CENTRAL STATISTICAL OFFICE

ENERGY

EFFICIENCY IN POLAND

IN YEARS 2001-2011

Warsaw, 2013

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Cover — *Statistical Publishing Establishment*

ISSN: 1732-4939

Publication available on www.stat.gov.pl

Supported by

Intelligent Energy Europe

PREFACE

This publication is successive edition of the study "ENERGY EFFICIENCY" published by the Central Statistical Office (GUS) as part of the series entitled "Information and statistical papers".

The aim of this publication is to present global and sector energy efficiency indicators with their analysis.

The development of energy efficiency indicators adapting statistics to changing economy conditions and present needs (monitoring of energy economy and controlling its management towards "sustainable development") is realized in answer to European Commission and International Energy Agency (IEA/OECD) documents. These documents recommended joined actions of Eurostat and Member States, aimed at creation of statistical indicators system to assess trends in the field of energy efficiency and supporting decisions making and coordination of these actions with works carried by International Energy Agency.

Realization of this objective served works carried in frames of European Union projects SAVE I and SAVE II and carry at the present in frames of "Intelligent Energy for Europe" programme.

Presented results show potentiality of system created in the EU and IEA/OECD and are not full analysis of present state and trends of energy intensity of Polish economy.

The publication was elaborated by employees of the Polish National Energy Conservation Agency, Energy Market Agency and Central Statistical Office.

With passing this publication to the hands of the readers we would welcome any comments that will help to improve next editions of the publication.

Wanda Tkaczyk
Deputy Director of
Production Department

Warsaw, July 2013

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1. Methodological remarks and definitions of basic concepts

The source of data for the publication are statistical surveys in the field of fuel and energy economy conducted by the Central Statistical Office in collaboration with the Ministry of Economy stored in the Odyssee database[1].

Currently used classification is the Polish Classification of Activities - PKD 2007 developed on the basis of the Statistical Classification of Economic Activities in the European Community (NACE Rev. 2). PKD 2007 was introduced with effect from 01.01.2008 by the Regulation of the Council of Ministers of 24 December 2007 (Journal of Laws No. 251, item. 1885) and replaced PKD 2004.

For the purposes of the publication industry activities are grouped as follows:

	NACE rev. 1.1	NACE rev. 2
Food	15-16	10-12
Textile	17-19	13-15
Wood	20	16
Paper	21-22	17-18
Chemical	24	20-21
Mineral	26	23
Primary metals	27	24
Machinery	28-32	25-28, 33
Transport equipment	34-35	29-30
Other	25, 33, 36-37	22, 31-32

The value-added of industrial branches is the sum of value added of the respective divisions.

Total primary energy consumption includes the consumption of primary energy sources, as well as recovery, trade balance, bunkers and stock changes of derived energy according to Eurostat methodology.

Final energy consumption means the final energy consumption for energy purpose calculated according to the methodology of Eurostat/IEA. Final consumption in the industry does not include the energy transformation sector.

Primary energy intensity of GDP is the ratio of total primary energy consumption to GDP.

Final energy intensity of GDP is the ratio of final energy consumption to GDP. **Energy**

[1] www.odyssee-indicators.org

intensity of branches is the ratio of the final energy consumption in these industries to their value added.

Energy consumption in constant structure is calculated using Divisia method in such a way that the product of the dynamic of energy intensity in constant structure and effect of the structural changes provides dynamics of the energy intensity. The effect of structural change was calculated as the weighted sum of the growth rates of the individual components. The growth rates are defined as the natural logarithm of the relative change in the value added of the total industry in the subsequent years, and the weights are the shares of average energy consumption in the industry in the total consumption in the subsequent years.

Climatic correction is based on the correlation between energy consumption and outdoor temperature. The consumption is proportional to the Heating Degree Days (SD). The constant heating share approach in calculating of final energy consumption with climatic correction ZEF^{kk} is based on the following formula:

$$ZFF^{kk} = \frac{ZFF}{1 - 0{,}9 \cdot \alpha \cdot \left(1 - \frac{Actual\ SD}{Long - term\ average\ SD}\right)}$$

where: ZEF - final energy consumption, SD - degree days number, α - heating share in total energy consumption in dwelling sector.

Heating Degree Days is introduced to enable control and comparison of energy consumption for heating. It expresses a product of number of heating days and difference between the average temperature of heated room and average outdoor temperature. Numbers of SD degrees in a given year according to Eurostat methodology is calculated as follows:

$$Sd = \sum_{n=1}^{N} \begin{cases} 18^{o}\mathrm{C} - t_{śr}(n) & dla\ \ t_{śr}(n) \leq 15^{o}\mathrm{C} \\ 0 & dla\ \ t_{śr}(n) > 15^{o}\mathrm{C} \end{cases}, \text{[day} \cdot \text{deg/year]}$$

where: $t_{śr}(n) = \frac{t_{\min}(n) + t_{maks}(n)}{2}$ - mean outdoor temperature for *n* day, [^{o}C]; $t_{\min}(n), t_{maks}(n)$ - minimum and maximum temperature of the *n* day, [^{o}C]; N - number of days per year. According to formula and the Eurostat assumption, the mean outdoor temperature of the heating day should be less than 15^{o}C.

Long-term average calculated for years 1980-2004 amounts to 3615.77.

An equivalent car is a measure used in the calculation of energy efficiency indicators. Stock of equivalent cars is calculated as follows: Se = 0.15 * M + So + 4 * Sc + 15 * A, where Se - equivalent stock of cars, M - the stock of motorcycles, So - the stock of cars, Sc - stock of trucks, A - the stock of buses. The coefficients are estimated relation of annual fuel consumption of a vehicle of a given type to the car.

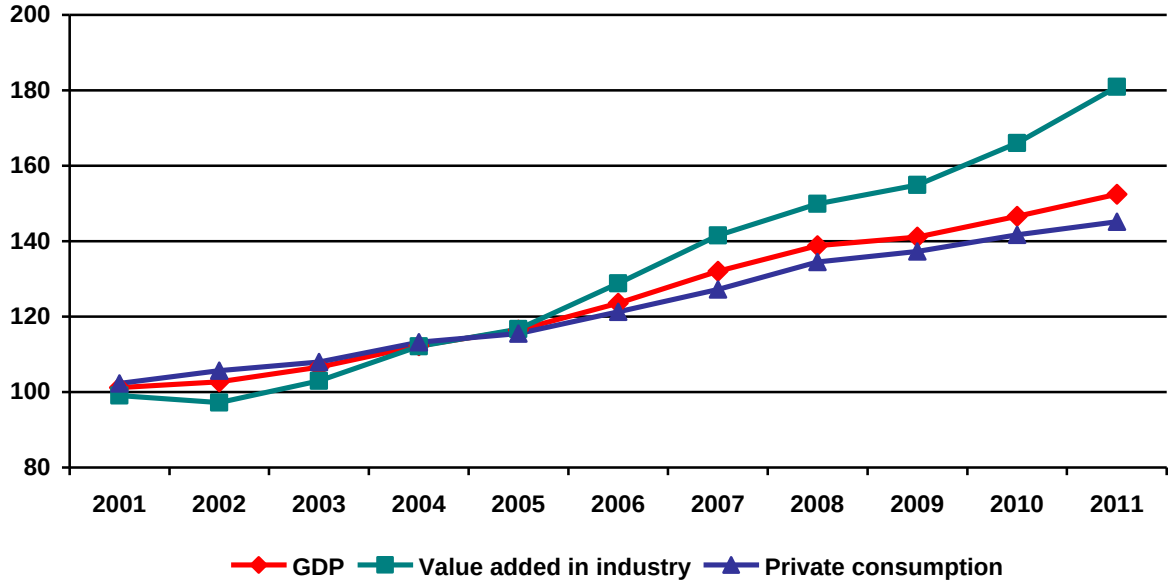
Energy efficiency index (ODEX) is calculated by aggregating the individual changes in energy consumption, observed on certain levels of end-use. ODEX indicator does not show the current level of energy intensity, but the improvement over the base year. ODEX is calculated for each year as the ratio of actual energy consumption in a given year and the theoretical energy consumption which does not take into account the individual effect (ie, assuming the previous level of energy intensity in the production processes). In order to reduce random fluctuations 3-year moving average is calculated. The decrease of indicator value represents an increase of energy efficiency.

2. Energy efficiency indicators for Polish economy and its sectors

2.1. Dynamic of development of the economy

Gross Domestic Product was constantly increasing in the period 2001-2011 reaching at the end of the period value higher by more than 51% than at the beginning. The fastest rate of growth of value added at constant prices was achieved in the given period in industry sector. Rate of growth[2] of private consumption was little smaller than rate of GDP growth.

Figure 1. Dynamics of basic macro-economic indicators (2000=100)

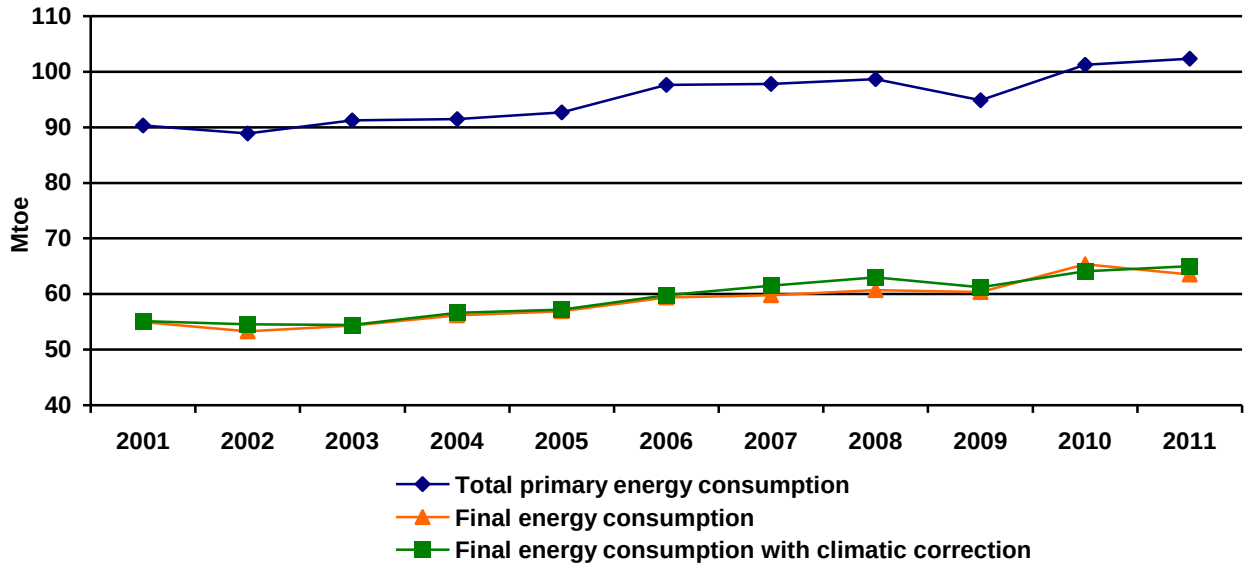


2.2 Energy consumption and prices of energy

Total primary energy consumption increased between 2001-2011 from 90 Mtoe to 102 Mtoe (1.3%/year). Decrease in consumption was recorded twice, in 2002 and 2009, ie during periods of low economic growth. In case of final energy consumption average annual growth rate amounted to 1.5% during given period. In absolute terms, this represents an increase from 55 to over 63 Mtoe. In this case, the fall in consumption was observed, in addition to those earlier years, also in year 2011. After taking into account different weather conditions, that is in case of final energy consumption with climatic correction consumption growth rate amounted to 1.8%/year in the period 2001-2011. Energy consumption with climatic correction determines the theoretical value of consumption for a given year, if the weather conditions were in line with long-term average. That calculated final consumption in 2011 amounted to 65 Mtoe.

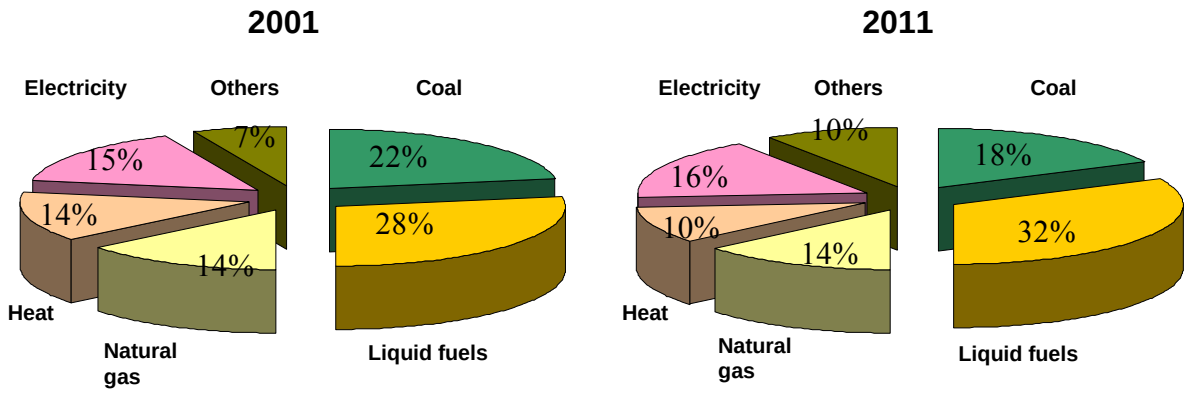
[2] Calculated as geometric mean

Figure 2. Total primary and final energy consumption



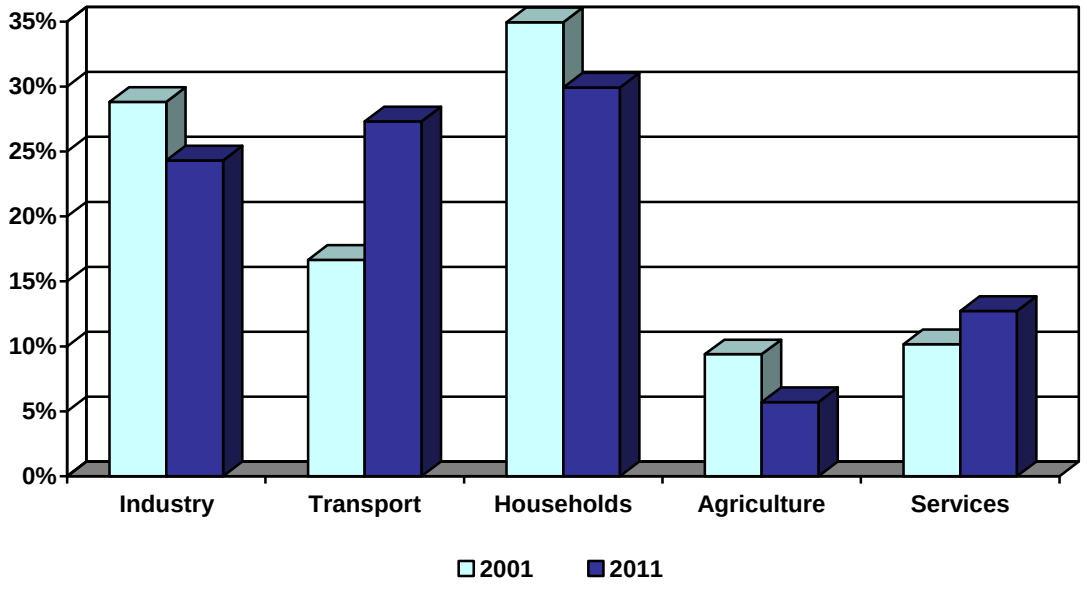
Polish energy sector has traditionally been focused on the use of country natural resources, which also had an impact on the types of energy consumed in other sectors of the economy. The main source of primary energy was and is hard coal and lignite. In case of final energy consumption, it is dominated by liquid fuels, whose share increased over the period 2001-2011 from 28 to 32% (Fig. 3). At the same time there has occurred a decline in the share of coal in final energy consumption - from 22% in 2001 to 18% in 2011. A significant increase compared to year 2001 occurred in the use of other energy sources, which in 2011 reached level of 10% of the final energy consumption. In case of electricity and natural gas share no major change has been observed, while the share of heat declined.

