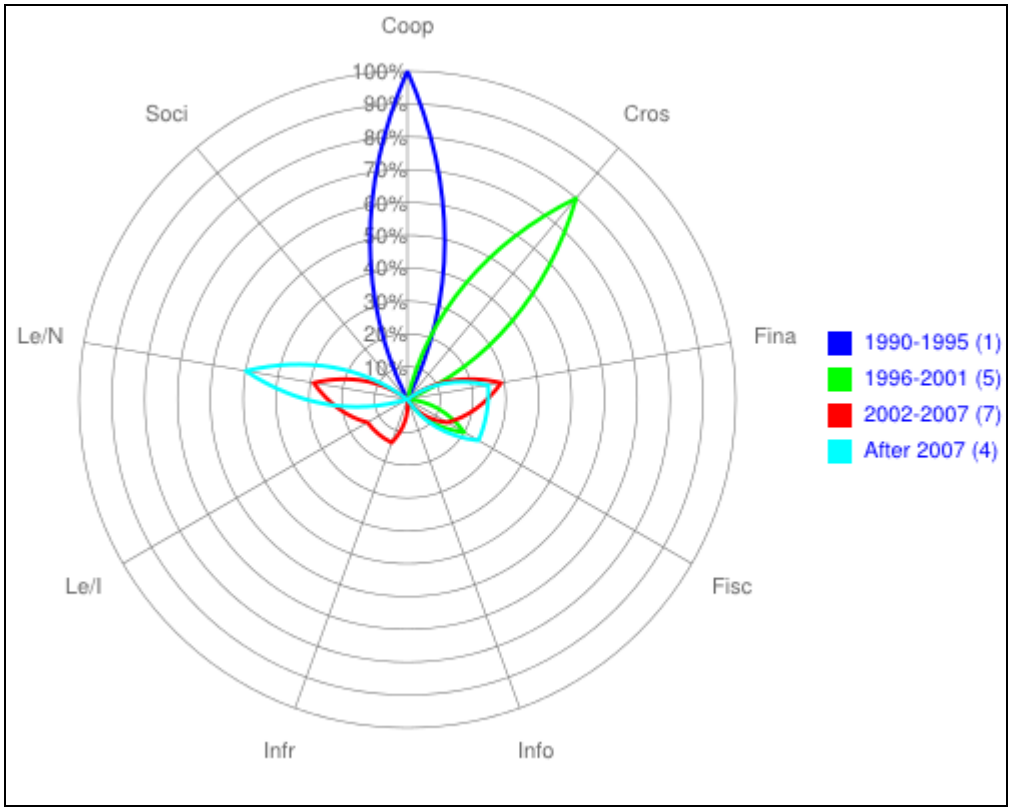
Figure 5-1: Patterns of policies and measures in Germany – Household sector



Transport Sector

In the transport sector, cross-cutting measures like the ecological tax reform were dominant till 2001. These were later replaced by a more diversified portfolio of measures: most important are measures aiming at the transport infrastructure, fiscal and financial measures (car taxies, levies for trucks on motorways and car scrapping) and information measures. As in the household sector, for the last couple of years legislative/normative measures became more important, too (Figure 5-2).

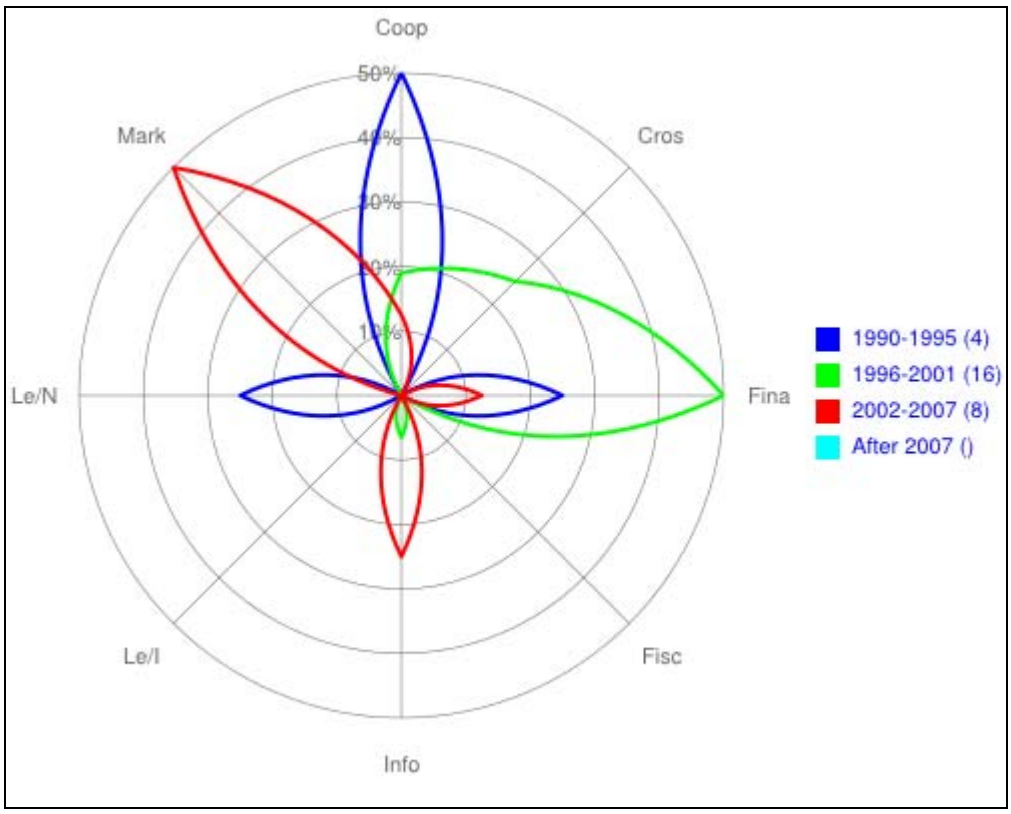
Figure 5-2: Patterns of policies and measures in Germany – Transport sector



Industrial Sector

In the industrial sector, the spider graph looks more spread than in the other sectors. While the time from 1996 to 2001 was dominated by financial measures, in the period from 1990 to 1995 cooperative measures (voluntary agreements) were the dominating instrument. From the mid 2000s, new market-based instruments, such as the KfW Carbon Fund and the EU Emission Trading Scheme became important, too. Informational also played a more important in the last couple years (Figure 5-3).

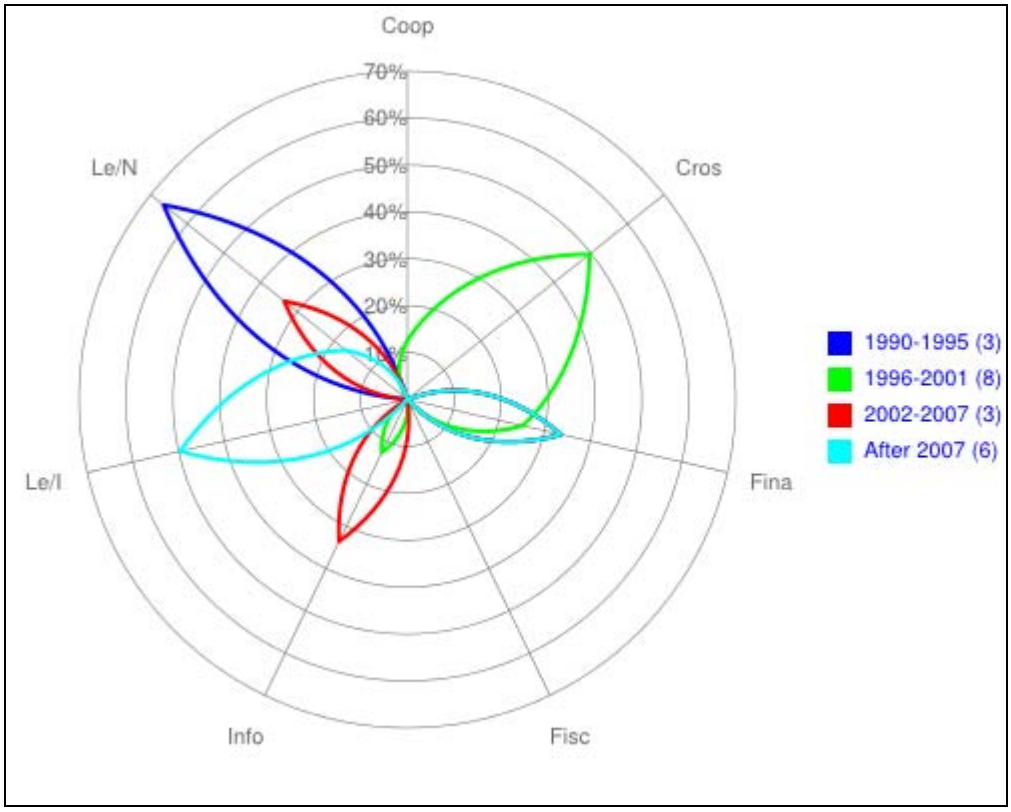
Figure 5-3: Patterns of policies and measures in Germany – Industry



Tertiary Sector

In the period from 1990 to 1995 the tertiary sector was dominated by legislative/normative measure like the Heating Installations Ordinance. Later cross-cutting measure, such as the ecological tax reform, became more important. After 2007 the main part is mostly EU-related legislative/informational types of measures, like the Ecodesign Directive, and financial measures like the special fund for energy efficiency in SMEs. This shows that the measures in the tertiary sector are often composed as a mix of industrial and household measures (Figure 5-4).

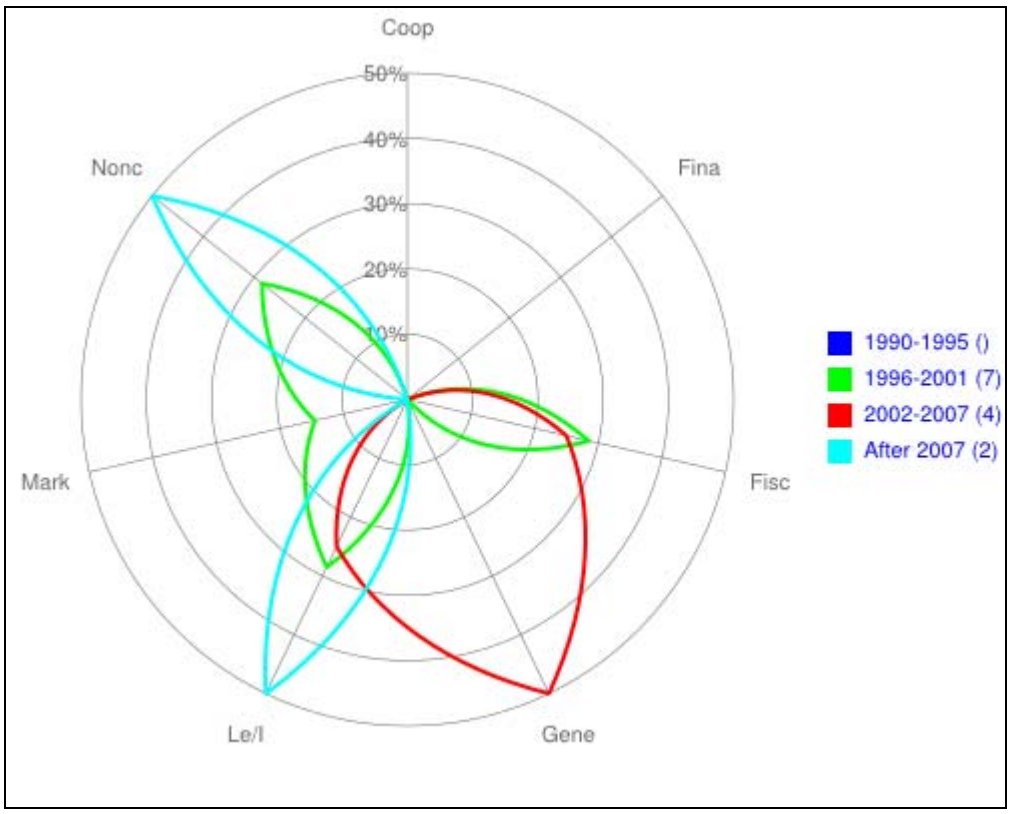
Figure 5-4: Patterns of policies and measures in Germany – Tertiary sector



Cross-cutting measures

The graph for the cross-cutting measure shows that nowadays non-classified and legislative measures are dominating (Figure 5-5). Before that, in the period from 2002 to 2007, most measures were focused on general energy efficiency and climate change programs like the Integrated Energy and Climate Programme of the German Government (IECP). Such type of programs also play an important role up to now in Germany.

Figure 5-5: Patterns of policies and measures in Germany – Cross-Cutting sector



5.3 Innovative Energy Efficiency Measures

In Germany, most of the measures introduced during the last years, represent a continuation of well-established measures and policies from the previous decades. This mainly applies to financial and legislative/normative measures, which are dominant in the residential sector and also important in the tertiary and industrial sector, and which are supplemented by some information and advice programmes.

A new development was the introduction of a *distance-based heavy load levy* in for trucks on motorways. An innovative automatic registration system for vehicles has been installed allowing distance-based charges to be calculated without affecting traffic flow. Though the building-up of this system was delayed due to technical and organisational difficulties, the system seems to operate very successfully since its introduction in January 2005. This means that the main target of the measure, namely increasing revenues for road building, is fulfilled.

Another successful instrument, which was mainly introduced for economic reasons, was the environmental bonus of 2,500 Euro for the scrapping of cars that at least are nine years old. The whole budget comprised subsidies of 5 billion Euros, which was

enough for a financial funding of approximately 2 million new cars between January and September 2009. The bonus became very successful in terms of supporting the demand for new cars, which was the main target. Since especially small cars with a low fuel consumption were bought, there was, however, also an energy-saving impact of the measure.

A relatively new discussion in Germany is on budget-neutral solutions for financing investments in energy efficiency especially in the building sector. The present mix of instruments is mainly based on regulatory and state-financed financial policy measures. This discussion was both strengthened by the the decisions on an accelerated transformation of the energy system from summer 2011 (see Chapter 3.3) and the proposal in the new Energy Efficiency Directive (EED) of the European Commission (2011) to introduce energy efficiency obligations (EEOs) in all Member States. At the moment, however, these options are still examined in several studies, but not decided (see e.g. Schlomann et al. 2012).

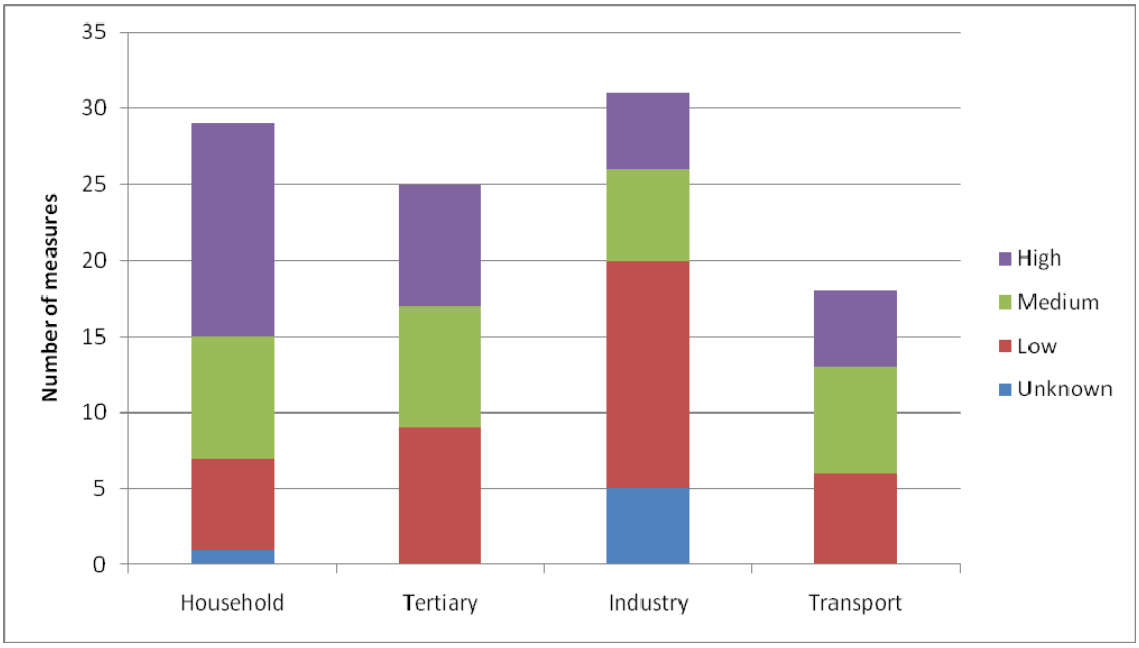
5.4 Energy efficiency measure evaluations

5.4.1 Semi-quantitative Impact Estimates of Energy Efficiency Measures

In the measure descriptions which are included in the MURE database, a high importance is attached to the impact evaluation of a measure. If a quantitative evaluation is available for a measure, the methods used for the evaluation and related results are provided, as well as real/estimated energy savings (fuels and electricity) and carbon dioxide emissions reductions achieved over a given time-frame. 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 CO_2 savings[8]. The last column in the overview Tables in Annex 1 show the respective semi-quantitative impact assessment for all German measures in the MURE database. In Figure 5-6 the number of measures in each qualitative impact evaluation category is summarized.

8 The categories (low, medium, high) are linked to the aggregate electricity or final energy consumption of the respective sector (households, transport, industry or tertiary). The following limits are defined for the three impact levels: low impact: <0.1 %; medium impact: 0.1 - <0.5 %; high impact: ≥0.5 %. If a quantitative evaluation is available, the qualitative impact can easily be calculated by applying this definition to the quantitative figures. For measures with no quantitative evaluation, the qualitative evaluation is a relatively rough expert judgement.

Figure 5-6: Semi-quantitative impact evaluations by sector



Source: MURE database (as of November 2012)

The highest number of high-impact measures shows the household sector. For the most part, legislative/normative measures (building regulations) are assigned to this impact category. Beyond it, the impact of the Ecological Tax Reform (cross cutting with sector-specific character) and of the mandatory labelling of electrical appliances (legislative/information) are assessed as high-impact measures. The impact of most of the financial measures, which are dominant in the household sector, is assumed to be in the medium category (apart from the main KfW programme for the energy-efficient modernisation of existing buildings with a high impact), whereas some financial programmes and informative measures are seen as low-impact measures.

In the transport sector, fewer measures, as such as the heavy goods vehicle toll charges, are evaluated with a high impact compared to total energy consumption of the sector. This is also due to the fact that many measures in the transport sector are not mainly aiming at energy and CO_2 savings, but also at other targets as improvement of the transport infrastructure etc. The bulk of the more important measures are categorized in the medium category (especially fiscal measures, voluntary agreements by automobile industry, informative measures).

In industry, relatively few measures are seen as a high-impact measure. Apart from the first voluntary agreement with German industry from 1995, these are the new KfW fund promoting energy efficiency in SMEs and some contracting programmes. The second voluntary agreement, two financial measures (CHP Act, KfW Umweltprogramm) and

the impact of the Ecological Tax Reform (due to the tax exemptions for industry) is estimated to have a medium impact, whereas most of the measures in industry are assessed as low-impact measures.

In the tertiary sector, some measures from different types are in the high-impact category: the Ecological Tax Reform, the Heating Installations Ordinance as a legislative measure and, as in industry, the first voluntary agreement with German industry and the new KfW fund promoting energy efficiency in SMEs. The other legislative measures and voluntary agreement and some additional financial measure are categorized as medium.

5.4.2 Lessons from Quantitative Energy Efficiency Measure Evaluations

The MURE database puts emphasis both on the semi-quantitative and – if information is available - quantitative evaluation of energy efficiency measures. Therefore, the description of policy measures in MURE also includes a table for the quantitative measure evaluation, which is directly available on the MURE online input shell and enables the user to quickly appraise the actual outcome of the measure (see Figure 5-7). The table is directly linked to targeted end uses (first column in Figure 5-7), which are adressed by a specific policy measure (as e.g. electric appliances and lighting, space heating or process or cross-cutting technologies in industry). If a measure is broader adressing total fuel and/or electricity consumption of a sector, this information can be included, too. The following information can be inserted into the quantitative evaluation table for each policy measure for which a quantitative impact evaluation is available:[9]

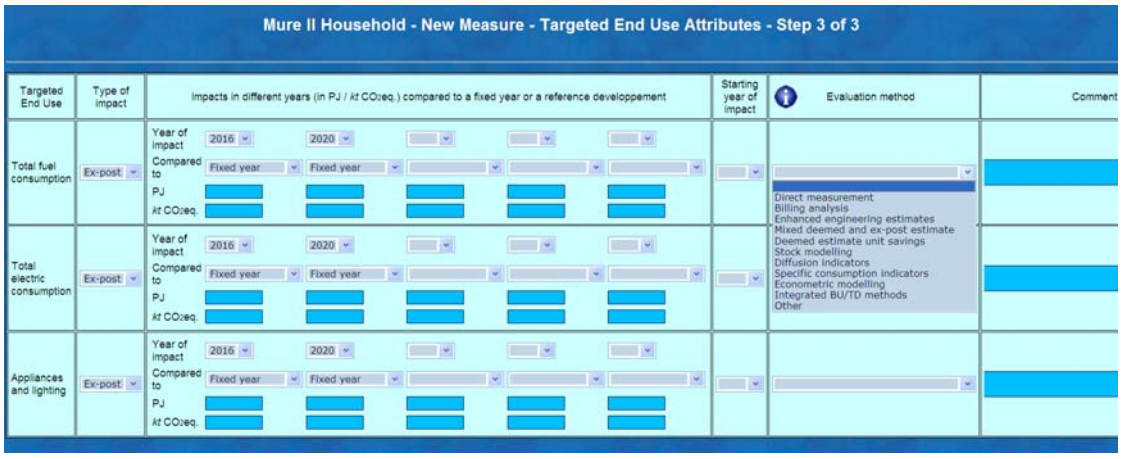
- The specific end-use which is targeted by the policy measure; if no specific end-use can be identified, the information can also be given for the aggregate electricity, fuel or final energy consumption.
- The categorization if the impact results from an ex-post or an ex-ante evaluation.
- The values from the impact evaluation: here, the year(s) of impact and if the value is compared to a fixed year or to a reference development can be chosen. The units are limited to PJ and kt CO_2eq., If a measure is classified as a NEEAP meas-

9 The availability of quantitative impact evaluation of policy measures differs a lot between the Member States. The 2nd NEEAPs under the ESD have considerably improved the situtation, since a significant number of Member States reported bottom-up calculated energy savings by policy measures or bundles of measures or, as e.g. Germany, a combination of top-down and bottom-up evaluated energy savings (see for the NEEAPs of all Member States: http://ec.europa.eu/energy/efficiency/end-use_en.htm).

ure, it is recommended to take the quantitative impact figure from the NEEAP, if available.