Figure 3. Final energy consumption by energy carrier



Changes in the structure of final energy consumption by energy carrier correspond with changes in the structure of final energy consumption by sector. In the years 2001-2011 the share of transport grew most - from 17 to 27%. Service sector has increased its share as well and accounted for 13% of final consumption. In case of industry, households and agriculture, there has been a decline in the share in total consumption. Households remained the largest consumer with a share of 30%. The growing importance of transport is associated with an increased role of both freight transport and passenger transport carried out in private cars.

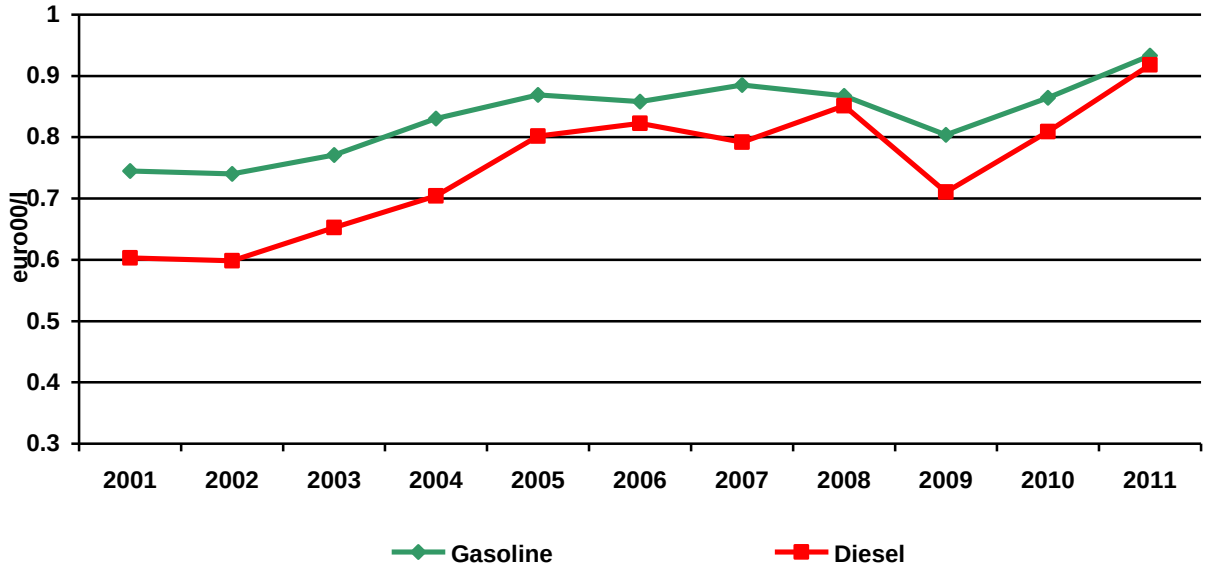
Figure 4. Final energy consumption by sectors



Prices of gasoline and diesel, expressed in constant prices of 2000 were subject to similar changes in 2001-2011. The decrease lasting until 2002 was followed by several years of rising

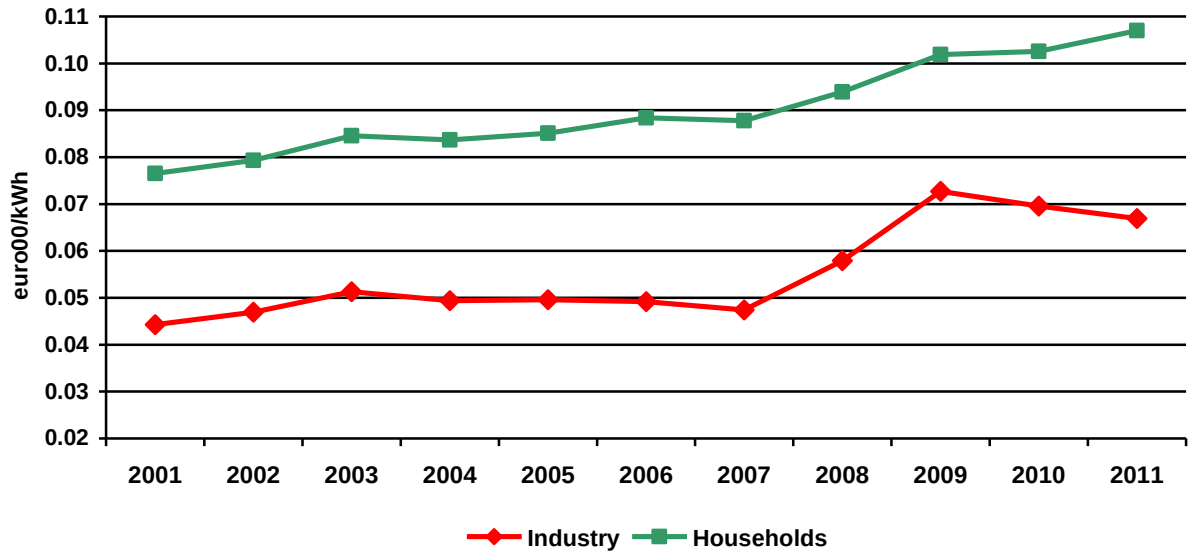
prices, and then a period of low volatility. In 2009, there was a significant drop in prices, particularly diesel oil which plays greater role in economic activity (Fig. 5). Afterwards prices began to grow and in 2011 reached a value of 0.93 euro00/l in case of gasoline and 0.92 euro00/l in case of diesel.

Figure 5. Gasoline and diesel oil prices



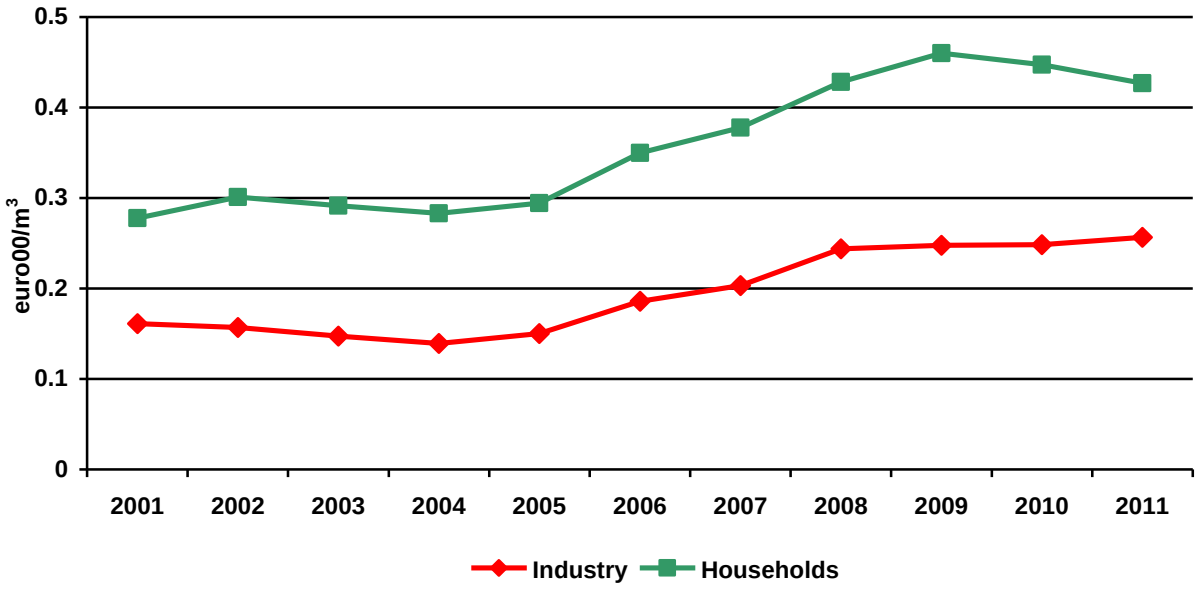
Electricity prices for households have increased during 2001-2011 period from 0.08 in 2001 to 0.11 euro00/kWh in 2011, which means in more than 3% average annual growth. The upward trend was clear, only declining years are 2004 and 2007. In case of electricity prices for industry a higher rate of growth was observed - more than 4%/year, but the increase was much less even. The high average annual growth over this period was reached due to high price increase in years 2007-2009, when growth exceeded 50%. In 2009-2011 there was a slight decline in prices.

Figure 6. Electricity prices for households and industry



Natural gas prices for households fluctuated slightly between 2001 and 2005, followed by a period of rapid growth which lasted until 2009. Between 2010 and 2011, prices have declined. In total, during the period average rate of increase of the price of natural gas for households has exceeded 4%/year. Natural gas prices for industry decreased in years 2001-2004. Since then, prices continued to rise, in years 2004-2008 dynamically, and in the years to come negligibly. Overall price of natural gas for the industry increased from 0.16 euro00/m^3 in 2001 to 0.26 euro00/m^3 in 2011.

Figure 7. Gas prices for households and industry



2.3. Macro-economic indicators

Growth of GDP faster than the growth in energy consumption resulted in observed decreasing, with the exception of year 2010, primary and final energy intensity of GDP (Figure 8-9, Table. 1). In the first half of the decade, energy intensity decreased by over 2% per year, in years 2006-2009 the rate of improvement exceeded 5% in case of primary intensity, and amounted to nearly 4% in final energy intensity. In years 2009-2011 the rate of improvement has drastically fallen (2010 the energy intensity of Polish intensity increased first time in many years).

Table 1. An average annual rate of changes in GDP energy intensity indicators (%/year)

Growth rate	2000-2006	2006-2009	2009-2010	2000-2010
Primary intensity of GDP……..	-2.41	-5.22	-0.21	-2.83
Primary intensity of GDP with climatic correction…….	-2.37	-5.07	0.07	-2.71
Final intensity of GDP……..	-2.44	-3.75	-1.45	-2.64
Final intensity of GDP with climatic correction……..	-2.36	-3.53	-0.99	-2.44

Figure 8. Energy intensity of GDP

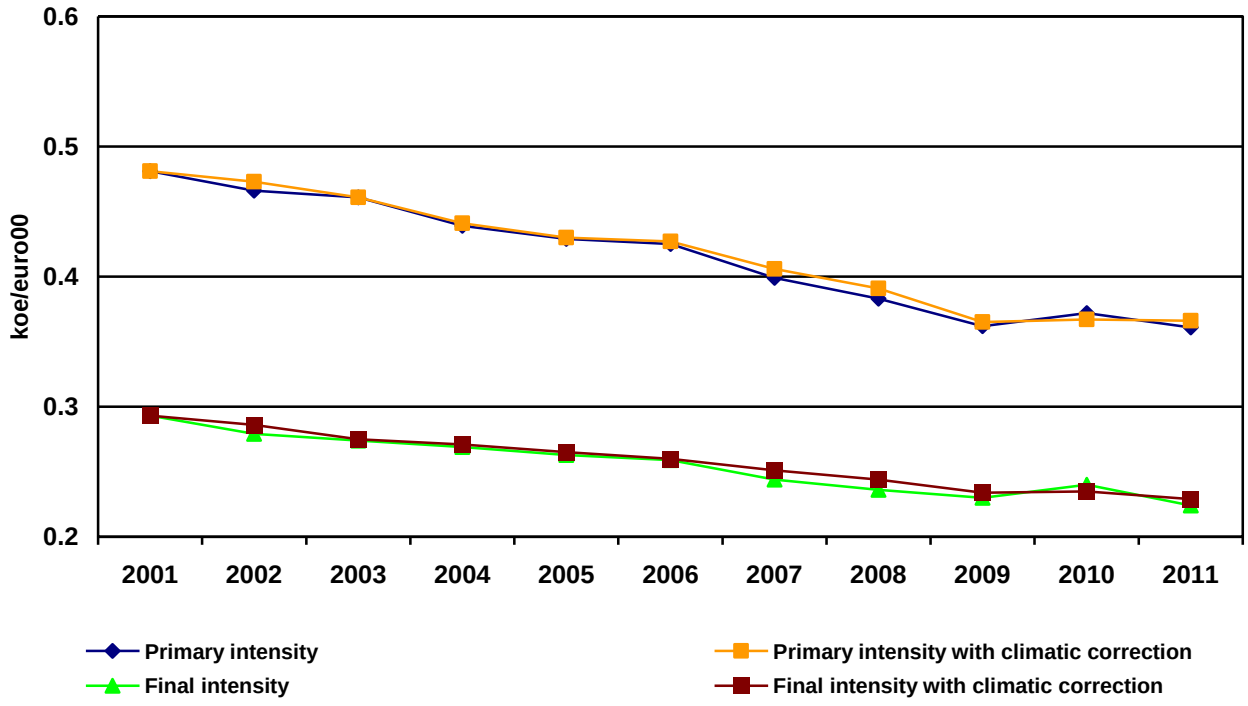
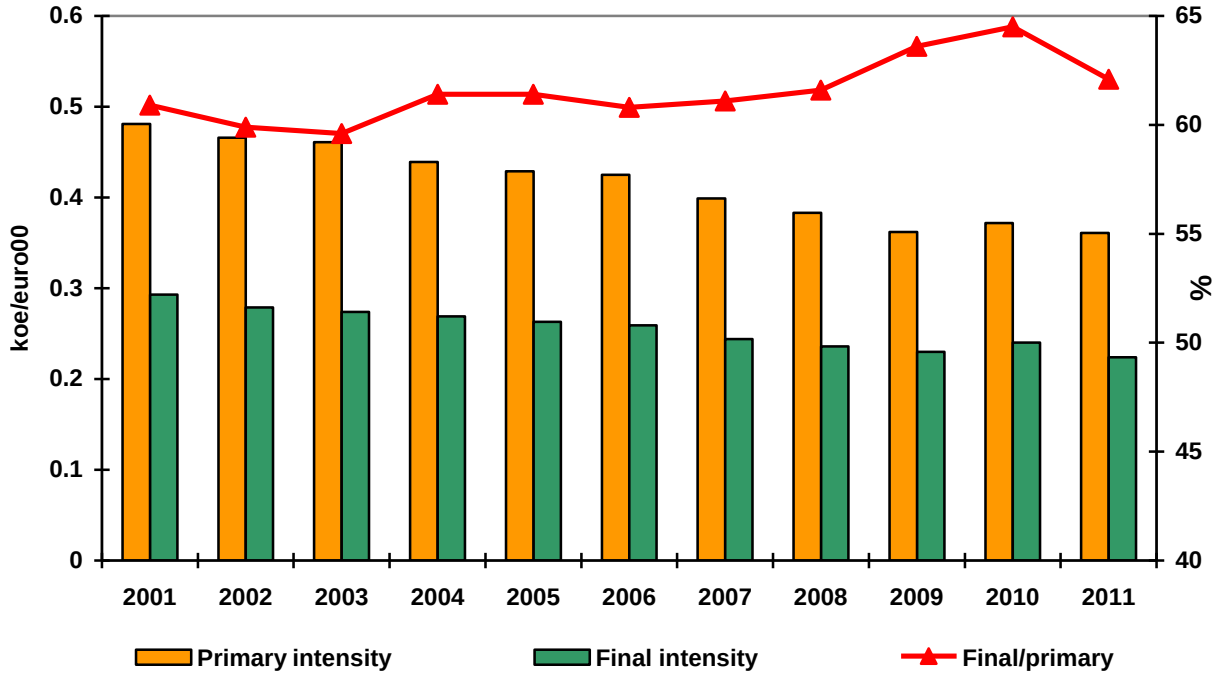


Figure 9. Ratio of final to primary intensity

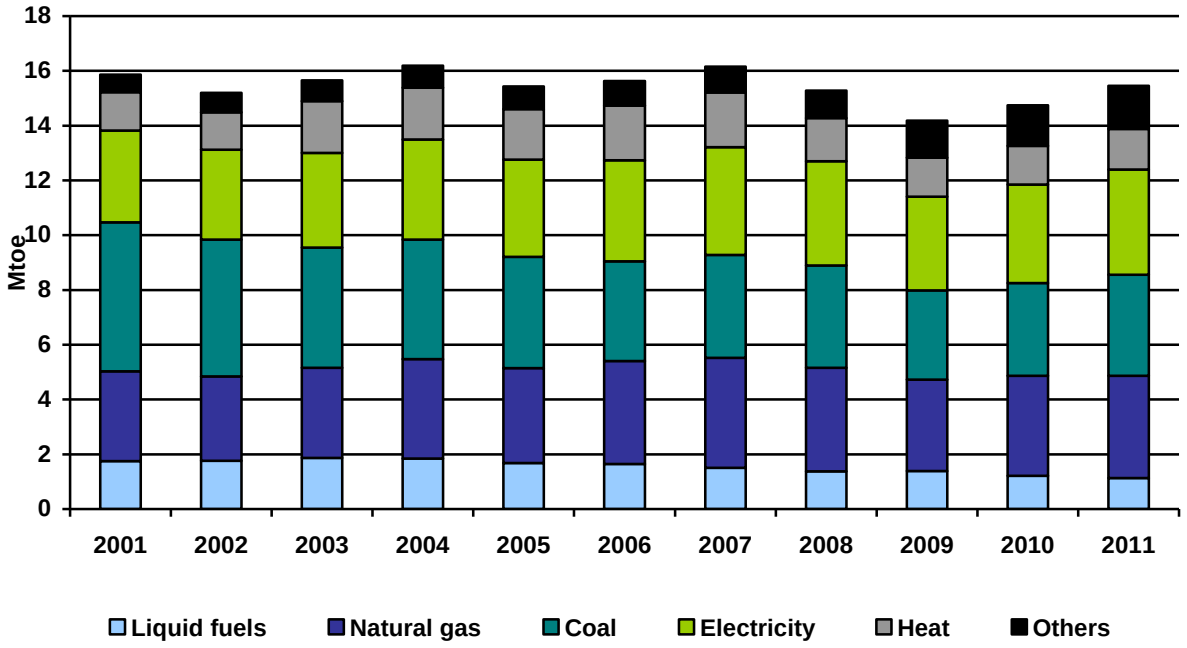


The ratio of final energy consumption to primary energy consumption reached values between 60% and almost 65% in 2010. In 2011, the value decreased to 62.6%. Its level is mainly affected by the energy transformation efficiency (the higher the efficiency the greater the value of the indicator) and the rate of growth of electricity consumption (the higher consumption the lower value of the indicator).