- The starting year of impact, i.e. when the policy measure started to have an impact on final energy consumption.
- The evaluation method which was used to quantify the impact; here, MURE refers to the classification of possible evaluation methods which was developed within the EU-IEE project “EMEEES” (Wuppertal Institute 2009; Eichhammer et al. 2008).

Figure 5-7: Impact quantification table for energy efficiency policy measures in the MURE database



For Germany, quantitative impact evaluations are available for a lot of policy measures in the MURE database, which were mainly taken from the 2nd NEEAP (BMWi 2011). The bottom-up impact evaluations in the German NEEAP incorporated the recommendations by the EU Commission (2010) for the impact evaluation of individual policy measures, but also made use of existing evaluations for some measures, especially with regard to the KfW programs for the enhancement of energy efficiency investments in the building sector and for small and medium-sized companies (for more details on the NEEAP see Chapter 6).

In the following, the impact evaluation of one of these programmes, the “Special fund for energy efficiency in SME's” is described as an example.

Example: Evaluation of the KfW program "Special fund for energy efficiency in SME's"[10]

A programme offering partial subsidies for energy audits was launched by the German Ministry of Economics in 2008. It is managed by the KfW, the German Promotional Bank. The purpose of the audits is to identify energy saving potentials in SMEs by qualified and independent consultants. They help to overcome know-how deficits and other obstacles whereas subsidies should encourage SMEs to make use of audits. Within the program, an initial audit (screening) up to 2 days it subsidized by 80 % of the audit costs, a possible comprehensive audit up to 10 days by 60 %.

The evaluation of this programme, which was performed in 2010, shows the effects of the scheme and gives recommendations for its optimisation. The study focused on empirical research: online surveys of the audited companies, consultants, and the "regional partners" who processed the applications, e.g. chambers of trade and commerce or energy agencies. In addition, final audit reports were analysed. The main aspects of the study were audit quality, implementation of proposed measures, remaining obstacles, and the effects of the programme in terms of energy savings, reduction of CO_2 emissions, and investments.

The study revealed a very good image of the programme (see Figure 5-8) and a high implementation rate of the recommendations of the consultants. The consultants found substantial energy efficiency potentials in all the companies. On average, each company implemented 2.8 out of 5.3 recommended measures as a direct result of the energy audit.

The total impact of the program with respect to energy savings, CO_2 reductions and induced investments was calculated based on the measures suggested in the audit reports and according to the information given in the company interviews. The impact of these measures was extrapolated by multiplying the savings with the total number of companies participating in the programme (Figure 5-9).

10 The following passage is based on IREES/Fraunhofer ISI 2010, Gruber et al. 2011 and Schlomann et al. 2011.

Figure 5-8: Customer satisfaction concerning the audits

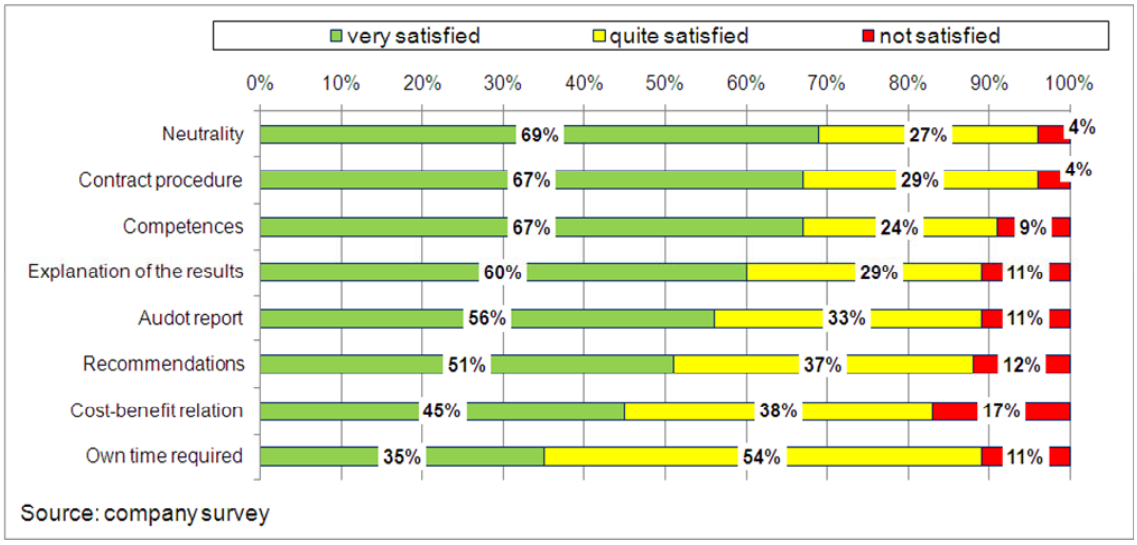
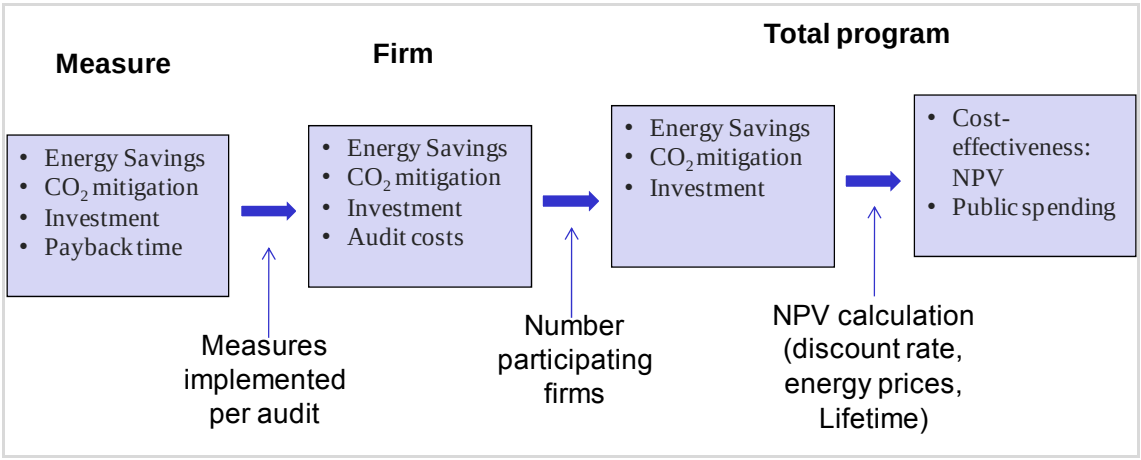


Figure 5-9: Impact assessment of the programme: calculation approach



In total, the measures implemented resulted in 1.4 TWh energy savings per year, 470,000 tons CO_2 reduction, investments of 480 million euros, and energy cost savings of 80 million euros. Programme costs amount to 0.5-0.7 euro/MWh energy saved.

Success factors of the audit scheme include its low threshold access caused by the high level of funding, the support from the regional partners and their personal contacts to SMEs, and the generally high quality of the audits. The authors recommend to optimise the KfW consultants' list in the internet with regard to the search for competent consultants, especially those with know-how of branch-specific process technologies, and to improve further the audit reports by a more detailed specification of the content.

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

Top-down and bottom-up energy savings calculated in the 2nd NEEAP

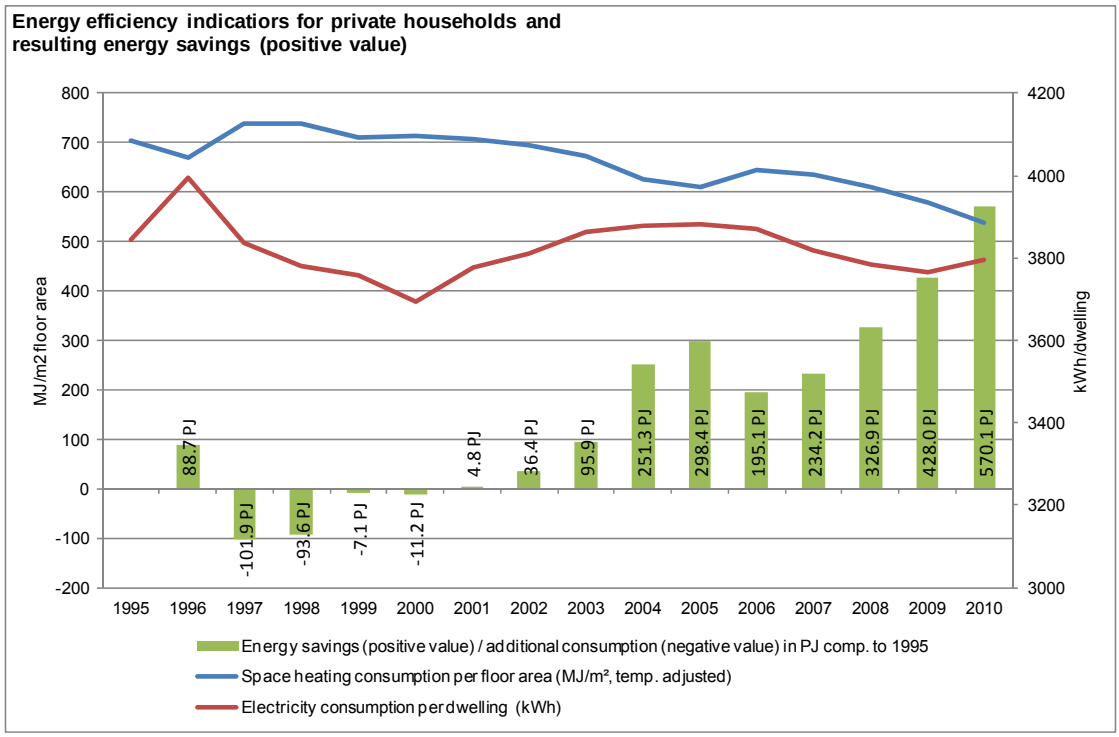
The second National Energy Efficiency Action Plan (NEEAP) of Germany in accordance with the EU Directive on Energy End-use Efficiency and Energy Services (2006/32/EC) and its national implementation, the Act on Energy Services and other Energy Efficiency Measures (EDL-G) was submitted by the Federal Ministry of Economics and Technology in September 2011 (BMWi 2011). The first NEEAP was submitted in September 2007. In the 2nd NEEAP, it is shown that Germany has achieved significant improvements in energy efficiency in all consumption sectors. The **top-down energy savings** in the 2nd German NEEAP based on aggregated statistical data were calculated using the energy efficiency indicators which were proposed by the European Commission (2010) and which are similar to those calculated in the ODYSSEE database. As in the case of the ODYSSEE indicators, these indicators include some corrections concerning variables which are not primarily attributable to changes in energy efficiency in a technical sense:

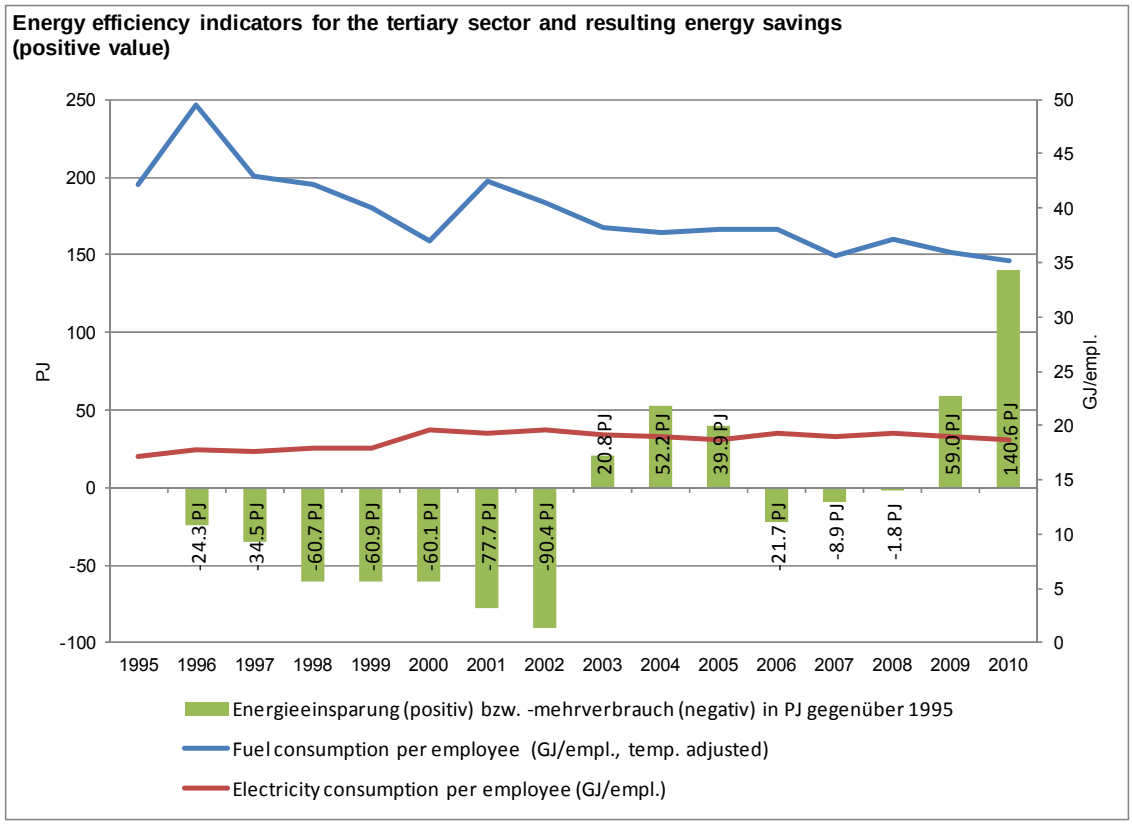
- Correction for temperature effects in the household and tertiary sector.
- Correcting for quantity effects (e.g. economic growth, increase in the number of households) by by the consistent use of specific indices where the energy consumption is related to an appropriate activity which differs according to the sector.
- Correcting for structural effects (e.g. sector or product structure in the industrial and tertiary sectors) by means of a calculation of the energy savings at a disaggregated level (e.g. passenger traffic and freight traffic sub-sectors in the transport area or various branches in the industrial and tertiary sector) and the subsequent addition of the sub-sectoral or branch-specific energy savings within a given sector.

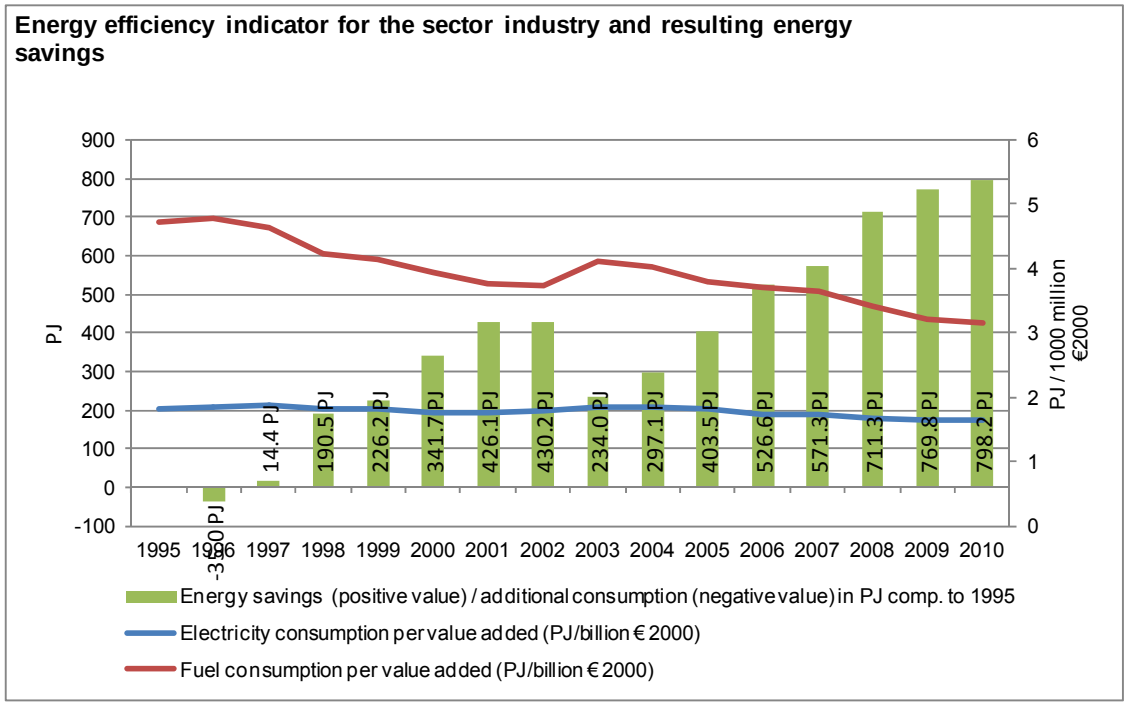
The data sources which were used for the calculation of top-down indicators in the NEEAP also were for the most part the same as for the ODYSSEE indicators (see Annex 3).[11] Figure 6-1 show the development of the main energy efficiency indicators calculated in the 2nd NEEAP for each of final energy consumption sectors since 1995 and the resulting energy saving (as a positive value) or - in years in which there is no efficiency improvement - an increase in energy consumption (as a negative value).

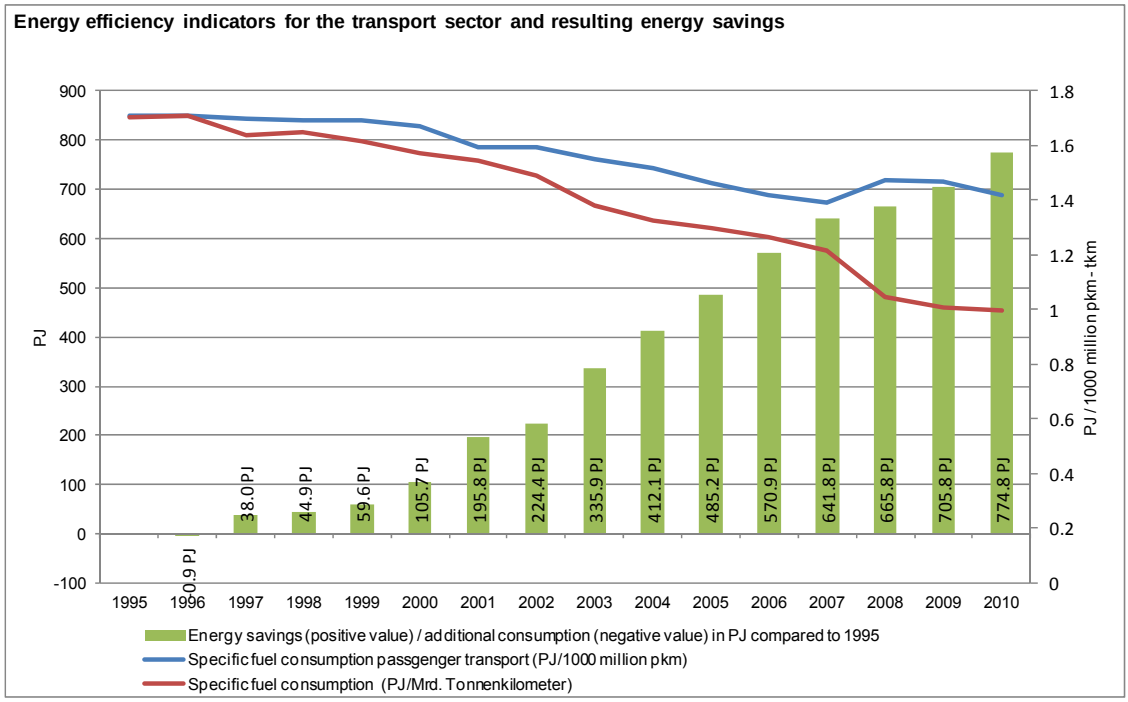
11 The actual status of the data used in the 2nd NEEAP was from January 2011, whereas in this report, statistical data up to August 2012 were taken into account. Since the calculations in the German NEEAP were provided in PJ, the results in this Chapter are presented in PJ and not in Mtoe as in the Chapters before (1 PJ = 0,0238846 Mtoe).