2.4. Industry

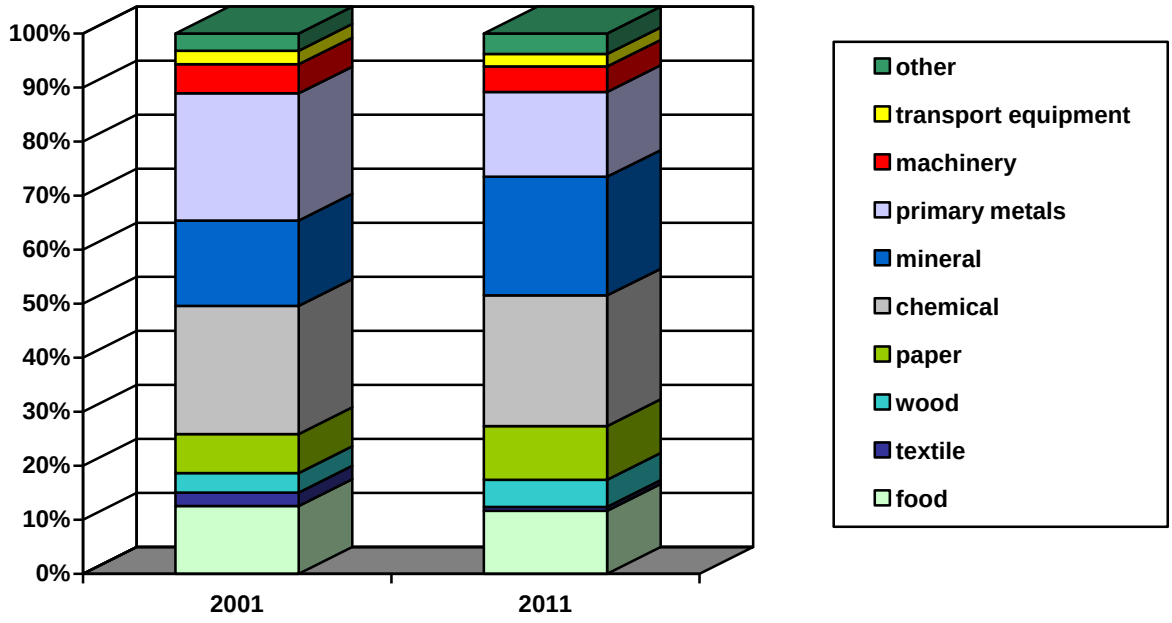
Final energy consumption in industry in the period 2001-2011 was subject to irregular fluctuations. The highest consumption was observed in 2007, then declined to 14 Mtoe in 2009 and grew again to more than 15 Mtoe in 2011. In terms of energy carriers, a decrease of consumption of coal and liquid fuels can be seen while the use of natural gas, electricity and other energy carriers increased. Heat consumption remained at the same level.

Figure 10. Final energy consumption in industry by energy carrier



Changes in shares of individual industries in total energy consumption in the manufacturing industry is shown in Fig 11. Approximately 60% of energy is consumed by energy-intensive industries: primary metals, chemical and mineral. The largest decline in comparison to 2001 which amounted to almost 8 percentage points was achieved by primary metals; food, textile, machinery and transport equipment industries also recorded a decrease in the share of energy consumption. The increase of share of energy consumption was recorded in case of wood, paper, chemical, mineral and other industries. Apart from mineral industry, which share increased by 6 percentage points and paper industry which achieved an increase of 3 percentage points, structural changes are small.

Figure 11. Energy consumption in manufacturing by branch



Figures 12 and 13 present energy intensity (final energy consumption/value added) of selected industrial branches in years 2001-2011.

Figure 12. Energy intensity of energy intensive industry branches

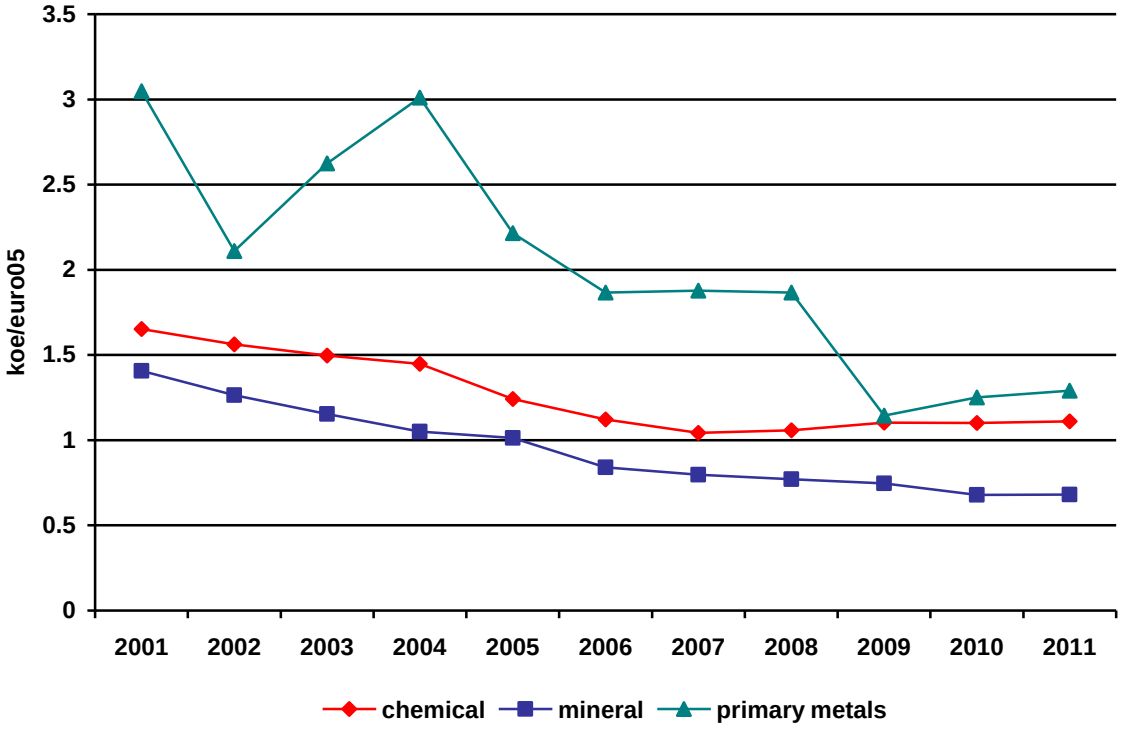
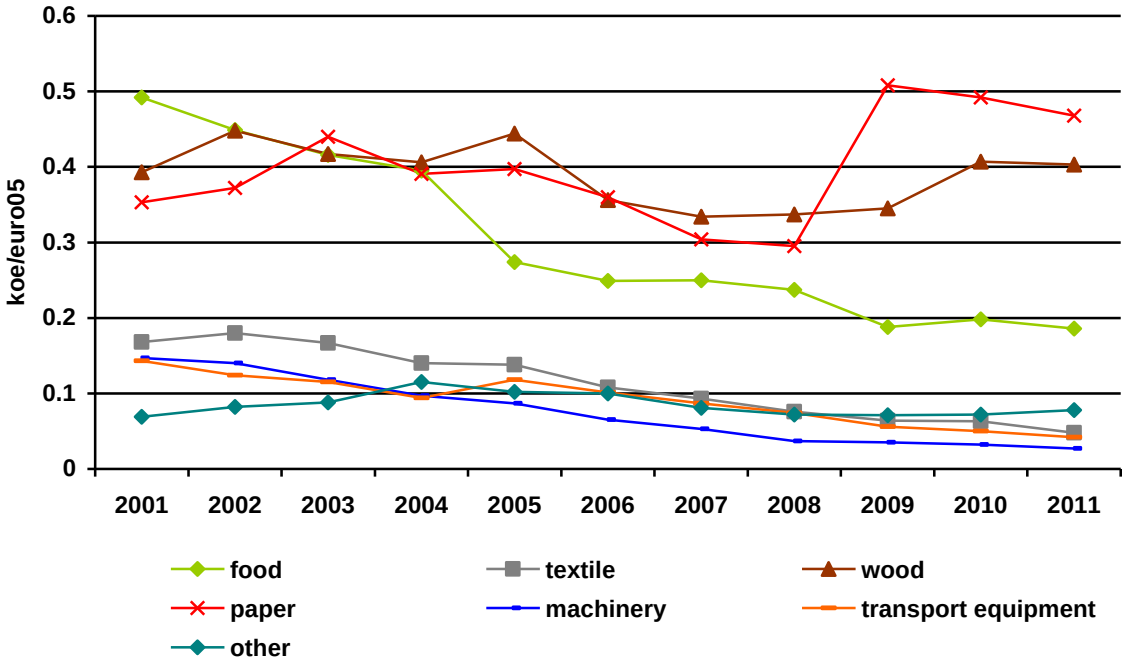


Figure 13. Energy intensity of low energy intensive industry branches



The most dynamic energy efficiency improvements were observed in machinery, as well as food, textile and transport equipment industry. Slowest improvement occurred in the paper industry, wood and others.

Changing shares of individual sectors of manufacturing in the final consumption of energy and value added in the section, that is the changing structure have affected the level of energy consumption in manufacturing.

The rate of improvement of energy intensity of manufacturing industry was high in years 2001-2008 and averaged to 9.1%/year. Impact of structural change was positive – it contributed to the decline in energy intensity by 0.8%/year. The situation changed in 2009 - 2011 - energy intensity at constant structure decreased by 1.5%, while structural changes have affected the growth of manufacturing energy intensity by more than 5%. Actual intensity decreased by 6.4%/year.

Figure 14. Energy intensity of manufacturing - role of structural changes

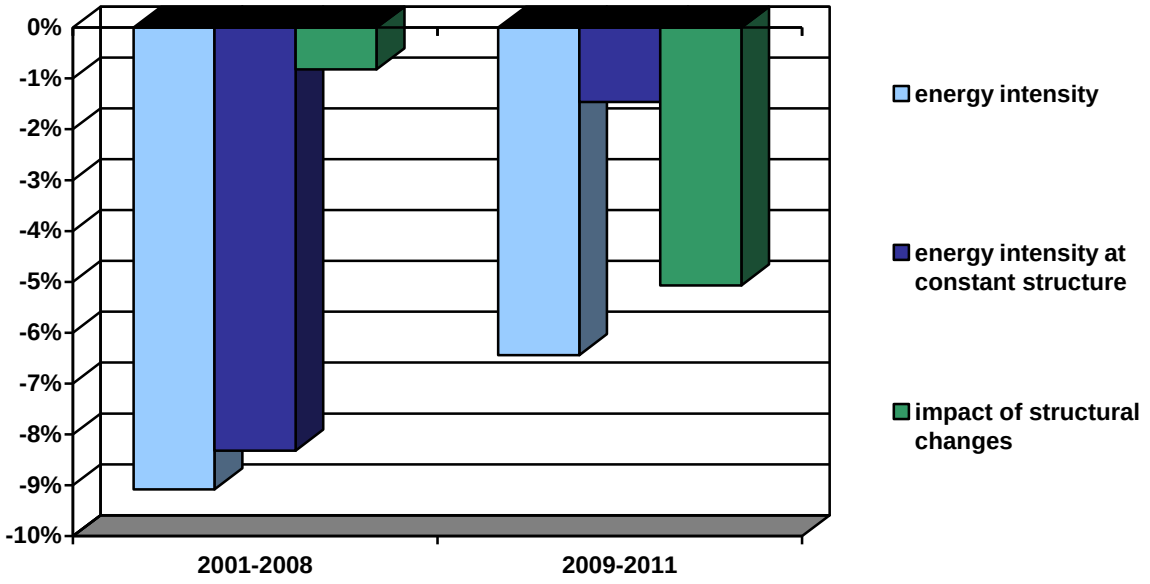


Table 2. Dynamics of energy intensity and impact of structural changes (%/year)

Specification	2000-2008	2009-2010
Energy intensity	-9.08	-6.44
Energy intensity at constant structure	-8.32	-1.46
Impact of structural changes	-0.82	-5.07

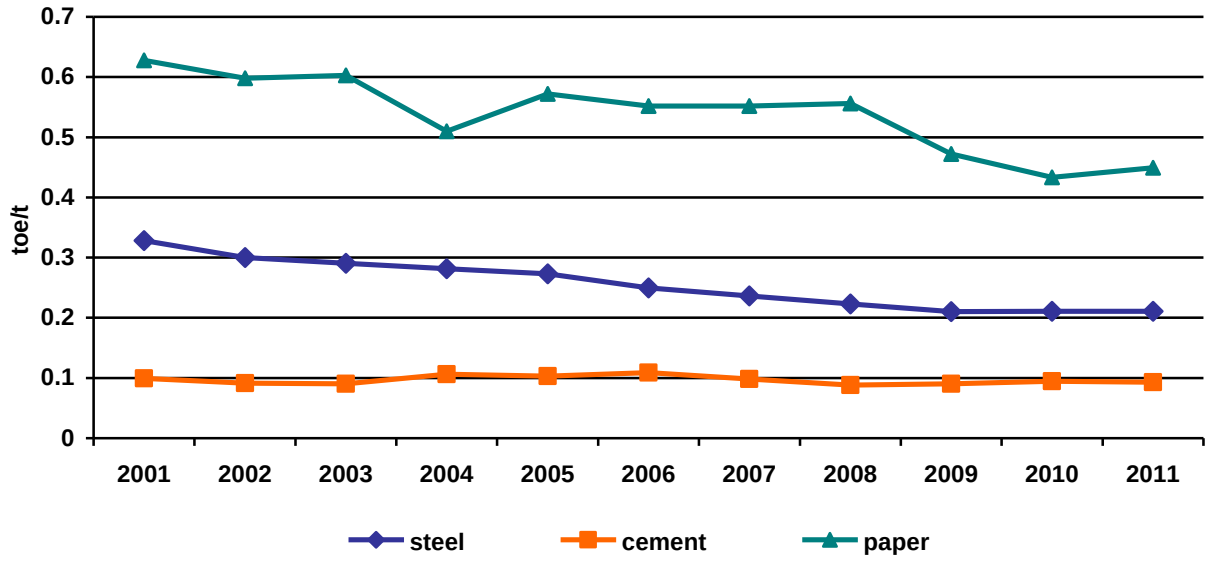
Figure 15 presents energy intensity of steel[3], cement[4] and paper[5] production in years 2001-2011. Energy used to produce these three products amounted to 34% of energy consumption in manufacturing in 2011.