Figure 6-1: Top-down calculations of ex-post energy savings in the 2nd NEEAP of Germany for the period 1995-2007









Source: BMWi 2011; calculations Fraunhofer ISI

Overall the energy savings, which were achieved above all in the years after 2000, dominated in all sectors. Until then increases in energy consumption were still being recorded in particular in private households and in the tertiary sector, because the improvements in energy efficiency were not enough to compensate for an increase in energy consumption due to factors such as new or larger electrical devices, higher

room temperatures in residential accommodation or increased automation in the tertiary sector.

The recommendations by the EU Commission (2010) were also incorporated in the calculation of the **bottom-up energy savings** for Germany, i.e. the impact evaluation of individual policy measures. In addition, national bottom-up calculation methods for those instruments for which no recommendations by the EU Commission were available for the calculation of the resulting energy savings. This relates in particular to instruments and measures from the transport and mobility sphere of activity as well as to "cross-sectoral measures". Existing evaluations of promotional measures or programmes were included in addition in those cases in which they were available in an appropriate form. In order to quantify the real bottom-up energy savings in a more accurate way, two correction factors have been applied in the German NEEAP:

- A correction factor for double-counting of energy savings which can occur if a single en-ergy conservation measure is addressed by a larger set of policy instruments and measures (interaction of policy instruments and measures) and
- a correction factor for the influence of failing to consider or not fulfil stipulations (non-compliance), especially in the case of regulatory instruments

Table 6-1 shows exemplary quantitative impact evaluations of policy measures in the 2nd German NEEAP. It both includes an ex-post evaluation of the impact between 1995 and 2007 („Early Action period) and of the target period from 2008 to 2016.

Table 6-1: Bottom-up impact evaluation of selected energy efficiency policy measures in the 2nd German NEEAP (ex-post and ex-ante savings)

Sector	Title of the measure	Bottom-up savings in 2016 [in PJ/a; power coeff.=1)	
		Comp. with 2007	Comp. with 1995
Industry	Voluntary agreements between German industry and Federal Government	1.2	37.8
	Special fund energy efficiency in SMEs	9.3	9.3
Households/ Tertiary (electrical appliances/lighting)	Energy-using Products Act (EPBG) (incl. electric motors)	37.4	37.4
	Energy Consumption Labelling (historical and new regulation)	5.2	10.1
	Energy advice from Consumer Advice Centres	1.4	2.3
Buildings (residential/ non-residential)	Energy Saving Ordinance	143.2	334.3
	Market incentive programmes (MAP) for biomass and solar power	30.1	40.0
	KfW programme "Energy-efficient rebuilding"	52.0	52.0
Transport	Motor vehicle tax (since 2009 emission-based)	15.7	30.4
	Heavy goods vehicle (HGV) toll charge	5.2	9.7

Source: BMWi 2011

The total energy savings in Germany calculated by the top-down method clearly exceed the requirements of the Directive on Energy End-use Efficiency and Energy Services both including early action (2479 PJ or 59 Mtoe) and without early action (1418

PJ or 34 Mtoe) compared with an indicative energy savings guideline value of 748 PJ (17.9 Mtoe) until the year 2016 (BWMi 2011). The highest contributions to savings were recorded in the industry and transport sectors (see Figure 6-1).

The total bottom-up savings in Germany amount to 819 PJ (incl. Early Action) by the year 2016 and therefore slightly exceed the target value of 748 PJ. This figure also means that around one third of all top-down savings in the order of 2479 PJ can be covered by bottom-up methods. Without early action, i. e. only taken into account the impact of policy measures from 2008, the bottom-up savings amount to 463 PJ, and therefore only reach 60 % of the ESD target (BMWi 2011). It must however be taken into account that these savings mainly include policy measures at the level of the Federal state. The numerous activities at the level of the Länder and the municipalities, as well as those of private actors, are taken into consideration scarcely or not at all in conjunction with this. The same applies to informational measures, which have only been considered in very few cases due to the difficulties to estimate the medium- and long-term impact of this kind of measures. In addition, the correction factors which have been applied for the double-counting and the non-compliance of measures also reduces the impact of the bottom-up calculated savings.

Apart from that, there are also methodological reasons, why the bottom-up savings remain significantly below the top-down values. The top-down approach evaluates what has happened in the whole of the sector or sphere of activity under consideration, irrespective of the question as to which reasons have led to a corresponding energy saving. Only quantitative, structural and temperature effects have been considered in the method applied. But energy savings can thus be induced both in terms of policy and for market-related (i.e. energy prices or autonomous technical progress) reasons or can be attributed to the behaviour of end consumers.[12]

Comparison of energy saving targets for Germany

As it was shown above, Germany will reach its energy saving target under the ESD of for the period between the beginning of 2008 and the end of 2016. This target amounts to 9% of the annual average consumption of all energy users within the scope of the Directive in the period of five years for which official data area available prior to the

12 From a methodological point of view, the correction of price- and technology-related influences could, in fact, be effected by adopting an econometric approach, by carrying out a regression analysis in relation to a (corrected) indicator. The testing of such an approach in the context of the EMEEES project (Wuppertal Institute 2009) supported by the EU Intelligent Energy Europe Programme has revealed, for example, that the regression analysis itself is methodologically problematical and as a consequence does not necessarily deliver adequate results.

implementation of the ESD. The respective target value was calculated for Germany by 748 PJ (17.9 Mtoe).

In the proposal for a new EU Energy Efficiency Directive, which will enter into force in December 2012, the European Commission (2011) suggests to lay down the (non-binding) European energy efficiency target of a 20% reduction of primary energy consumption in 2020 compared to a baseline (which is set by the PRIMES 2007 scenario of the EU) as a fixed target value of 1474 Mtoe primary energy consumption. This means primary energy savings of 368 Mtoe (excl. non-energy uses). In the EU Energy Efficiency Plan from 8 March 2011 (COM(2011) 109 final) and in the proposal for the EED, the Commission also states that the EU is only halfway towards the energy saving target. This means a gap of at least 185 Mtoe which will not be achieved by present energy saving policies. In order to still reach the target, the new EED[13] includes provisions on the setting of energy efficiency target in the Member States (Article 3), general energy efficiency policy measures (especially the introduction of energy efficiency obligations or equivalent measures in Article 7) and measures adressing specific energy consumption sectors (e.g. building renovation in Article 4, public buildings in Article 5, energy audits and management systems for enterprises in Article 8, energy efficient heating and cooling incl. CHP in Article 14).

For Germany, the EU energy efficiency target means a reduction by 60 Mtoe primary energy in 2020 (compared to the PRIMES 2007 scenario values for Germany). This is considerably more than the ESD target value, though it has to be taken into account that the ESD target refers to final energy and excludes energy consumption by ETS branches. The national energy saving target in the German Energy Concept from 2010 is also defined as 20 % primary energy savings in 2020, but compared to the primary energy consumption in the year 2008 (incl. non-energy uses). In 2008, the primary energy consumption in Germany amounted to 14,260 PJ or 340 Mtoe (AGEB 2012), this means a reduction by 68 Mtoe in 2020. In order to achieve these targets, additional efforts compared to the 2nd NEEAP are necessary. Up to now, only the total top-down savings including early actions and market-induced improvements tightly reach the order of magnitude of the 20 % target.

13 The following provisions refer to the compromise amendment to the EED, which was voted for by the European Parliament on 11 September 2012 and approved by the Member States at their Council meeting on 4 October (European Union 2012).

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Annex 1

Summary of energy efficiency measures in Germany

Source:
Download from MURE database (http://www.muredatabase.org/) as of October 2012

Table 1: Policy measures in the household sector

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER3	Thermal Insulation Ordinance of 1977	Completed	Legislative/Normative	1977	1983	High
GER4	Energy advice for private consumers	Ongoing	Information/Education	1977	--	Medium
GER14	Environmental Label "Blue Angel"	Ongoing	Information/Education	1977	--	Low
GER25	Heating Installations Ordinance of 1978/82	Completed	Legislative/Normative	1979	1994	Medium
GER11	Ordinance on Heat Consumption Metering	Ongoing	Legislative/Normative	1981	--	High
GER5	Thermal Insulation Ordinance of 1982	Completed	Legislative/Normative	1984	1994	High
GER9	On-site energy advice	Ongoing	Financial	1991	--	Medium
GER15	Small-Scale Combustion Plant Ordinance	Ongoing	Legislative/Normative	1993	--	Low
GER23	Heating Installations Ordinance of 1994	Completed	Legislative/Normative	1994	2002	Medium
GER24	Thermal Insulation Ordinance of 1994	Completed	Legislative/Normative	1995	2002	High
GER18	EU-related: Energy Labelling of Household Appliances (Directive 92/75/EC) - Energy Consumption Labelling Ordinance	Ongoing	Legislative/Informative	1998	--	High
GER26	KfW CO2 Reduction Programme	Completed	Financial	1999	2004	Medium
GER28	Ecological Tax Reform	Ongoing	Cross-cutting with sector-specific characteristics	1999	--	High
GER32	Market Incentive Programme for Renewable Energies	Ongoing	Financial	1999	2020	High
GER33	KfW Programme "Energy-efficient refurbishment" (former CO2 Building Rehabilitation Programme)	Ongoing	Financial	2001	--	High
GER6	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Energy Savings Ordinance	Completed	Legislative/Informative, Legislative/Normative	2002	2007	High

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER34	Energy Efficiency Campaign	Ongoing	Information/Education	2002	--	Low
GER68	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Länder activities in the building sector	Ongoing	Legislative/Informative, Legislative/Normative	2002	2012	High
GER42	KfW Programme Housing Modernisation	Completed	Financial	2005	2009	Medium
GER43	KfW Programme Ecological Construction	Completed	Financial	2005	2009	Low
GER47	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Energy certificates for buildings	Ongoing	Legislative/Informative	2008	--	Low
GER65	Information Campaign on Climate Protection	Completed	Information/Education	2008	--	Low
GER8	EU-related: Ecodesign Directive for Energy-using Products (Directive 2005/32/EC)	Ongoing	Legislative/Normative	2009	--	High
GER87	Act on the Promotion of Renewable Energies in the Heat Sector	Unknown		2009	--	Unknown
GER64	Smart Metering	Ongoing	Legislative/Informative	2010	--	Medium
GER72	EU-related: Revised Directive for Labelling of Energy-related Products (Directive 2010/30/EU) - Energy Consumption Labelling Ordinance – revised version (EnVKV - revised)	Proposed (advanced)	Legislative/Informative	2011	--	Medium
GER67	EU-related: Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Energy Savings Ordinance - revision 2012	Unknown	Legislative/Normative	2013	--	High
GER48	Top Runner Strategy	Proposed (medium/long-term)	Legislative/Informative, Legislative/Normative	--	--	High
GER78	EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) (revised version)	Proposed (advanced)				High

Table 2 : Policy measures in the tertiary sector

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER19	Thermal Insulation Ordinance of 1977	Completed	Legislative/Normative	1977	1983	Medium
GER22	Environmental Label "Blue Angel"	Ongoing	Information/Education/Training	1977	--	Low
GER16	Heating Installation Ordinance of 1978/1982	Completed	Legislative/Normative	1979	1994	Medium
GER12	Thermal Insulation Ordinance of 1982	Completed	Legislative/Normative	1984	1994	Medium
GER14	KfW Environmental Protection Programme	Ongoing	Financial	1984	--	Medium
GER17	Small-Scale Combustion Plant Ordinance	Ongoing	Legislative/Normative	1988	--	Low
GER5	Heating Installations Ordinance of 1994	Completed	Legislative/Normative	1994	2002	High
GER11	Thermal Insulation Ordinance of 1994	Completed	Legislative/Normative	1995	2002	Medium
GER15	ERP Environmental Protection and Energy Saving Programme	Ongoing	Financial	1995	--	Low
GER8	ECO Managment and Audit Scheme (EMAS)	Ongoing	Information/Education/Training	1996	--	Low
GER2	Ecological Tax Reform	Ongoing	Cross-cutting with sector-specific characteristics	1999	--	High
GER23	Market Incentive Programme for Renewable Energies	Ongoing	Financial	1999	2020	High
GER4	Voluntary Agreement on CHP	Ongoing	Co-operative Measures	2001	2010	Low
GER7	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Energy Savings Ordinance	Ongoing	Legislative/Normative	2002	--	Medium
GER9	Heat Power Cogeneration Act	Ongoing	Financial	2002	2010	Medium

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER27	Energy Efficiency Campaign	Ongoing	Information/Education/ Training	2005	--	Low
GER29	Special fund for energy efficiency in SMEs	Ongoing	Financial	2008	--	High
GER33	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Energy Certificates for buildings	Ongoing	Legislative/Informative	2008	--	Low
GER34	Information Campaign on Climate Protection	Completed	Information/Education/Training	2008	--	Low
GER25	Stimulus programme for the promotion of climate protection measures in commercial cooling installations	Ongoing	Financial	2009	--	Low
GER31	EU-related: Ecodesign Directive for Energy-using Products (Directive 2005/32/EC) - Eco-Design of Energy-using Products	Completed	Legislative/Informative	2009	2011	High
GER32	Smart Metering	Ongoing	Legislative/Informative	2010	--	Medium
GER35	EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Eco-Design of Energy-using products	Ongoing	Legislative/Normative	2011	--	High
GER40	EU-related: Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Energy Savings Ordinance 2012	Unknown		2012	--	High
GER30	Top Runner Strategy	Proposed (advanced)	Legislative/Informative	--	--	High

Table 3 Policy measure in industry

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER24	Environmental Label Blue Angel	Ongoing	Information/ Education/ Training	1978	--	Low
GER2	BMU Programme for the Financing of Demonstration Projects	Ongoing	Financial	1979	--	Low
GER14	Heating Installations Ordinance of 1978/82	Completed	Legislative/Normative	1979	1984	Low
GER13	Large-Scale Combustion Plant Ordinance	Ongoing	Legislative/Normative	1983	--	Medium
GER28	KfW Environmental Protection Programme	Completed	Financial	1984	2005	Medium
GER30	DtA Environmental Protection Programme	Completed	Financial	1984	2002	Low
GER19	Small-Scale Combustion Plant Ordinance	Ongoing	Legislative/Normative	1988	--	Low
GER32	Heating Installations Ordinance of 1994	Completed	Legislative/Normative	1994	2002	Low
GER8	Voluntary agreement with German industry I	Completed	Co-operative Measures	1995	2001	High
GER22	ERP Programme for Environment and Energy Saving	Completed	Financial	1995	2005	Low
GER20	ECO Managment and Audit Scheme (EMAS)	Ongoing	Informati-on/Education/Training	1996	--	Low
GER1	100 000 Roofs Solar Power Programm	Completed	Financial	1999	2003	Low
GER5	Market Incentive Programme for Renewable Energies	Ongoing	Financial	1999	--	Low
GER7	Promotion of contracting	Ongoing	Financial	1999	--	Low
GER11	EU-related: Community framework for the taxation of energy products and electricity (Directive 2003/96/EC) - Ecological tax reform	Ongoing	Cross-cutting with sector-specific characteristics	1999	--	Medium
GER35	KfW Programme Renewable Energy	Ongoing	Financial	1999	--	Low
GER18	Voluntary agreement with German industry II	Ongoing	Co-operative Measures	2000	--	Medium

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER29	Voluntary Agreement on CHP	Ongoing	Co-operative Measures	2001	2010	Low
GER3	Heat-Power Cogeneration Act	Ongoing	Financial	2002	--	Medium
GER4	KfW Carbon Fund	Ongoing	New Market-based Instruments	2004	--	Unknown
GER31	Law on the national allocation plan for greenhouse gas emissions allowances	Ongoing	New Market-based Instruments	2004	--	Unknown
GER23	EU-related: EU Emission Trading Scheme (2003/87/EC) - Greenhouse Gas Emissions Trading Act	Ongoing	New Market-based Instruments	2005	--	Unknown
GER33	Energy Efficiency Campaign	Ongoing	Information/Education/Training	2005	--	Low
GER34	EU-related: - Project Mechanism Act	Ongoing	New Market-based Instruments	2005	--	Unknown
GER38	Contracting in relation to lighting	Ongoing	Information/Education/Training	2007	--	Medium
GER39	Contracting in relation to heating, ventilation and air conditioning	Ongoing	Co-operative Measures	2007	--	High
GER36	Special fund for energy efficiency in SMEs	Ongoing	Financial	2008	--	High
GER43	ERP Environmental and Energy Efficiency Programme	Ongoing	Financial	2008	--	Low
GER37	Contracting in relation to compressed air	Ongoing	Co-operative Measures		--	High
GER40	European Top Runner Strategy	Unknown	Legislative/Normative		--	High
GER41	Contracting and cogeneration campaign	Unknown	Information/Education/Training		--	Unknown

Table 4: Policy measures in the transport sector

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER27	Motor vehicle duty (with CO2-based components since 2009)	Ongoing	Fiscal	1985	--	High
GER18	Voluntary agreement by German automobile industry	Completed	Co-operative Measures	1995	2005	Medium
GER8	Ecological tax reform	Ongoing	Cross-cutting with sector-specific characteristics	1999	--	High
GER6	Conversion of flat mileage rate to distance rate	Ongoing	Fiscal	2001	--	Low
GER32	Improving the infrastructure for using bicycles	Ongoing	Financial	2002	--	Medium
GER17	Federal Transport Infrastructure Plan 2003	Ongoing	Infrastructure	2003	2015	Low
GER37	EU-related: Passenger Car Labelling on fuel economy rating (Directive 1999/94/EC) - Ordinance on Energy Consumption Labelling of new vehicles	Ongoing	Legislative/Informative	2004	--	Medium
GER2	Heavy goods vehicle toll charges	Ongoing	Financial	2005	--	High
GER22	Fuel Quality Ordinance	Ongoing	Legislative/Normative	2007	--	Low
GER23	EU-related: Community framework for the taxation of energy products and electricity (Directive 2003/96/EC) - Energy Tax Privilege	Ongoing	Fiscal	2007	--	Low
GER24	EU-related: Promotion of Biofuels or other Renewable Fuels for Transport (Directive 2003/30/EC) - Biofuel Quota Act	Ongoing	Legislative/Normative	2007	--	High
GER25	Biomass Sustainability Ordinance	Proposed(advanced)	Legislative/Normative	2008	--	Medium
GER28	Campaign “me and my car. Driving smart, Saving gas”	Ongoing	Information/Education/Training	2008	--	Medium

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER30	Promoting mobility, communication and city logistics	Ongoing	Co-operative Measures , Infrastructure	2008	--	Low
GER33	Car scrapping	Completed	Financial	2009	2009	Medium
GER39	EU-related: Emission performance standards new passenger cars (Regulation 443/2009/EC) - Accelerating technical development / CO2 strategy for passenger cars	Ongoing	Legislative/Normative	2009	--	High
GER26	Statutaory Ordinance on Hydrogenation of vegetable oil	Unknown	Legislative/Normative	2010	--	Low
GER5	Levy on air traffic	Ongoing	Fiscal	2011	--	Medium

Table 5: Policy measures in the cross-cutting sector

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER11	National Climate Protection Programme	Ongoing	General Energy Efficiency / Climate Change / Renewable Programmes		--	High
GER15	Special tariffs and Certificates for electricity from renewable energies	Ongoing	Market-based Instruments	1997	--	Low
GER16	Energy Consumption Labelling Act	Ongoing	Non-classified Measure Types	1997	--	High
GER12	Renewable Energy Sources Act	Completed	Fiscal Measures/Tariffs, Legislative/Normative Measures	2000	2004	High
GER10	Voluntary Commitment by the Federal Government to reduce CO2 emissions	Ongoing	Non-classified Measure Types	2001	--	Low
GER14	Biomass Ordinance	Ongoing	Fiscal Measures/Tariffs, Legislative/Normative Measures	2001	2020	High
GER13	Act revising the legislation on renewable energy sources in the electricity sector	Ongoing	Fiscal Measures/Tariffs, Legislative/Normative Measures	2004	2020	High
GER20	Integrated Energy and Climate Programme of the German Government	Ongoing	General Energy Efficiency / Climate Change / Renewable Programmes	2007	2020	High
GER18	Renewable Energy Promition Ordinance for Heat	Ongoing	Legislative/Normative Measures, Market-based Instruments	2008	2020	High

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
GER19	National Energy Efficiency Action Plan (NEEAP) of the Federal Republic of Germany	Ongoing	General Energy Efficiency / Climate Change / Renewable Programmes	2008	2016	High
GER17	Renewable Energy Sources Act for Heat	Ongoing	Legislative/Normative Measures	2009	2020	High
GER21	Sustainability Ordinance for Electricity from liquid Biomass	Proposed (advanced)	Non-classified Measure Types	2010	2020	Medium

Annex 2

Country Profile Germany

Energy Efficiency Profile: Germany

Energy Efficiency Trends

Overview

Over the period 1991-2010, the energy efficiency index for the whole economy (ODEX) decreased by 24 % in Germany, which is equivalent to an energy efficiency improvement of 1.2 %/year on average. Whereas between 1991 and 2000, a continuous efficiency improvement by almost 1.7 %/year could be observed, which was slightly above the EU average, the improvement slowed down to 0.8%/year after 2000. Since 2003, the German ODEX decreased less than the EU ODEX. Since 2009, even an increase of the ODEX was observed in Germany, which means a slight worsening of the energy efficiency of final consumers.

Industry

The main reason for the slowing down of the energy efficiency improvement since 2000 was the reversal of the energy efficiency development in the industrial sector. During the 90s, energy efficiency in industry, as measured by the industrial ODEX, improved by about 24 %, which was at least partly due to the breakdown of industry in Eastern Germany in the first half of the 1990s. Since 2001, however, energy efficiency progress slowed down or even turned back in some branches, especially in the energy-intensive steel and paper industries. After a phase of further energy efficiency improvement between 2004 and 2007, the following years were again characterized by an increase of the ODEX in manufacturing, i.e. a worsening of energy efficiency, both at the level of the energy-intensive branches (steel, chemicals, paper) and for manufacturing industry.