The energy intensity of cement production remained in this decade at a similar level of 0.1 toe/t. This value is close to the European average. In the case of steel production energy intensity decreased steadily until 2009, and then stabilized. Energy consumption of paper industry showed a declining trend in the years 2001-2011, although in some years there has been an increase of energy consumption. In 2011, there was a slight increase in intensity to the level of 0.45 toe / ton. In the years 2001-2011 energy consumption of crude steel

[3] Calculated as final energy consumption in steel industry (since 2009 in groups 24.1, 24.2, 24.3 and classes 24.51 and 24.52 according to NACE Rev. 2) divided by steel production
[4] Calculated as final energy consumption in cement industry (since 2009 in group 23.5 according to NACE Rev. 2) divided by cement production
[5] Calculated as final energy consumption in paper industry (since 2009 in division 17 according to NACE Rev. 2) divided by paper production

production fell by 35.8% (4.3%/year), paper by 28.5% (3.3%/year) and cement by 6.5% (0.7%/year).

Figure 15. Unit consumption of selected industrial products



2.5. Households

The share of energy consumption in households in final energy consumption amounted to 32% in 2010. The structure of consumption by end-use, resulting from surveys carried out by the CSO in 1993, in 2002, in 2009 and in 2012 are shown in Figure 16 and Table 3.

The share of energy consumption for heating systematically decreased, which was associated with the installation of more efficient gas and electric appliances; the influence of thermal modernization and more stringent construction standards is also noticeable. Higher penetration of electrical equipment and behavioral changes (eg changes in the intensity of use of equipment - washing machines, dishwashers, TV, computers) have contributed to the doubling of the share of energy consumption for electrical equipment between 1993 and 2012.

Figure 16. Structure of energy consumption in households by end use

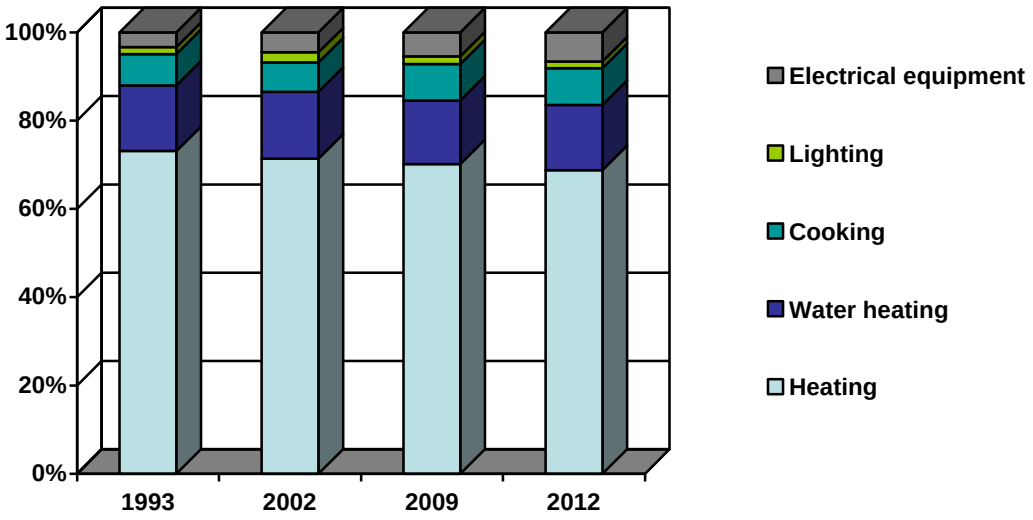


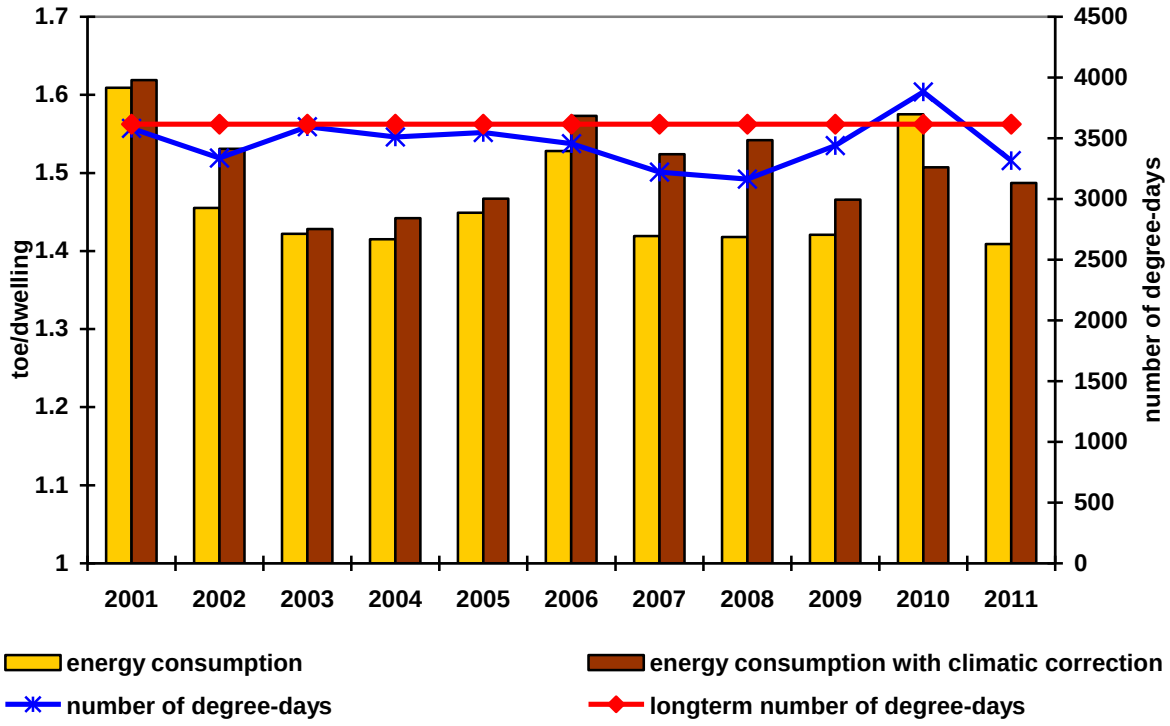
Table 3. Structure of energy consumption in households by end use (%)

Items	1993	2002	2009	2012
Total	100.0	100.0	100.0	100.0
Heating	73.1	71.3	70.2	68.8
Water heating	14.9	15.0	14.4	14.8
Cooking	7.1	7.1	8.2	8.3
Lighting	1.6	2.3	1.8	1.5
Electrical equipment	3.3	4.3	5.4	6.6

Figure 17 shows the changes of energy consumption per dwelling. Energy consumption per dwelling was decreasing by 1.3% per year. In 2011 it reached the lowest value during given period. It partly resulted from good weather conditions this year.

The value of indicator with climatic correction decreased between 2001 and 2011 from 1.62 to 1.49 toe/dwelling, which means the average annual decline of 0.8%. The lowest value was achieved in 2003 and afterwards experienced several years of growth. Since 2006, the downward trend of energy consumption with climatic correction can be observed.

Figure 17. Energy consumption in households per dwelling



source: Eurostat and Joint Research Center, GUS

Table 4. Heating degree-days in years 1997-2011

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Sd - annual	3686	3559	3341	3092	3581	3337	3594	3510	3547	3454	3222	3164	3439	3881	3317

source: Eurostat and Joint Research Center

Trend of energy consumption per m^2 is similar, although the growth rate of improvement is higher by about 1 percentage point, reflecting the gradual increase in the average size of the dwelling. Figure 18 shows the energy consumption in households per m^2.

Electricity consumption in households showed an increasing trend in years 2001-2011. The growth of electricity consumption in 2003 is due to methodological changes - electricity consumption in households whose main source of income was the income from the use of an individual farm was added.

Figure 18. Energy consumption in households per m^2

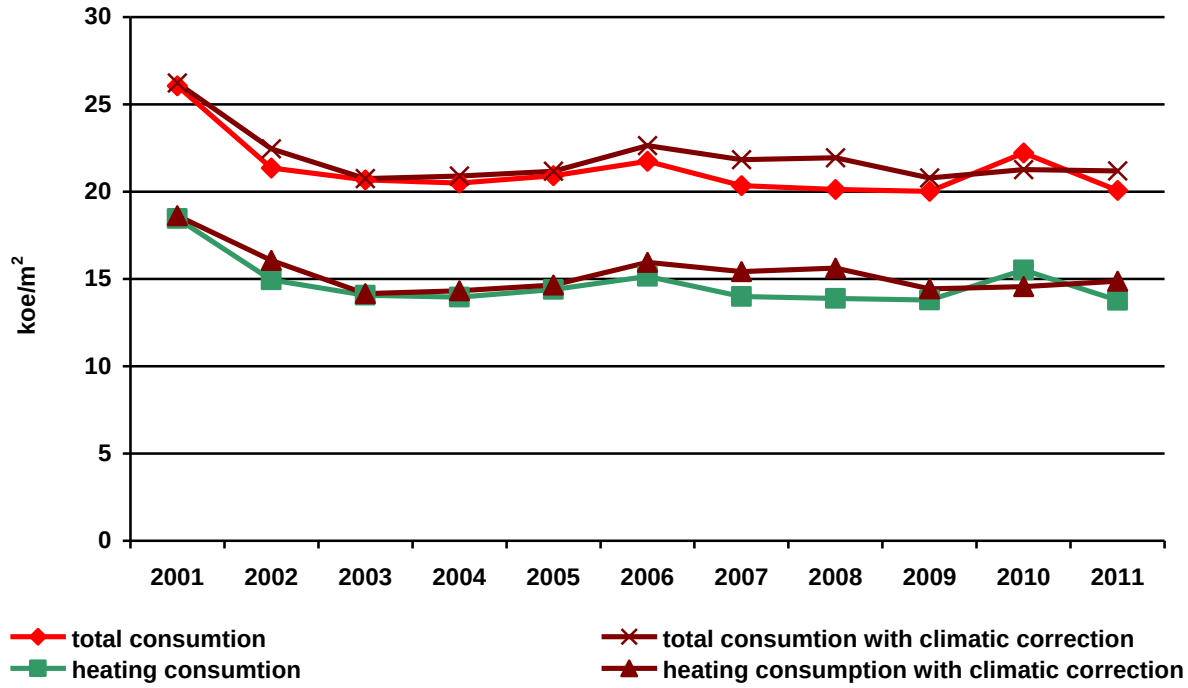
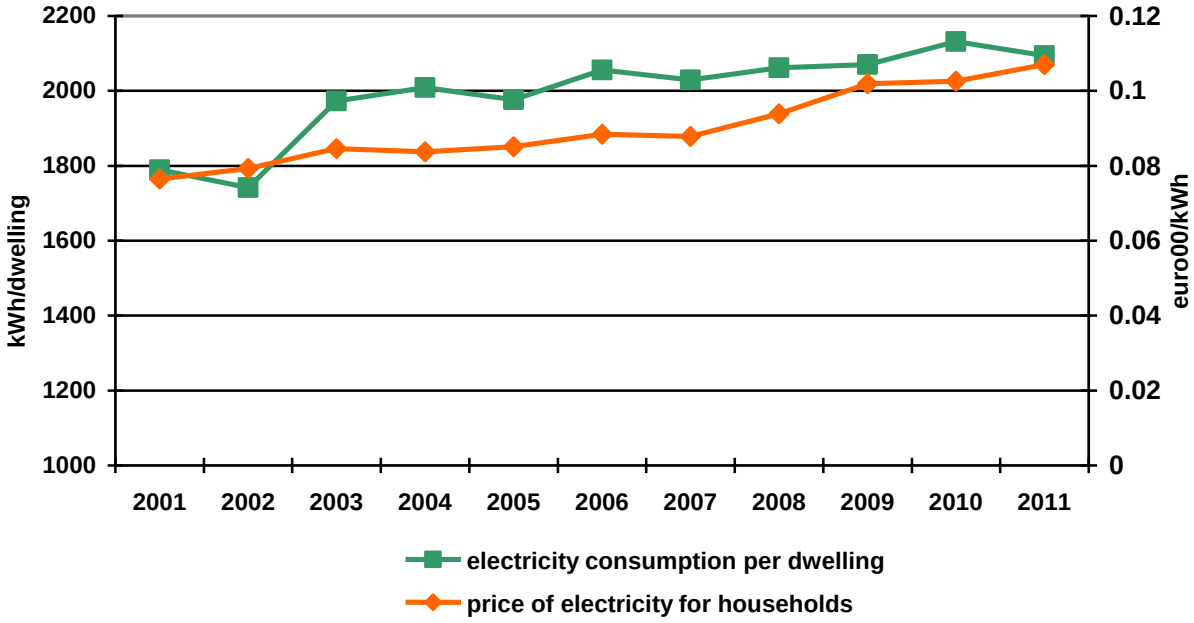


Figure 19. Electricity consumption and price in households per dwelling



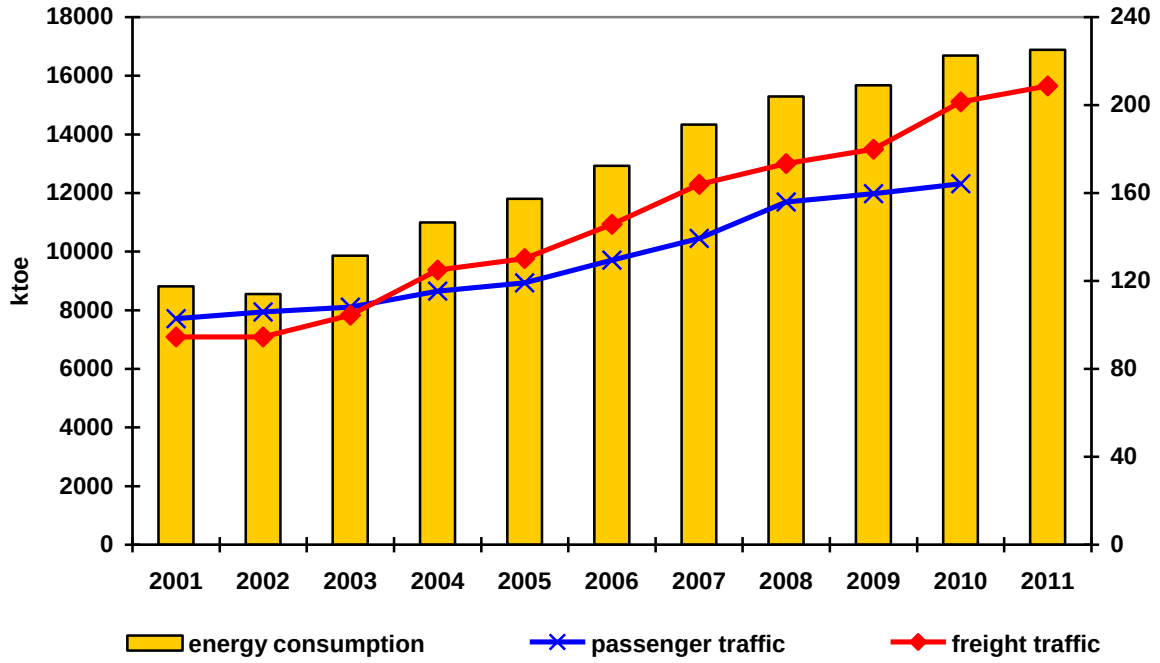
2.6. Transport

In Poland, over 95% of the energy consumed in transport sector is consumed by road transport, and more than 2% in rail transport. In addition, more nearly 3% of energy consumed is by air transport and small amounts by the inland and coastal water transport.

In the years 2001-2011 average annual growth rate of fuel consumption in road transport amounted to 7.1%, while energy consumption in rail transport significantly (by 27%, 3.1%/year) decreased. Total average annual growth rate of fuel consumption in transport (excluding air transport) amounted to 6.7% in years 2001-2011.

Freight and passenger traffic was increasing in this period regularly, except for the drop in freight traffic in the early 2000's. In case of freight traffic an average rate of growth amounted to 8.2%/year, while in the case of passenger transport to 5.3%/year (in year 2001-2010).

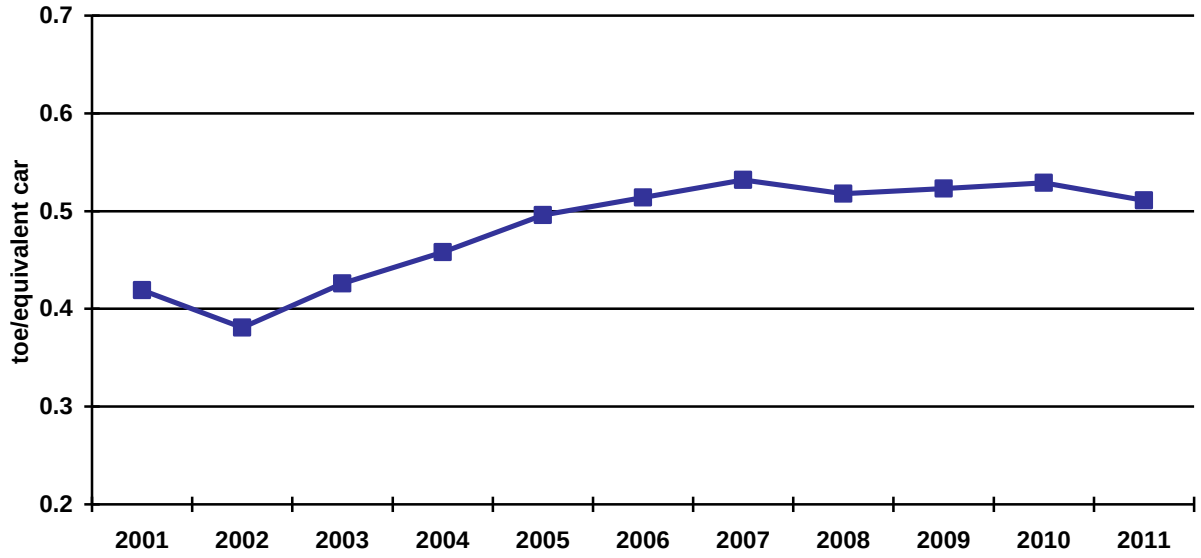
Figure 20. Passenger and freight traffic and energy consumption in transport*



** excluding air transport, source: DG TREN, GUS*

Figure 21 shows the evolution of specific fuel consumption per car equivalent. In years 2008-2010 the value of the indicator has stabilized after earlier growth period between 2003 and 2007. The value of this indicator is influenced mainly by the economic situation of the country, variation of fuel prices and the growing efficiency of new cars.

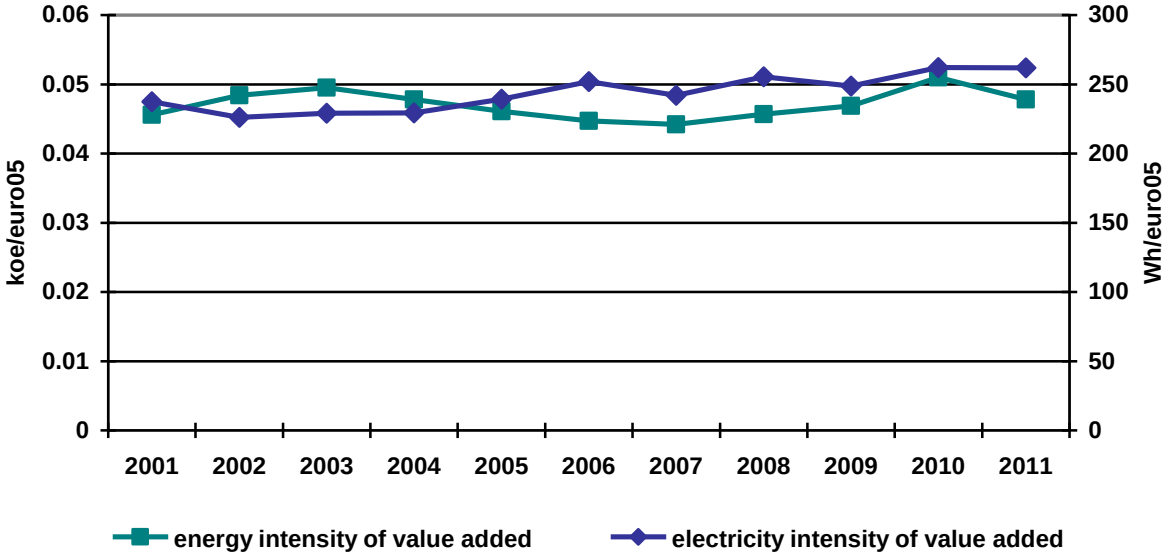
Figure 21. Fuel consumption per equivalent car



2.7. Service sector

The services sector is the most efficient sector. Energy intensity of value added[6] in the services sector was showing slight fluctuations in years 2001-2011. In 2011, energy intensity fell below 0.05 kgoe/euro05. The average annual growth rate amounted to 0.5%. Electricity intensity of value added in the period 2001-2011 increased by an average of 1.0% per year.

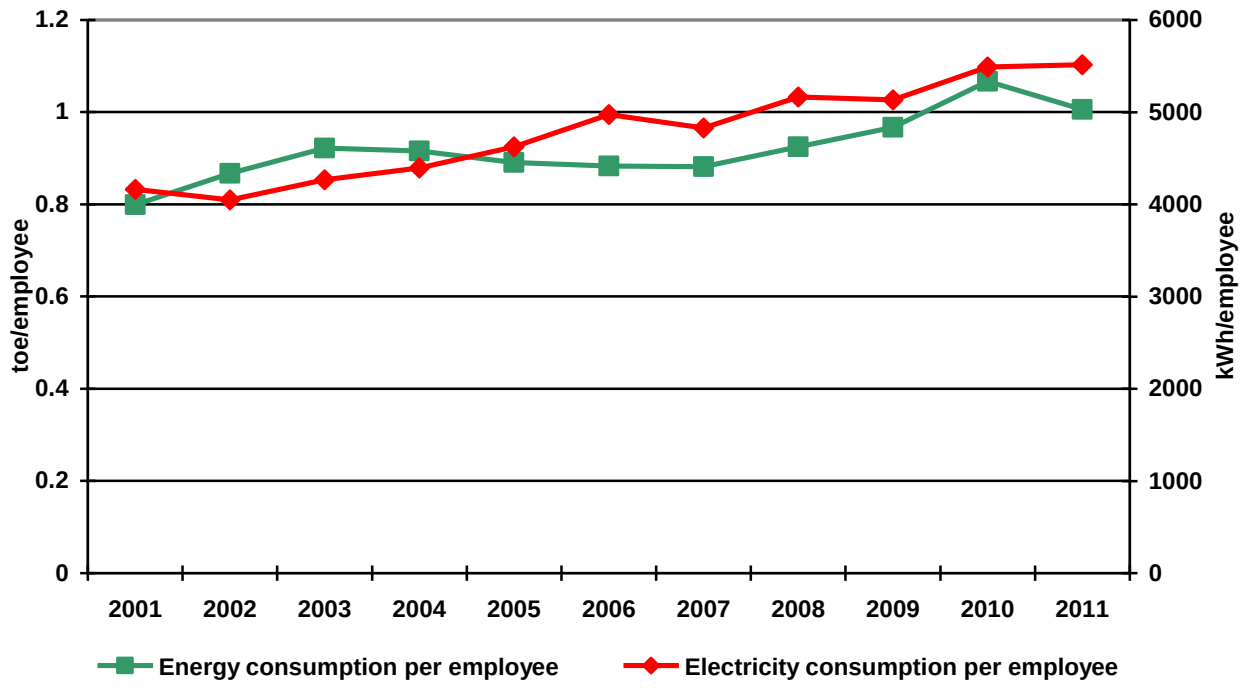
Figure 22. Energy intensity and electricity intensity in service sector



[6] Calculation of this indicator excludes energy consumption of transport but includes value addend of transport. The same procedure concerns electricity intensity indicator.

In case of energy and electricity consumption per employee an irregular trend can be seen in the period 2001-2011 (Fig. 23). Energy consumption has increased in the early years of the period, then came to a stabilization of consumption. In 2010 strong growth of consumption occurred followed by drop to 1 toe/employee in 2011. The average rate of growth of this indicator amounted to 2.3% per year. In the case of electricity consumption per 1 employee growth rate of 2.9% per year.

Figure 23. Energy consumption and electricity consumption per employee of the service sector

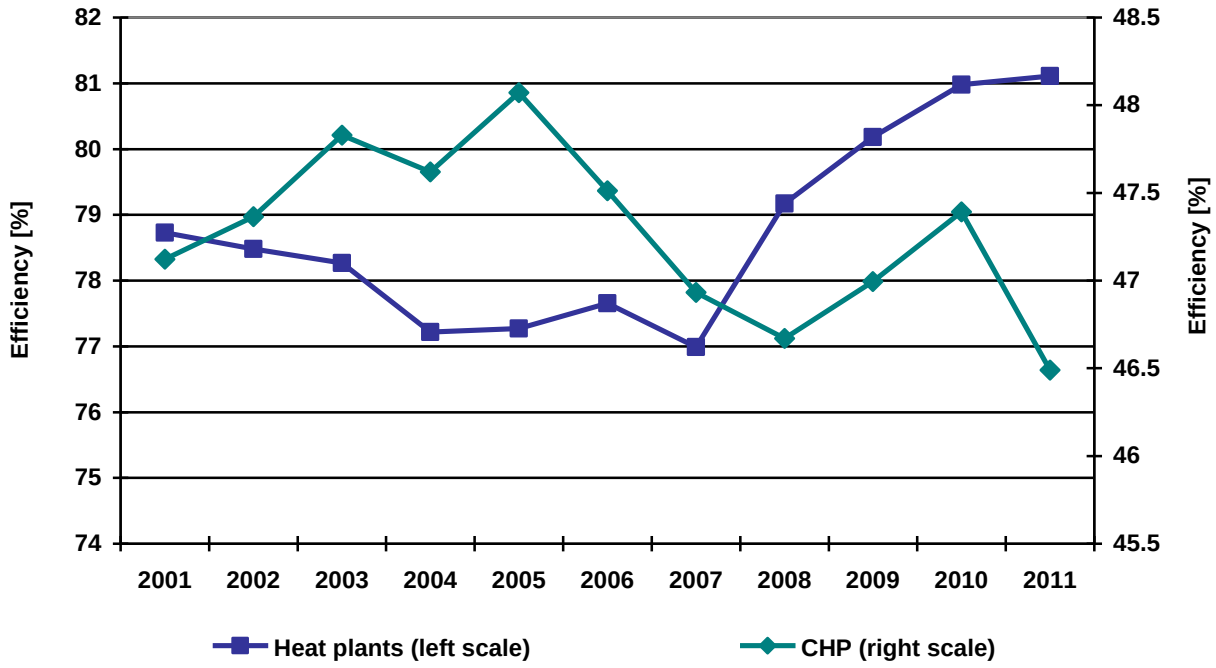


2.8. Heat plants and heat and power generating plants

The efficiency of heat plants producing district heat gradually decreased in years 2001-2007 to 77% from 79%, followed by a sharp increase to over 81% in 2011.

In case of combined heat and power plants transformation efficiency was increasing until year 2005 and exceeded 48%. In subsequent years, the efficiency of CHP was decreasing, except for years 2009 and 2010. In 2011, the efficiency dropped to the lowest level in the period and amounted to 46.5%.

Figure 24. Efficiency of heat plants and CHP

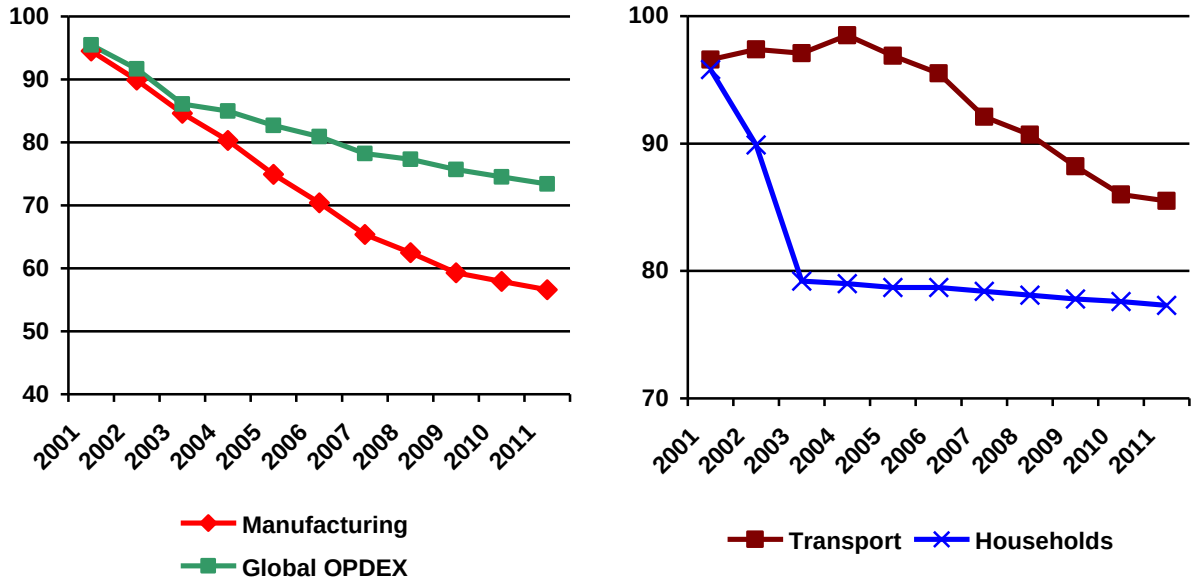


2.9. ODEX indicator and energy savings

ODEX indicator declined in years 2001-2011 from 99.5 to 73.4 points. The average rate of improvement amounted to 2.6% / year. The fastest rate of improvement (5.0% annually) was achieved by manufacturing. In the household sector ODEX indicator[7] was dynamically falling until year 2003, then the rate of improvement was little. Average annual improvement in the years 2001-2011 in this sector amounted to 2.1%. In the transport sector, the indicator remained at similar level to 2004 and then began to decline. Overall in the period 2001-2011 the average rate of improvement amounted to 1.2%/year[8].

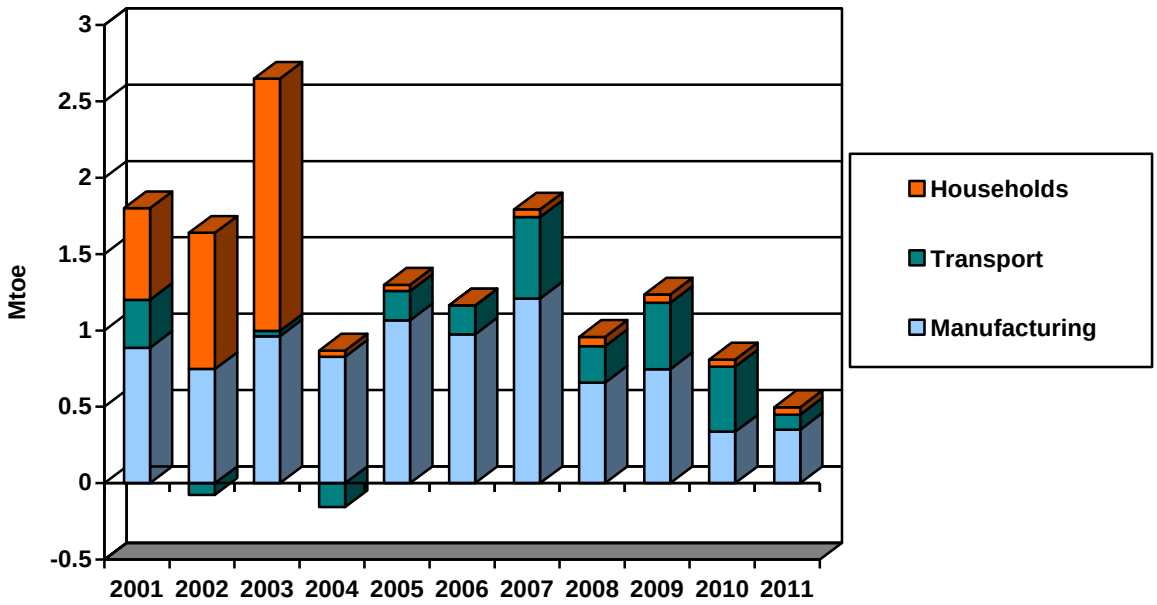
[7] For household sector technical ODEX was calculated, that is basing on the technical parameters of buildings.
[8] Because of lack of official data on specific consumption of different types of transport, calculation of indicator for transport is based on estimated and constant parameters and therefore can be burdened with an error.