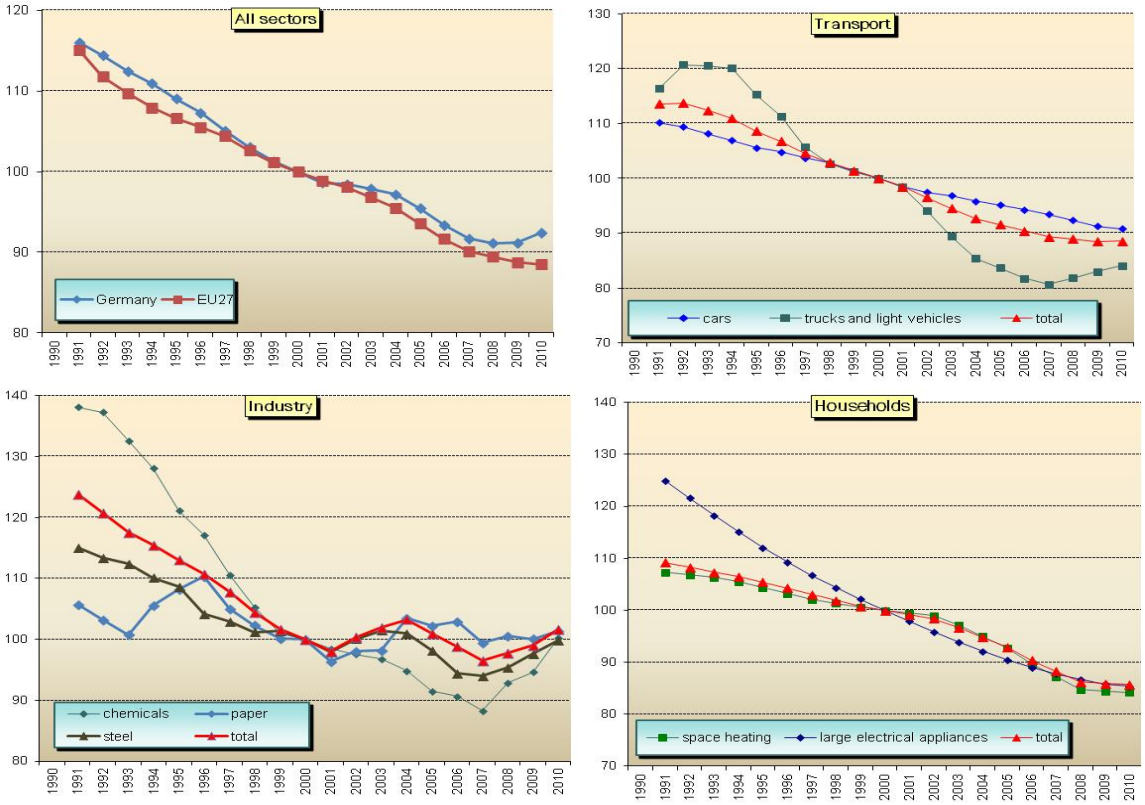
Households

Between 1991 and 2010, the technical ODEX in the household sector as a whole decreased by about 23 %, which represents an average energy efficiency improvement of 1.3 %/year. Energy efficiency both improved for electrical appliances and space heating. In contrast to the development at the level of the whole economy, the efficiency improvement accelerated between 2002 and 2008. Since 2009, however, a stagnation can be observed.

Transport

In 2010, the energy efficiency index of transport improved by 25 % compared to 1991. Efficiency improvements in the car stock as a consequence of the penetration of new, more efficient cars (measured by a specific consumption in l/km) and a continuous trend to diesel cars, contributed steadily to this development. The energy efficiency index for trucks and light duty vehicles increased until the mid 1990s, but afterwards, it also contributed to energy efficiency gains in transport, especially over 2001-2006. From 2007, however, the ODEX for trucks increased again. The contribution of the other transport modes (air, train, buses, motorcycles) is less important due to their small shares in consumption. Modal shift had a comparatively small impact on transport energy consumption.

Energy efficiency index ODEX (base 100=2000)*



*All indicators me

Source ODYSSEE For more information : http://www.odyssee-indicators.org/

Energy Efficiency Policy measures

Institutions and programmes

On 28 September 2010, the German Government adopted a new **Energy Concept**[14]. The aim was to develop an overall strategy for the period up to 2050. Among the nine fields of action, energy efficiency was seen as a key issue, since the Energy Concept is based on a dual strategy: reduction of energy demand by significantly increasing energy efficiency and meeting the energy demand mainly by renewables. As a consequence of the nuclear accident in Fukushima, the German Government has rethought the planned prolongation of the operation life of nuclear power plants and decided on a phase-out of nuclear energy until end of 2022. With their decisions from June and July 2011, the Federal Government and the Bundesrat decided on an accelerated transformation of the energy system, the so-called "Energiewende"[15]. With regard to energy efficiency, the Energy Concept includes ambitious targets. At the level of the whole economy, primary energy consumption shall be reduced by 20% until 2020 and by 50% until 2050. Electricity consumption is planned to be cut by 10 % until 2020 and by 25 % until 2050 (all compared with 2008). In addition, the following sectoral energy efficiency targets have been set: for buildings a doubling of the building renovation rate from about 1 % to 2 % and a reduction of the heating requirements by 20% until 2020 and by 2050 a reduction of the primary energy demand by 80% for transport a reduction in final consumption by about 10% by 2020 and 40% by 2050 (compared with 2005).

Industry, tertiary and private consumers

For the first time, a special energy efficiency fund was established and financing for the existing National Climate Initiative will be significantly increased. Both initiatives shall initiate important efficiency measures at all levels - municipalities, industry, SMEs and consumers. With regard to product labeling and standards, Germany is advocating ambitious standards at EU level and a transparent labeling for cars, products and buildings. In order to save electricity, the advisory service for private consumers was considerably extended, esp. for poor households. In industry, a wider spread of energy management systems and energy audits is supported in order to help industry to better identify and tap its efficiency potential. In the course of reorganization of the eco-tax relief to energy-intensive companies, this requirement is to be linked to the operation of energy management systems in accordance with international standards (EN 16001, ISO 50001) from 2013.In addition, successful financial support programmes especially for small and medium-sized companies shall be extended, as e.g. the special energy efficiency fund for SMEs.

Buildings

The building sector, both including residential and non-residential buildings, is regarded as the key to greater energy efficiency. In this sector, the following measures are planned: inclusion of the climate neutral building standard, to be met by new buildings by 2020, in the Energy Saving Ordinance in 2012; developing of a renovation roadmap for existing buildings which starts in 2020; ensuring better funding for the CO2 building rehabilitation programme to support efficiency measures and assessment whether a budget-independent financing of building refurbishment programmes (e.g. by White Certificates) from 2015 is possible; increasing the market incentive programme for the use of renewable energies for heat generation in buildings; launching a new support scheme "performance-enhancing urban rehabilitation". The planned tax deductibility of energy-efficient building renovation is controversially discussed between the Federal Government and the Federal states.

Transport and Mobility

In the transport sector, a strong focus is on Germany's electric mobility strategy, which aims to have 1 million electric vehicles on road by 2020 and 6 million by 2030. At the EU level, the German Government is advocating for ambitious CO_2 limit values for all classes of vehicles. The German Government is also taking steps to foster a higher share of vehicles that run on natural gases and to increase the share of sustainably produced biofuels. A further developing of the emission-based vehicle tax and the heavy goods vehicle (HGV) toll charge in order to achieve a greater reduction of greenhouse gases is foreseen, too.

14 http://www.bmu.de/english/energy_efficiency/doc/46516.php

15 http://www.bmu.de/english/transformation_of_the_energy_system/chronology/doc/48051.php

Impact evaluation of selected measures

Sector	Title of the measure	Bottom-up savings in 2016 [in PJ/a; power coeff.=1)	
		Comp. with 2007	Comp. with 1995
Industry	Voluntary agreements between German industry and Federal Government	1.2	37.8
	Special fund energy efficiency in SMEs	9.3	9.3
Households/ Tertiary (electrical appliances/lighting)	Energy-using Products Act (EPBG) (incl. electric motors)	37.4	37.4
	Energy Consumption Labelling (historical and new regulation)	5.2	10.1
	Energy advice from Consumer Advice Centres	1.4	2.3
Buildings (residential/ non-residential)	Energy Saving Ordinance	143.2	334.3
	Market incentive programmes (MAP) for biomass and solar power	30.1	40.0
	KfW programme “Energy-efficient rebuilding”	52.0	52.0
Transport	Motor vehicle tax (since 2009 emission-based)	15.7	30.4
	Heavy goods vehicle (HGV) toll charge	5.2	9.7

Source: 2nd NEEAP of the Federal Republic of Germany (http://www.bmwi.de/English/Navigation/Service/publications,did=476674.html under the EU Directive on Energy End-use Efficiency and Energy Services

Annex 3

Detailed data sources for the calculation of energy indicators in the ODYSSEE database - Germany

Status: as of August 2012

The most important data source for energy consumption data in Germany is the **German energy balance**, which is provided by the Arbeitsgemeinschaft Energiebilanzen (AGEB). Energy consumption data from the energy balances at an aggregated level were available up to 2011 from the summary tables to the energy balances (as of August 2012). The detailed energy balances which also include subsectoral energy consumption (industrial branches, transport modes) were available up to 2010 (and preliminary data for 2011).

Most of the macro-economic data in the ODYSSEE data base, both at the level of the total economy and at sectoral level (GDP, value added of industry and industrial branches, value added of the commercial/public sector, private consumption, number of employees) are from the **National Accounts**. What concerns GDP in real terms, there was a change of the methodology for the deflation. Now, a chain index is used, and all figures are given for the year 2000 for all years from 1990.

Concerning the special data situation in the sectors, the following remarks have to be made:

Industrial sector

Energy consumption of the construction industry had to be estimated for the whole period based on survey data (Schlomann et al. 2011), because in the German energy balance the construction industry is not separated.

Residential sector

Detailed energy consumption data by energy carriers and end-uses for the residential sector, e. g. on space heating, hot water, cooking and electric appliances, were provided by AGEB and BDEW until 2007, based on the energy balances. From 2008, these data were provided based on regular surveys on energy consumption in the household sector and tertiary sector and for industry based on engineering estimates (Ziesing 2011).

Data for electrical appliances were taken from a stock model (Prognos 2010), since no statistical or survey data are available for this part of residential energy consumption in Germany up to now.

Construction, agriculture and tertiary sector

One peculiarity of the German energy balance is the summarizing of the construction, agriculture and tertiary sector in one sector which was called "Kleinverbraucher" until 1994 and is now called "Gewerbe, Handel, Dienstleistungen (tertiary) und sonstige

Verbraucher" (tertiary and other consumers) since 1995. For the definition of the sectors within the ODYSSEE data base, energy consumption of these three sectors has to be separated. For some years, energy consumption data are available from special studies, the other years were interpolated.