Figure 25. ODEX indicator



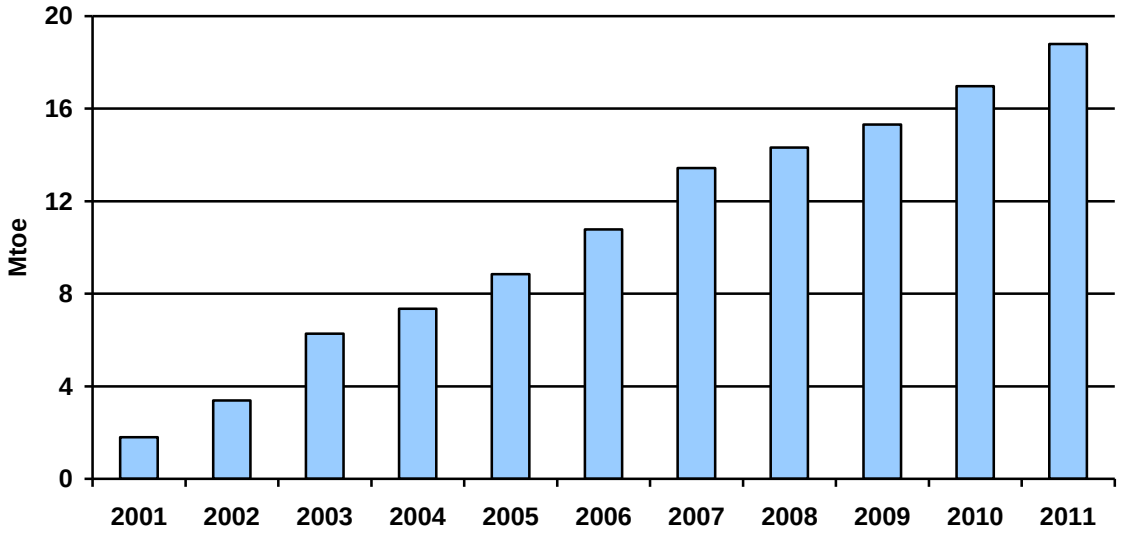
The chart below shows energy savings achieved in subsequent years in manufacturing, households and transport sector after 2000 calculated using ODEX indicators.

Figure 26. Annual energy savings



The cumulative energy savings since 2000, showing as far as energy consumption would be higher in a given year if improvements in scope of energy efficiency had not been introduced after 2000, amounted in 2011 to 18.8 Mtoe. This result takes into account also the savings achieved by the sectors covered by the European Emissions Trading Scheme (ETS).

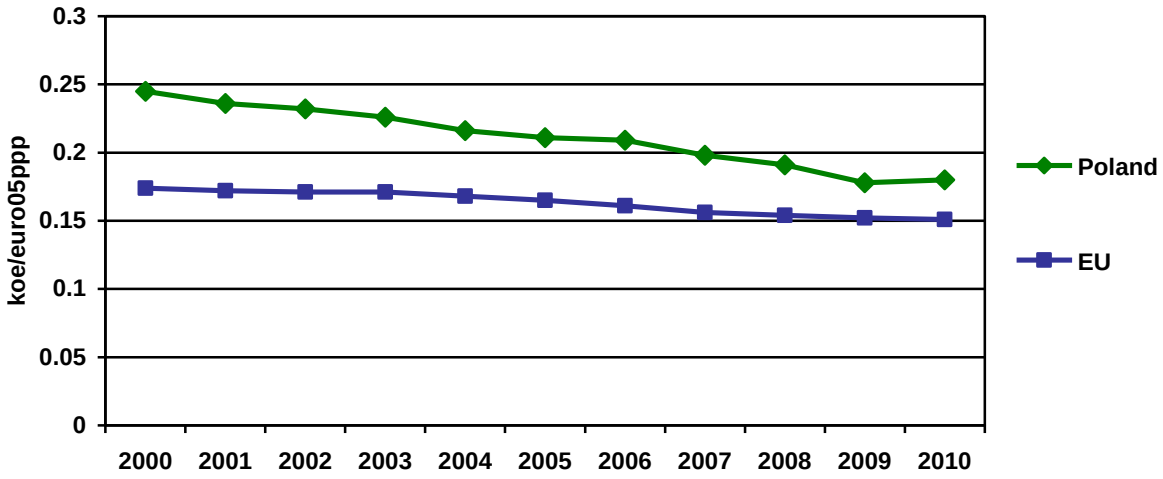
Figure 27. Energy savings since year 2000



2.10. Poland against a background of other EU countries

Primary intensity of GDP at constant prices and purchasing power parity (base year 2005) amounted in Poland in 2010 to 0.180 koe/euro05ppp and was 19% higher than European average. This difference fell by 24 percentage points. compared to the year 2000. The rate of improvement of energy intensity was in Poland in years 2000-2010 more than twice higher than in the European Union. Among the countries showing a similar level of primary energy consumption can be found Romania, Hungary and Latvia.

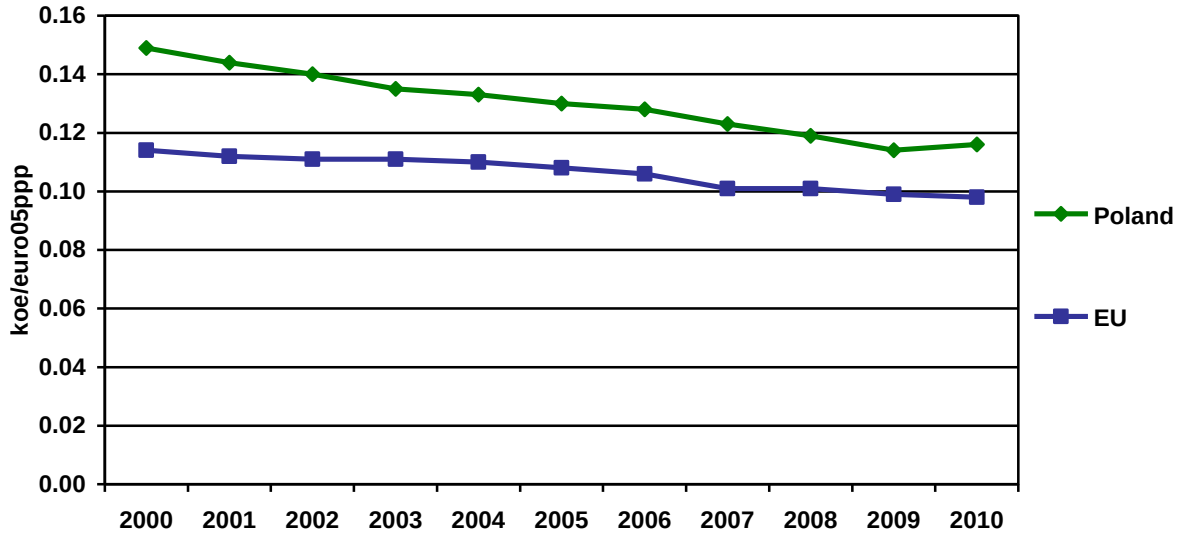
Figure 28. Primary intensity of GDP with climatic correction (euro05, ppp)



Source: Odyssee database, www.odyssee-indicators.org

In case of final energy intensity difference is smaller and amounts to 18% between Poland (0.116) and EU average (0.098). It is the result of the fact, that ratio of final to primary energy consumption is lower in Poland than in Europe.

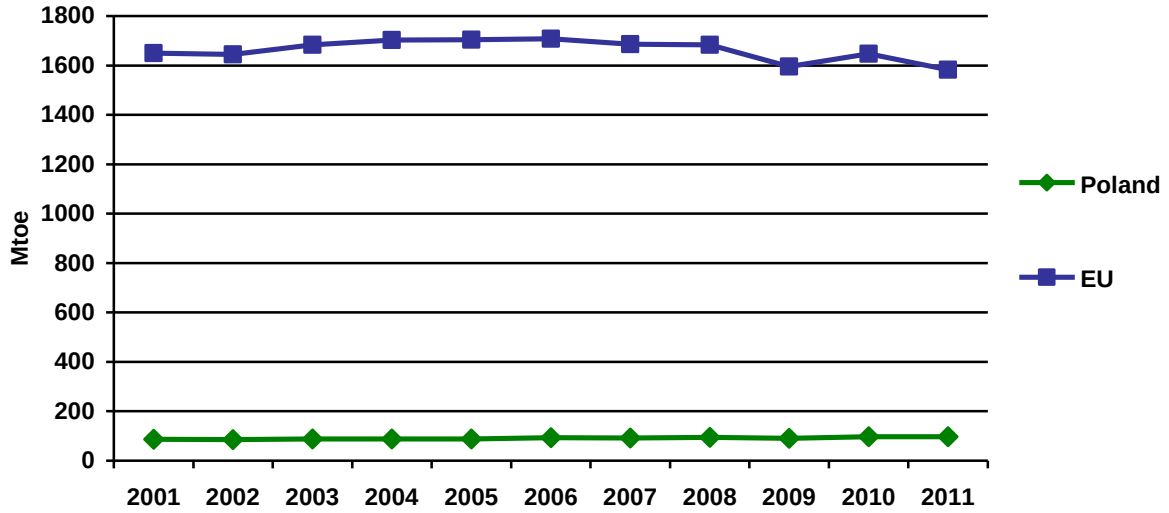
Figure 29. Final intensity of GDP with climatic correction (euro05, ppp)



Source: Odyssee database, www.odyssee-indicators.org

For the purpose of monitoring of the Strategy 2020 currently is used indicator of "Primary energy consumption". It is defined according do Directive 2012/27/EU as gross inland consumption excluding all non-energy use of energy carriers. Values for the Poland for year 2011 amounted to 97.3 Mtoe.

Fig. 30. Primary energy consumption



Source: Eurostat

3. Energy Efficiency Policy and measures towards its improvement

3.1. Energy Efficiency Policy in the European Union

The increase in energy prices and growing dependence on energy supplies from outside the European Union (EU) are a threat to the energy security and competitiveness of the EU industry. In the past few years, the EU has adopted a number of documents in this regard.

The most important of these is the climate – energy package (3 x 20%) published in January 2008, according to which Member States are obliged to:

- reduce CO_2 emission by 20% in 2020 compared to 1990 levels,
- increase energy consumption from renewable energy sources (RES) to 20% in the EU in 2020, for Poland a target of 15% has been set,
- increase energy efficiency in 2020 by 20%.

EU energy targets were also included in the "Europe 2020" strategy for smart and sustainable growth which contributes to social inclusion, adopted by the European Council in 2010. Also in the "Energy 2020" communicate, the European Commission presented a new energy strategy for 2020 regarding competitive, sustainable and safe energy. Priorities were set out in the communicate in regard of the energy for the next 10 years and actions were presented which have to be taken in order to achieve energy savings, creating a competitive price market with secure supplies, strengthening technological leadership, and effective negotiations with international partners. The European Union realises its objectives through directives.

One of the most important directives on energy efficiency was Directive 2006/32/EC of the European Parliament and of the Council from the 5th of April 2006 on end-use energy efficiency and energy services, and also, repealing Council directive 93/76/EEC. Directive 2006/32/EC obliged member states to take up actions leading to a decrease in final energy use by end users in the next nine years beginning on the 1st of January 2008 until the 31st of December 2016. Directive 2006/32/EC, which requires Member States to submit National Energy Efficiency Action Plans, was aimed to realise the EU's potential in this area and become a major contribution to the security of energy supply, competitiveness and sustainable growth. Following the implementation of the Directive 2006/32/EC a number of new

economic activities are to appear, beneficial to both households and businesses, such as new energy services, energy audits, "smart" energy measurement, billing that provides more information and range of financial instruments and support programs.

In 2011, the European Commission examined the possibility of achieving the objectives of climate - energy package (3x20%) and considering the threat of attaining the increase of energy efficiency by 20% in 2020 objective compared to the scenario forecasts, the work started on a new directive on energy efficiency.

On November 14th 2012, Directive 2012/27/EU of European Parliament and Council from 25 October 2012 on energy efficiency was published in the European Union Official Journal, along with directive changes to 2009/125/EC and 2010/30/EU and a repeal of the 2004/8/EC and 2006/32/EC directives. According to paragraph 2 of the new directive preamble in the European Council conclusions from the 4th of February 2011 emphasis was put on the adopted objective of June 2010 by the European Council of increasing energy efficiency by 20% to 2020 was emphasized - which was not sufficiently achieved – and should be realized. According to predictions developed in 2007, primary energy consumption in 2020 will amount to 1 842 Mtoe. Reduction by 20% gives 1474 Mtoe of primary energy consumption in 2020, i.e. a decrease by 368 Mtoe compared to forecast. This is equivalent to 1 078 Mtoe of final energy consumption in 2020.

Article 3, paragraph 1 of Directive 2012/27/UE obliges each Member State to determine the national indicative target value for energy efficiency based on its primary or final energy consumption, savings or energy intensity. The target values should be expressed in terms of the absolute primary and final energy consumption level in 2020 and Member States should provide an explanation how and based on what data these values were calculated.

Article 7 of Directive 2012/27/UE obliges each Member State to establish a system requiring an increase in energy efficiency. The system should ensure the achievement of the joint target in terms of final energy savings for the 31st December 2020 by energy distributors or energy retail sales companies, which have been designated as the required side and which operate on the territory of a Member State.

That target should be at least equivalent to achieving new savings each year starting from the 1st of January 2014 until 31st December 2020 in the level of 1,5 % of the annual energy sales to final customers for all energy distributors and energy retail sales companies by volume,

averaged over the most recent three-year period prior to the 1st of January 2013. The sales of energy, by volume, used in transport may be partially or fully excluded from this calculation.

In accordance with Article 7, paragraph 9 of Directive 2012/27/EU, as an alternative solution to the establishment of energy efficiency obligation, Member States may decide to adopt other measures in the field of policy in order to obtain energy savings among final customers (such as taxes, standards and norms, labelling schemes and voluntary agreements), assuring that such measures in the field of policy will meet appropriate criteria and generate required new energy savings.

Member States are required to implement Directive 2012/27/EU on energy efficiency by the 5th June 2014. On the 30th June 2014 the Commission will review and evaluate progress in achieving the 20% improvement in energy efficiency. If the measures set out in the directive will be insufficient to achieve the targets set for 2020, the Commission may propose additional legal acts.

3.2. Energy Efficiency Policy in Poland

Energy Efficiency Policy in Poland is defined in several documents. The most important of these include:

- Poland Energy Policy until 2030.
- National Energy Efficiency Action Plan (NEEAP) 2007, 2012.

National Energy Efficiency Action Plan

Fulfilling the requirements of Article 14 Paragraph 2 of Directive 2006/32/EC, in 2007 the Ministry of Economy developed the first National Energy Efficiency Action Plan.

The document defined the indicative target in energy saving for 2016 as achieving energy savings of no less than 9 % in relation to the average final energy use between 2001 and 2005 (53 452 GWh). A national intermediate target of 2 % energy savings by 2010 was defined, creating a route for achieving the 2016 target as well as evaluating its realization. Additionally the document presented an outline of national level resources and actions, realized or planned, used to achieve the national indicated target in the expected period.

Directive 2006/32/EC obliges Member States to develop national action plans on energy efficiency every three years. Second National Energy Efficiency Action Plan (NEEAP 2) was adopted by the Polish government in April 2012.

The effectiveness of using energy efficiency measures proposed in the first NEEAP was analysed in the second NEEAP, according to the requirements Directive 2006/32/EC the calculations were performed on energy savings achieved between 2008 and 2009 with regards to those expected in 2016.

The result is a document including particularly descriptions of the planned measures aiming to improve energy efficiency in various sectors of economy, necessary for the implementation of the national target for efficient energy management in 2016.

Second National Energy Efficiency Action Plan

The Second National Energy Efficiency Action Plan was prepared to fulfil the obligation of Directive 2006/32/EC (Official Journal L 114, 27.04.2006, p. 64) as well as the Directive on energy performance in buildings, 2010/31/EC (Official Journal L 153, 18.06.2010, p. 13) to pass on reports to the European Commission. The document was developed based on art. 6, law 1 from the 15th of April 2011, on energy efficiency (Journal of Laws No. 94, pos. 551), implementing regulations of Directive 2006/32/EC.

NEEAP 2 contains descriptions of measures for improving energy efficiency at end-use and calculations on current energy savings achieved in years 2008 and 2009 as well as expectations until 2016 according to the requirements of the directive.

The document was prepared by the Ministry of Economy, with involvement from the Ministry of Transport, Construction and Marine Economy, Central Statistical Office (GUS) and the Polish National Energy Conservation Agency (KAPE S.A.).

NEEAP 2 contains detailed descriptions of planned measures of improving energy efficiency, defining actions aimed at improving energy efficiency in the different areas of the economy, essential to achieving the national target for sustainable energy management for year 2016, which is to be achieved in nine years from 2008 according to art. 4 of the directive.

When developing NEEAP 2 the following assumptions were taken into account:

- proposed measures will be based on market mechanisms and in minimally use the state budget.

- goals will be accomplished according to lowest cost rule with maximal use of existing mechanisms and organizational infrastructure,
- the participation of all parties in developing the total national energy efficiency potential is assumed.

The document also contains the report, required by Directive 2010/31/EC on building energy performance. The European Commission is acquainted with information required by the directive, that is a list of current and planned measures and instruments including financial and supporting actions on energy saving in buildings (article 10 of Directive 2010/31/EC).

Realized (2009) and projected (2016) final energy savings based on Directive 2006/32/EC were considered in two ways. Based on data from statistical research and evaluation models, total final energy saving for the entire national economy was set with distinction for each sector of end use.

Additionally the final energy savings will be calculated for selected measures by the bottom-up method. This method enables the presentation of the direct link between realization of these measures and the state's energy policy. Measures monitored with the bottom-up method contribute a large part of the total final energy savings, and it is important to note that it exceeds 30% of total energy savings, which according to Directive 2006/32/WE should be described by the bottom up method.

The NEEAP 2 defines the following measures of increasing efficiency:

1. Measures in residential sector (households)
   a. Fund for Modernization and Renovation (continued).
2. Measures in the public sector
   a. System of green investments (Part 1) – management of energy in public utility buildings (new).
   b. System of green investments (Part 5) – management of energy in buildings of selected public finance sector entities (new).
   c. Operational Program "Energy saving and promotion of renewable energy sources" using financial resources as part of the EOG Financial Mechanism and the Norwegian Financial Mechanism in 2012-2017 (new, planned).

d. Operational Program Infrastructure and Environment (POIiŚ) – Action 9.3 Thermo-modernization of public buildings (continued).

3. Measures in industry and small and medium companies (SMEs)

a. Effective energy use (Part 1) – Subsidies to energy and electricity audits (new).

b. Effective energy use (Part 2) – Subsidies to investments leading to energy savings or energy efficiency improvements in companies (new).

c. Access to financial instruments for the SME sector (PolSEFF) (new).

d. Priority Program Intelligent energy networks (new, implemented in 2012).

e. Operational Program Infrastructure and Environment (POIiŚ) – Action 9.2 Effective energy distribution (continued).

f. Operational Program Infrastructure and Environment (POIiŚ) – Action 9.1 High efficiency energy generation (continued).

4. Measures in the transport sector

a. Traffic management systems and optimization of freight transport (continued).

b. Replacing the fleet in municipal transport departments and eco-driving promotion (new, from 2012).

5. Horizontal measures

a. System of energy efficiency certificates – white certificates (new).

b. Informational campaigns, workshops and education in scope of energy efficiency improvement (continued)

In NEEAP 2 energy savings levels in 2016 for certain activities were estimated and summarized in Table 5.

Table. 5. Estimated energy savings to 2016, obtained through tasks realization described in NEEAP 2 referring to energy efficiency

Measures of improving energy efficiency from 2 NEEAP	The estimated energy savings until 2016	
	GWh	Mtoe
Target	67211	5,779
Sectors		
Residential		
Thermomodernisation Fund	8121	0,698
Services - Public Sector		
Green investment System (1)	1950	0,168
Green investment System (5)		
Energy saving and RES (EOG and Norwegian Fund)		
POIiŚ (Action 9.3)	320	0,028
Industry and SMEs		
EEU (part 1)		
EEU (part 2)	2900	0,249
PolSEFF		
Intelligent energy networks		
POIiŚ Action 9.2 (Effective Energy Distribution)	498	0,043
POIiŚ Action 9.1 (High efficiency energy generation)	3100	0,267
Transport		
Traffic Management System	13360	1,149
Replacing the transport fleet	2500	0,215
Horizontal		
White Certificates Scheme	25586	2,200
Nationwide information campaigns	12793	1,100
Total	70928	6,116

3.3. National energy efficiency targets and achieved energy savings

Table 6 presents energy savings targets realized basing on Directive 2006/32/EC as well as the achieved (calculated using the top-down method) and predicted results (energy saving).

Table 6. Summary of the targets and final energy savings achieved and predicted based on Directive 2006/32/WE

Description	Targets for energy savings (GWh)	Final energy savings achieved and predicted (2016) (GWh)
2010	11 878	51 716
2016	53 452	67 211

The first National Energy Efficiency Action Plan, prepared in year 2007, contained indicative targets for energy savings between 2010 and 2016.

For 2010 the target was set at 2% of the average national final energy consumption in years 2000 - 2005, and for 2016 it was set at 9% of this consumption. These goals are sustained in NEEAP 2.

Due to the data availability at the time, final energy savings achieved by 2009 were calculated in the NEEAP 2. Energy savings for years 2010 and 2011, based on data from these tears are presented below.

Table 7 presents target and achieved energy savings (end-use) (end-use) calculated on the basis of Directive 2006/32/EC, which have been set in the first National Energy Efficiency Action Plan from 2007.

Table 7. Summarised targets for energy efficiency and achieved final energy savings (in end-use energy sectors)

Description	Target final energy savings		Final energy saving achieved and predicted (2016)	
	In absolute terms (GWh)	Percentage - of average consumption between 2001 and 2005 (%)	In absolute terms (GWh)	Percentage - of average consumption between 2001 and 2005 (%)
2010	11 878	2	51 716	8,7
2016	53 452	9	67 211	11

Table 8 shows final energy savings obtained in 2010 broken down by end-use sectors.

Table 8. Final energy savings divided into sectors (top-down)

Sector	Achieved energy savings (GWh)
Households	12 908
Services	-
Industry	21 076
Transport	11 732
Total:	51 716

Table 9 shows energy savings calculations, achieved through 2008 - 2011.

Table 9. Energy savings in years 2008-2011, calculated using the top-down method[9] and year 2007 as a base

Description	2008	2009	2010	2011
ktoe	1453	3132	4448	3874
GWh	16896	36413	51716	45043

3.4. Measures for improving energy efficiency in Poland

Exemplary role of the public sector

Chapter 3 of the act from the 15th of April 2011 on energy efficiency, "Task of public sector entities in scope of energy efficiency" defines measures ensuring the public sector in Poland perform an exemplary role in investments, maintenance and other expenses on energy-using equipment and other measures for increasing energy efficiency. Art. 10 of the act states that an entity of the public sector, while realizing its tasks, should apply at least two of energy efficiency improving measures listed below:

- A legal contract which secures execution of, and financing for the project aimed at improving energy efficiency;
- Purchasing new equipment, installation or vehicle that is characterised by low power consumption and low operating costs;
- Replacement or modernization of the operated device, system or vehicle;
- Purchase or renting of energy-efficient buildings or their section or either reconstruction or renovation of utilised buildings, including execution of a thermo-modernization project in accordance with act from the 21st of November 2008 on supporting thermo-modernizations and renovations;
- Preparing an energy audit according to act from the 21st of November 2008 on supporting thermo-modernization and renovations of used buildings according to the act

[9] Energy savings calculations were made using a top-down method, in accordance with the methodology published by the European Commission "Recommendations on Measurement on Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services". Year 2007 is recommended by the European Commission as the base for calculations.

from the 7th July 1994 – Building code, with usable area above 500m^2, of which the public sector entity is either owner or manager.

At the same time the public sector entity should ensure to promote the appropriate, undertaken measures for improving energy efficiency by publishing information on its website or in any other local manner.

In addition the act from 15th of April 2011 on energy efficiency obliges the Minister of Economy and Minister of Transport, Construction and Maritime Economy to promote the measures aiming at energy efficiency improvement and to conduct activities in the fields of information, education and training.

The White Certificates Scheme

The White Certificates Scheme was introduced by the provisions of the Energy Efficiency law from the 15th of April 2011 (Journal of Laws No. 94, pos. 551), which implemented Directive 2006/32/EC, of the European Parliament and the European Council from the 5th of April 2006, one effective end-energy use and energy services repealing Directive 93/76/EWG, into the Polish legal framework. The Directive indicates the white certificates scheme as one of the measures for achieving an improvement of end-energy use efficiency on account of its dynamic effectiveness. The system stimulates the development of energy services markets. By creating a demand for energy services and end-use energy savings, it is expected, that through achieving the benefits of scale and specialization the costs of energy services will decrease.

Chapter 4 of the Energy Efficiency Law from the 15th of April 2011, titled "Rules for obtaining and revoking of energy efficiency certificates as well as Chapter 5 – "Rules for performing energy efficiency audits", and Chapter – 6 "Fines" define the regulations of the white certificates scheme in Poland.

The Act from the 10th of October 2012 on changes to the Energy Efficiency Law removed the regulations concerning the person of the energy efficiency auditor. Due to these changes, on the 27th of December 2012, the Regulation of the Minister of Finance from the 14th of September 2011 on the compulsory civil liability insurance of energy efficiency auditors was repealed.

The functioning of the White Certification Scheme in Poland, apart from the Energy Efficiency Law, is also regulated by the fallowing regulations:

1) Regulation of the Minister of Economy from the 10th of August 2012 on the detailed scope and methods of performing energy efficiency audits, energy efficiency audit card templates and energy savings calculation methods (Journal of Laws from 2012 pos. 962).

2) Regulation of the Minister of Economy from the 4th of September 2012 on the calculation method for primary energy quantities corresponding to to energy efficiency certificate values and the values of compensation fees (Journal of Laws from 2012, pos. 1039).

3) Regulation of the Minister of Economy from the 23rd of October 2012 on the tender for the selection of projects aimed at improving energy efficiency (Journal of Laws from 2012, pos. 1227).

4) Minister of Economy Announcement from the 21st of December 2012 on the detailed list of energy efficiency improving projects (M.P. 2013 pos. 15).

In line with Article 5 of the act from the 15th of April 2011 on energy efficiency, natural persons, legal entities, and enterprises without legal entity that use energy, take actions aimed at improving energy efficiency. The purpose of the white certificates scheme is to motivate individuals and enterprises to take steps accelerating the improvement of energy efficiency of the Polish economy and directed at reducing final energy consumption. It is important to assume the achievement of potential energy savings in an economically efficient way, meaning, creating financial saving after considering the required investment expenditure.

White certificate scheme operates in three areas, called categories of measures for improving energy efficiency:

1) Increasing energy savings by end-users.

2) Increase energy savings by energy producers from devices used for their production needs.

3) Reducing the electricity, heat or natural gas loss in transmission or distribution.

The first category includes all end-use sectors. The second category applies only to devices used for production needs, defined as a group of supporting objects or installations within the meaning of Article 3 Section 10 of the Act from the 10th of April 1997 - Energy Law, aimed at process of generating electricity or heat (which can be e.g. motor conveyor belt feeding coal to the mill in the plant). Whereas, the category of reducing electricity, heat and natural

gas loss in transmission and distribution, concerns the modernization of energy carrier transportation networks as well as the corresponding objects associated to these processes.

A detailed list of measures aimed at energy efficiency improvement includes the following items:

1. Measures of improving energy efficiency by insulation of industrial installations:
    1) thermal insulation modernization of heating pipes and process lines in buildings (e.g. insulation of: pipes, tanks, boilers, exhausts, turbines, inlet gases purification devices, industrial fittings);
    2) thermal insulation of media transport systems within industrial processing, including devices for transport, preparation of products and intermediate products (e.g. pig iron, liquid steel, rolling-mill products), heating, water and gas networks (transporting e.g. natural gas, coke gas, metallurgic gas, technical gases and compressed air);
    3) thermal insulation of rolling-mill reheating furnaces.
2. Measures of improving energy efficiency through reconstruction or renovation, including thermo-modernization and renovation projects according to Act from the 21st of November 2008 on supporting thermo modernization and renovations (Journal of Laws No. 223 pos. 1459 with later amendments):
    1) insulation of walls, ceilings, foundations, roofs or flat roofs;
    2) modernization/replacement of window/door woodwork or replacement of old glazing with energy efficient glazing;
    3) installation of windows shading (e.g. blinds, louvers);
    4) thermal insulation, hydraulic balancing or comprehensive modernization of heating or hot water installations;
    5) linear and point thermal bridges elimination;
    6) modernization of ventilation systems by installing heat recovery systems (energy regeneration).
3. Measures for improving energy efficiency through modernization or replacement:
    1) devices of domestic use (e.g. washing machines, dryers, dishwashers, , refrigerators, ovens);

2) indoor lighting (e.g. in public use buildings, residential buildings, offices buildings, industrial buildings and halls, commercial buildings) or outdoor lighting (e.g. tunnel lighting, squares, parks, streets, decorative lighting, gas station lighting and traffic lights), including:

a) replacement of old lighting sources with energy efficient ones,

b) replacement of lighting fixtures equipment with energy efficient ones,

c) implementing lighting systems with adjustable parameters (intensity, efficiency, control) depending on the user needs,

d) use of energy efficient power systems;

3) production-need devices, including:

a) air and exhaust ventilators,

b) pumping systems and pumps – using pumps with smooth rotation regulation,

c) slag removal systems,

d) coal handling systems – coal mills,

e) control systems – boiler automation systems, measurement systems, safety and signalling,

f) compressors and compressor systems,

g) electric motors – inverter installation in motors with variable power requirements,

h) water treatment systems,

i) lighting of: area, halls, workshops, and other production facilities,

j) workshop equipment (e.g. welding machines, furnaces, lathes, milling machines).

4. Measures for improving energy efficiency in devices and installations used in industrial processes:

1) modernization or replacement of energy and technology equipment including their respective installations: compressors, electric motors, pumps, ventilators and their motors, and control systems, or use of inverters in motors with variable power requirements;

2) modernization or replacement of pipes, tanks, exhaust gas ducts, chimneys, and other equipment used for water treatment;

3) use of measuring and monitoring energy utilities systems;

4) optimization of media flow systems (heat, water, gas, compressed air, ventilation air) and production lines transport strings.

5. Measures for improving energy efficiency in district heating networks and local heat sources, such as:

1) replacement/upgrading of group and individual heating substations using equipment and technologies with higher energy efficiency (insulation, motors, heat exchangers);

2) modernization of systems powered by group heating substations through the reconstruction of these systems to individual substations;

3) installation/upgrade of automation and monitoring systems in heating substations and heating networks;

4) replacement of local refrigeration and air conditioning systems;

5) use of cogeneration systems in local heat sources;

6) modernization of local boiler houses.