The data situation for these three sectors and also within the tertiary sector improved, since surveys were published including energy consumption data for the years 1995, and 2001 onwards. The study of Geiger/Gruber/Megele (1999) is a very detailed analysis of energy consumption of this sector in Germany. As in the household sector, regular surveys on energy consumption in the tertiary sector started in 2001 (Schlomann et al. 2004, 2009, 2011).

Transport sector

The most important data source for the transport sector is a yearly publication ("Verkehr in Zahlen"), which is done by the DIW on behalf of the Bundesministerium für Verkehr, Bau- und Stadtentwicklung BMVBS (2012) including stock data, kilometres and energy consumption data by transport modes. Due to this publication, the quality of the transport data in the ODYSSEE database for Germany is rather satisfactory, both what concerns the comparability and the up-to-dateness of the data.

There is only one definition problems which restricts the comparability of the German data with other countries. In the transport sector, the ODYSSEE database distinguishes between three main types of vehicles: cars, light vehicles (<3 t useful load) and trucks. The problem in the German statistics of transport is that light vehicles can only be separated concerning the stock of vehicles (VDA statistiscs). The data on energy consumption and kilometres are only available for the aggregate light vehicles and trucks. Because of this problem, a new category was included in the ODYSSEE database which is called "trucks and light duty vehicles". Another statistical problem is the different definition of energy consumption in the energy balances (domestic consumption) and the DIW road transport statistics (energy consumption of Germans in Germany and abroad).

Data sources for the calculation of the energy efficiency index (ODEX)

In ODYSSEE, various indicators of unit consumption are calculated to depict the changes in energy efficiency by sector on a detailed level (end-uses, transport mode and types of vehicles, sub-sectors). To provide the best proxy of energy efficiency and address the various definitions of energy efficiency, they are expressed in different units depending on the sub-sector or end-use: litre/100km, toe/vehicle, toe/ton-km or passenger-km in the transport sector; toe per dwelling or per m^2 and kWh per dwelling

or per appliance for households; toe/ton or per unit of value in industry. These detailed calculations need to be complemented with an overall perspective of the energy efficiency trends by sector. For this purpose, an aggregate indicator has been developed in ODYSSEE for the main sectors (industry, households, transport and services) and the economy as a whole to combine the efficiency trends as depicted by the detailed indicators by end-use or sub-sector. Such indicators are called “bottom-up energy efficiency indexes” or in short “energy efficiency indexes” (ODEX). They represent a better proxy to evaluate energy efficiency trends at an aggregate level than the energy intensities (i.e. energy consumption per unit of GDP or value added) generally used to describe the overall trends, as they are adjusted for structural changes and other factors not related to energy efficiency. The energy efficiency index of a given sector is calculated from the unit consumption indices by end-use (or equipment) based on the weight of each end-use in the total consumption of the sector. As indices are used, it is possible to combine different units for unit consumption indices, e.g. toe/dwelling, koe/m^2, kWh/appliance, or toe/capita for households. A decrease in the index means an energy efficiency improvement. Presently, about 30 indicators are used in ODYSSEE.

Therefore, the quality of the data sources for those indicators which are part of the ODEX is very important. It became even more important since the ODEX is mentioned in the "Directive on energy end-use efficiency and energy services" (ESD) as a possible top-down-tool for the monitoring of the Directive. In Table A1-1, all data sources are summarized which are used for the ODEX calculations. In the last column, a quality assessment of the data is given, which was introduced in the ODYSSEE-MURE project in order to facilitate the reliability of the ODEX calculations.

Table A.1-1: Data sources for the calculation of the energy efficiency index (ODEX) in the ODYSSEE database

Data in ODYSSEE	**Data Source Germany**	**Assessment of data quality**	
		Data source[1)]	**Quality of data[2)]**
General data			
Value added, private Consumption	Statistical Office, National Accounts	A	1
Population	Statistical Office, Statistical Yearbook	A	1
Primary and final energy consumption by sector	Arbeitsgemeinschaft Energiebilanzen (AGEB), Energy Balances (Summary Tables)	A	1
Electricity generation by energy carriers	BMWI: Energiedaten BMU: Erneuerbare Energien in Zahlen	A	1
Degree days	Deutscher Wetterdienst (DWD), AGEB	A	1

Data in ODYSSEE	Data Source Germany	Assessment of data quality	
		Data source[1)]	Quality of data[2)]
Tertiary sector and other (in Germany: GHD)			
Value added and employment by sub-sectors	Statistical Office, National Accounts	A	1
Floor area by subsector	Surveys on energy consumption in the tertiary sector (Fraunhofer ISI et al. 2011, 2009, 2004; Geiger, Gruber, Megele 1999)	B	2
Energy consumption by end-uses	Until 2007: AGEB/BDEW based on expert guesses; from 2008: AGEB/ TU Munich based on survey data	A	1
Energy consumption by sub-sectors	Surveys on energy consumption in the tertiary sector (Fraunhofer ISI et al. 2011, 2009, 2004; Geiger, Gruber, Megele 1999)	B	1
Household Sector			
Number of households and dwellings, floor area	Statistical Office, Statistical Yearbook and Fachserie 5	A	1
Stock and sales of electrical appliances	ZVEI; GfK (partly interpolation and extrapolation of missing years by Fraunhofer ISI)	B	2
Energy consumption by end-uses	Until 2007: AGEB/BDEW based on expert guesses; from 2008: AGEB/ RWI based on survey data	A	1
Specific consumption of electrical appliances	Stock modelling data (Prognos)	B	2
Sector Industry			
Value added by industrial branches	Statistical Office, National Accounts	A	1
Production index	Statistical Office, Industrial Statistics	A	1
Physical production	Statistics of industrial associations (Wirtschaftsvereinigung Stahl, Wirtschaftsvereinigung Metalle, VCI, vdp, BVGlas, BDZ)	B	1
Energy consumption by branches	Arbeitsgemeinschaft Energiebilanzen (AGEB), detailed energy balances Statistical Office, statistics on energy consumption in industry	A	1
Transport Sector			
Stock of cars and kilometers	DIW Berlin/BMVBS: Verkehr in Zahlen and additional calculations by DIW	A, B	1-2
Energy consumption by sub-sectors	AGEB, DIW Berlin	A	1
Energy consumption by vehicle types	DIW Berlin/BMVBS: Verkehr in Zahlen and additional calculations by DIW	A, B	1-2
Energy consumption of new cars	ACEA	B	1

1) **A** = Official Statistics (Statistics/surveys by national Statistical Offices, Eurostat/IEA, Ministries; model estimations used as official statistics; data "stamped" by ministries)
B = surveys/modelling estimates by research institutes, universities, consultants, industrial associations
C = Estimations made by the national team for the project

2) **1** = good quality; **2** = medium quality; **3** = poor quality

Detailed data source for the German data in the ODYSSEE database

AGEB (2012): German Energy Balances 1990-2010 and Summary Tables 1990-2011. As of August 2012. DIW Berlin, EEFA, Köln (http://www.ag-energiebilanzen.de)

AGEB (2011): Anwendungsbilanzen für dieEndenergiesektoren in Deutschland in den Jahren 2009 und 2010. Berlin, 16 November 2011 (http://www.ag-energiebilanzen.de/viewpage.php?idpage=255)

AGEB (2011): Anwendungsbilanzen für dieEndenergiesektoren 2008. Berlin, 15 February 2011 (http://www.ag-energiebilanzen.de/viewpage.php?idpage=255)

Endenergieverbrauch in Deutschland 2007. Berlin, Dezember 2008 and earlier years

BMWI (2012): Zahlen und Fakten. Energiedaten. Berlin. (http://www.bmwi.de/DE/Themen/Energie/Energiedaten/gesamtausgabe.html)

BMU (2012): Erneuerbare Energien in Zahlen. As of July 2012 (and earlier years). Berlin (www.bmu.de)

DIW Berlin (2011): Kraftfahrzeugverkehr 2010. DIW-Wochenbericht Nr. 47/2011. Berlin (and similar publication for earlier years)

DIW Berlin/BMVBS (2009): Verkehr in Zahlen 2008/2009. Bearbeitet vom DIW Berlin. Bonn/Berlin 2009

Energieverbrauch des Sektors Gewerbe, Handel, Dienstleistungen (GHD) für die Jahre 2006 bis 2010. Interim Report (English Summary available; (http://www.isi.fraunhofer.de/isi-de/x/projekte/ghd_314889_sm.php; http://www.bmwi.de/DE/Mediathek/publikationen,did=452016.html)

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Fraunhofer ISI, DIW, GfK, IE, IfE/TUM (2004): Energieverbrauch der privaten Haushalte und des Sektors Gewerbe, Handel, Dienstleistungen (GHD). Abschlussbericht an das Bundesministerium für Wirtschaft und Arbeit. Karlsruhe, Berlin, Nürnberg, Leipzig, München, April 2004 (English Summary available).

Geiger, B., Gruber, E., Megele, W. (1999): Energieverbrauch und Einsparung in Gewerbe, Handel und Dienstleistung. Heidelberg: Physica.

RWI Essen/forsa (2005): Erhebung des Energieverbrauch der privaten Haushalte für das Jahr 2003. Im Auftrag des Bundesministeriums für Wirtschaft und Technologie. Endbericht. Essen, November 2005.

RWI Essen/forsa (2007):Erhebung des Energieverbrauch der privaten Haushalte für das Jahr 2005. Im Auftrag des Bundesministeriums für Wirtschaft und Technologie. Endbericht. Essen, 2007.

RWI Essen/forsa (2011): Erhebung des Energieverbrauch der privaten Haushalte für die Jahre 2006-2008. Im Auftrag des Bundesministeriums für Wirtschaft und Technologie. Essen. http://www.bmwi.de/DE/Mediathek/publikationen,did=452032.html

Prognos (2010): Internal information (data on energy consumption for household appliances in Germany)

Statistisches Bundesamt (Federal Statistical Office): Statistik zum Energieverbrauch und zu Stromerzeugungsanlagen der Betriebe im Bergbau und Verarbeitenden. Gewerbe. Wiesbaden. 2011 and earlier years

Statistisches Bundesamt (Federal Statistical Office): Bautätigkeit und Wohnungen. Fachserie 5, verschiedene Reihen. Wiesbaden 2012 and ealier years.

Statistisches Bundesamt (Federal Statistical Office): National Accounts. Inlandsproduktberechnung. August 2012.

Statistisches Bundesamt (Federal Statistical Office): Statistisches Jahrbuch 2012 and earlier years. Wiesbaden (http://www.destatis.de).

ZVEI/GfK Marketing Services: Zahlenspiegel des deutschen Elektro-Hausgerätemarktes 2011 and earlier years. (http://www.zvei.org).