6. Measures for improving energy efficiency through energy recovery in industrial processes, including installations or modernizations:

1) systems of heat recovery from equipment and industrial processes, and its use directly or in other technological processes;

2) "freecooling" systems - the process of using cold air outside of the building to cool the air inside the building;

3) gas turbines and power generation systems using the energy of gas, steam or water pressure expansion/reduction;

4) heat recovery systems in industrial processes used for electric energy;

5) waste gas processing systems in industrial processes (such as coke gas, blast furnace, BOF) and exhausts for electricity and thermal energy or fuel.

7. Measures for improving energy efficiency through reducing following losses:

1) connected with reactive power consumption by various electric appliances, including the use of local and central systems for reactive power compensation (capacitors, inductors, machine and electronic compensators);

2) transmission or distribution network losses of electricity;

3) transformation losses in transformers by:

   a) use of compensation systems in idle and low-load states,

   b) replacement of transformers into units of higher energy efficiency, or adapting to the power demand;

4) in district heating networks, implementing:

   a) modernization and reconstruction of heating network by:

   - changing the technology of the network (main lines, distribution networks, connections to buildings),
   - changing the route of the pipeline in order to reduce its length or remove unnecessary sections,
   - changing the diameter of the pipe in order to improve the hydraulic requirements,
   - repairing leaks and their causes,

   b) improvement of thermal insulation of the pipelines and their equipment in valves,

   c) change of heating network performance or method of its adjustment,

   d) the entry or expansion of the system for monitoring and controlling the operation of the heating system.

8. Measures for improving energy efficiency as referred to in Article 17 Paragraph 1 Section 6 of the Act on energy efficiency from the 15th of April 2011, such as:

   1) replacement of low-efficient, local and individual heat sources using coal, coke, gas or oil energy sources with ones characterized by a higher energy efficiency, including renewable energy sources, heat produced in cogeneration and waste heat from industrial plants;

2) replacement of low-efficient, local and individual means of preparing hot water by means characterized by a higher energy efficiency, including the use of renewable energy sources, heat produced in cogeneration and waste heat from industrial plants;

3) construction of district heating connections and acquiring or modernization of heating substations to replace low-efficient, local or individual heat sources with district heating produced from renewable energy sources, cogeneration and waste heat from industrial plants;

4) modernization of cooling equipment to systems using heat from the district heating network, generated from renewable energy sources, in co-generation or waste heat from industrial installations.

The above cited directory should be treated as open within the individual points from 1 to 8. However, new types of measures for improving energy efficiency cannot be added.

The white certificate scheme has been operating since December 31, 2012, the day the Energy Regulatory Office announced the first tender for projects for which energy performance certificate could be issued.

Other measures to improve energy efficiency in Poland and other countries

The undertaken or planned actions and measures for improving energy efficiency in all European countries, including Poland, are presented in the MURE database *(Mesures d'Utilisation Rationnelle de l'Energie*, http://www.mure2.com/). The MURE database was developed under the SAVE program "Intelligent Energy - Europe" by a team of European experts and coordinated by ISIS (Institute of Studies for the Integration of Systems, Italy) and the Fraunhofer Institute for Systems and Innovation Research ISI (Germany). The MURE database is a description of ongoing, planned or already completed measures to improve energy efficiency as well as their quality and quantitative assessment. The involvement of all European Union members guarantees the continuous updating of the database which contains selected statistical data and an overview of energy efficiency issues in each country. It consists of five sections classifying information on programs to improve efficiency in relation to four key sectors of economy: industry, households, transport, services and horizontal actions (concerning all sectors of economy).

4. Summary

Increasing the energy efficiency of generation, transmission and use of energy is a pillar of the sustainable energy policy. This is reflected in the legislation and actions taken by state institutions and the European Union. Directive 2012/27/EU of 25 October 2012 on energy efficiency is a continuation of this policy, and stresses the importance of improving the efficiency of the European Union. The Directive obliges EU countries to introduce measures to improve energy efficiency in order to achieve the target of 20% primary energy savings by 2020. Improving energy efficiency is a key element of the EU strategy to reduce dependence on energy supplies, increasing energy security, reducing harmful impact of the energy sector on the environment and reduce energy costs, resulting in an increase competitiveness of the European economy. The Directive also requires Member States to report annually on progress in the implementation of national energy efficiency targets and obliges to prepare every three years the national energy efficiency action plan.

Poland, as a member state of the European Union is actively involved in creating common energy policy and legislation in the field of energy efficiency and implements it in the national context, taking into account the protection of the interests of customers, domestic energy resources and technological conditions of production and transmission of energy. Improving energy efficiency is one of the priorities of EU energy policy, aiming to reduce energy consumption by 20% in year 2020 compared to the scenario of "business as usual". Poland pursues indicative target arising from a Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC, that is to achieve by 2016 energy savings of 9% of the average final energy consumption in the years 2001-2005, with the intermediate goal of 2% in year 2010. In accordance with the provisions of the Directive, the energy savings should be counted as an absolute reduction in energy consumption as a result of organizational activities and achieved as a result of realization of investment and modernization. By 2010, Poland has made significant progress in this regard.

The effect of GDP growth faster than the growth rate of energy consumption caused decrease of primary and final energy intensity of GDP, with the exception of 2010. In the first half of

the decade, energy intensity decreased by more than 2% a year, in years 2006-2009 the rate of improvement has exceeded 5% for the primary intensity and amounted to nearly 4% in the case of final intensity. However, in 2010 there was a growth of energy intensity of the Polish economy, for the first time since 1993. The fastest rate of energy efficiency improvement was achieved in the industrial sector, while the slowest in the service sector.

The necessity of monitoring effects of actions towards energy efficiency improvement, described in Directive 2006/32/EC, endeavour to harmonization and making international comparisons possible, force to introduce changes in respect of collection of statistical data i.e. enlarge subject and object scope of surveys, as well as to supplement administrative data bases (administrative sources).

TABLES

Table 1. Energy consumption and intensity of GDP

No.	Specification	Unit	2001	2002	2003
1	Primary energy consumption ……..…..	Mtoe	90.3	88.9	91.2
2	Final energy consumption ……..	Mtoe	55.0	53.3	54.3
3	Final energy consumption with climatic correction…….	Mtoe	55.1	54.5	54.4
4	Primary energy intensity of GDP……...	kgoe/euro00	0.481	0.466	0.461
5	Final energy intensity of GDP…..……	kgoe/euro00	0.293	0.279	0.274
6	Final energy intensity of GDP with climatic correction……...	kgoe/euro00	0.293	0.286	0.275

Table 2. Energy intensity of industry branches

No.	Specification	Unit	2001	2002	2003
1	Food.....	kgoe/euro05	0.492	0.449	0.416
2	Textile.....	kgoe/euro05	0.168	0.180	0.167
3	Wood.....	kgoe/euro05	0.393	0.448	0.417
4	Paper.....	kgoe/euro05	0.353	0.372	0.440
5	Chemical.....	kgoe/euro05	1.653	1.563	1.497
6	Mineral.....	kgoe/euro05	1.407	1.264	1.153
7	Primary metals.....	kgoe/euro05	3.048	2.110	2.624
8	Machinery.....	kgoe/euro05	0.147	0.140	0.118
9	Transport equipment.....	kgoe/euro05	0.143	0.124	0.115
10	Other.....	kgoe/euro05	0.069	0.082	0.088

Table 3. Energy intensity of production

No.	Specification	Unit	2001	2002	2003
1	Steel……	toe/t	0.328	0.300	0.290
2	Cement..……..	toe/t	0.099	0.091	0.090
3	Paper..…….	toe/t	0.628	0.598	0.603

2004	2005	2006	2007	2008	2009	2010	2011	No.
91.5	92.7	97.7	97.8	98.7	94.9	101.3	102.4	1
56.1	56.9	59.4	59.8	60.7	60.4	65.4	63.5	2
56.6	57.2	59.8	61.5	63.0	61.2	64.1	65.0	3
0.439	0.429	0.425	0.399	0.383	0.362	0.372	0.361	4
0.269	0.263	0.259	0.244	0.236	0.230	0.240	0.224	5
0.271	0.265	0.260	0.251	0.244	0.234	0.235	0.229	6

2004	2005	2006	2007	2008	2009	2010	2011	No.
0.395	0.274	0.249	0.250	0.237	0.188	0.198	0.186	1
0.140	0.138	0.108	0.093	0.076	0.064	0.063	0.048	2
0.406	0.444	0.356	0.334	0.337	0.345	0.407	0.403	3
0.391	0.397	0.360	0.304	0.295	0.508	0.492	0.468	4
1.448	1.242	1.121	1.042	1.058	1.103	1.101	1.110	5
1.051	1.012	0.841	0.798	0.770	0.747	0.679	0.680	6
3.011	2.215	1.867	1.877	1.866	1.145	1.252	1.291	7
0.097	0.087	0.065	0.053	0.037	0.035	0.032	0.027	8
0.094	0.118	0.101	0.087	0.074	0.056	0.050	0.042	9
0.115	0.102	0.100	0.081	0.072	0.071	0.072	0.078	10

2004	2005	2006	2007	2008	2009	2010	2011	No.
0.281	0.273	0.250	0.237	0.223	0.210	0.211	0.211	1
0.106	0.103	0.109	0.098	0.088	0.090	0.095	0.093	2
0.510	0.572	0.552	0.552	0.556	0.472	0.433	0.449	3

Table 4. Energy efficiency indicators in households sector

No.	Specification	Unit	2001	2002	2003
1	Energy consumption per dwelling.....	toe/dwel.	1.609	1.455	1.422
2	Energy consumption per dwelling with climatic correction.....	toe/dwel.	1.619	1.531	1.428
3	Energy consumption per m^2.....	kgoe/m^2	26.1	21.4	20.7
4	Energy consumption for heating per m^2.....	kgoe/m^2	18.5	14.9	14.1
5	Electricity consumption per dwelling.....	kWh/dwel.	1789.4	1741.4	1973.0[b)]

Table 5. Energy efficiency indicators in service sector

No.	Specification	Unit	2001	2002	2003
1	Energy intensity.....	kgoe/euro05	0.046	0.048	0.050
2	Electricity intensity.....	Wh/euro05	237.4	226.1	229.1
3	Energy consumption per employee.....	toe/emp.	0.799	0.867	0.922
4	Electricity consumption per employee.....	kWh/emp.	4162.4	4050.1	4265.9

Table 6. Energy efficiency indicators in transport and energy sector

No.	Specification	Unit	2001	2002	2003
1	Fuels consumption per equivalent car.....	toe/eq. car	0.419	0.381	0.426
2	Heat plants efficiency.....	%	78.7	78.5	78.3
3	CHP efficiency.....	%	47.1	47.4	47.8

Table 7. ODEX indicator

No.	Specification	Unit	2001	2002	2003
1	Manufacturing.....	2000=100	94.5	89.9	84.6
2	Transport.....	2000=100	96.6	97.4	97.1
3	Households.....	2000=100	95.8	89.9	79.2
4	Global ODEX.....	2000=100	95.5	91.7	86.1

a) data estimated, b) since 2003 including electricity consumption in households, whose primary

2004	2005	2006	2007	2008	2009	2010	2011	No.
1.415	1.449	1.528	1.419	1.418	1.421	1.575	1.409	1
1.442	1.467	1.573	1.524	1.542	1.466	1.507	1.487	2
20.5	20.9	21.7	20.3	20.1	20.0	22.2	20.1	3
14.0	14.4	15.2	14.0	13.9	13.8	15.5	13.8	4
2008.6	1976.6	2055.4	2029.4	2061.9	2069.9	2131.9	2093.9	5

2004	2005	2006	2007	2008	2009	2010	2011	No.
0.048	0.046	0.045	0.044	0.046	0.047	0.051	0.048	1
229.4	239.2	251.9	242.0	255.4	248.8	262.2	261.8	2
0.916	0.891	0.883	0.882	0.925	0.967	1.067	1.006	3
4396.5	4625.3	4973.4	4829.9	5165.6	5134.5	5489.3	5515.1	4

2004	2005	2006	2007	2008	2009	2010	2011	No.
0.458	0.496	0.514	0.532	0.518	0.523	0.529	0.511	1
77.2	77.3	77.7	77.0	79.2	80.2	81.0	81.1	2
47.6	48.1	47.5	46.9	46.7	47.0	47.4	46.5	3

2004	2005	2006	2007	2008	2009	2010	2011	No.
80.3	74.9	70.4	65.4	62.5	59.3	57.9	56.6	1
98.5	96.9	95.5	92.1	90.7	88.2	86.0	85.5	2
79.0	78.7	78.7	78.4	78.1	77.8	77.6	77.3	3
85.0	82.7	80.9	78.2	77.3	75.7	74.5	73.4	4

source of income was profit from individual farming

Attachment. List of legal acts

EU documents concerning issues related to energy efficiency are as follows:

1) *Green Paper for a European Union Energy Policy (1995).*
2) *Energy Charter Treaty and Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA).*
3) *White Paper Energy for the Future: RES.*
4) *Council Resolution on energy efficiency in the European Community (1998).*
5) *Action Plan to Improve Energy Efficiency in the European Community.*
6) *European Climate Change Programme (ECCP).*
7) *A sustainable Europe for a better world – A European Union strategy for sustainable development.*
8) *Green Paper - Towards a European Strategy for Energy Supply Security.*
9) *White Paper. European Transport Policy for 2010: Time to Decide.*
10) *EUROPE 2020 - A European strategy for smart, sustainable and inclusive growth.*
11) *White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.*
12) *Energy Efficiency Plan 2011.*
13) *Green Paper. Lighting the Future - Accelerating the deployment of innovative lighting technologies.*
14) *Directive 2006/32/EC of the European Parliament and of the council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.*
15) *Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics.*

Directives and regulations concerning energy efficiency of appliances:

1. *Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC.*

2. *Directive 2010/30/EU of the European Parliament and of the of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products.*
3. *Commission Delegated Regulation (EU) No 1059/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household dishwashers.*
4. *Commission Delegated Regulation (EU) No 1060/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household refrigerating appliances.*
5. *Commission Delegated Regulation (EU) No 1061/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household washing machines.*
6. *Commission Delegated Regulation (EU) No 1062/2010 of 28 September 2010supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of televisions.*
7. *Commission Delegated Regulation (EU) No 626/2011 of 4 May 2011 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of air conditioners.*
8. *Commission Delegated Regulation (EU) No 392/2012 of 1 March 2012 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household tumble driers.*
9. *Commission Directive 96/60/EC of 19 September 1996 implementing Council Directive 92/75/EEC with regard to energy labelling of household combined washer-driers.*
10. *Council Directive 98/11/EC of 27 January 1998 implementing Council Directive 92/75/EEC with regard to energy labelling of household lamps.*
11. *Commission Directive 2002/340/EC of 8 May 2002 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric ovens.*
12. *Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.*
13. *Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (recast).*

14. *Commission Regulation (EC) No 1275/2008 of 17 December 2008 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment.*
15. *Commission Regulation (EC) No 107/2009 of 4 February 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for simple set-top boxes.*
16. *Commission Regulation (EC) No 244/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for non-directional household lamps.*
17. *Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaries able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council.*
18. *Commission Regulation (EC) No 278/2009 of 6 April 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for no-load condition electric power consumption and average active efficiency of external power supplies.*
19. *Commission Regulation (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors.*
20. *Commission Regulation (EC) No 641/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for glandless standalone circulators and glandless circulators integrated in products.*
21. *Commission Regulation (EC) No 642/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for televisions.*
22. *Commission Regulation (EC) No 643/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for household refrigerating appliances.*

23. *Commission Regulation (EC) No 859/2009 of 18 September 2009 amending Regulation (EC) No 244/2009 as regards the ecodesign requirements on ultraviolet radiation of non-directional household lamps.*
24. *Commission Regulation (EU) No 347/2010 of 21 April 2010 amending Commission Regulation (EC) No 245/2009 as regards the ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps.*
25. *Commission Regulation (EU) No 1015/2010 of 10 November 2010 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household washing machines.*
26. *Commission Regulation (EU) No 1016/2010 of 10 November 2010 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household dishwashers.*
27. *Commission Regulation (EU) No 327/2011 of 30 March 2011 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW.*
28. *Commission Regulation (EU) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners and comfort fans.*