PREFACE

This publication is successive edition of the study „ENERGY EFFICIENCY" published by the Central Statistical Office (GUS) as part of 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 energy 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 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 aim 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" program.

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.

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1. Introduction

The increase of energy efficiency of generation, transmission and use processes is a pillar of sustainable energy policy. It is reflected in the law and actions undertaken by national institutions and international organizations. Regulations connected with energy efficiency should be mentioned, including:

- Directives of European Parliament and the Council (including the last - Directive 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),
- Renewed Lisbon Strategy,
- National Coherence Strategy for years 2007-2013.

The main aim of the latest directive, presented in chapter 11, is achieving economically reasonable improvement of fuels and energy end-use efficiency in Member States of the European Union through: setting goals, mechanisms and incentives; setting institutional, financial and legal frames to cancel existing market barriers having influence on energy end-use efficiency; promotion of programmes aiming at improving energy efficiency; development of high quality energy services for end users; harmonization of methodology of energy savings calculation and verification.

Above mentioned directive obliges Member States to collect and transmit data required to monitor, asses and plan actions towards energy end-use efficiency improvement.

There are two methods of measuring growth of energy efficiency (energy savings). These are: "top-down" method and "bottom-up" method.

- In method „top-down" aggregated data is used and therefore it is called energy efficiency indicators method. This method enables to set indicators of situation development, but it does not ensure detailed measuring on specific level. Mostly, sections, divisions, groups of economy, groups of devices, and types of transport means are the subjects of calculations. Calculated values of energy consumption or intensity are recalculated with reference to such external factors as number of degree days during heating season, structural changes, production profile, etc.
- „Bottom-up" method is more precise way of energy savings calculations resulting from energy efficiency increase. Primary, energy consumption of single end user for

instance refrigerator is calculated during defined time period before introducing pro-efficiency action, obtaining base value[1]. Next, the energy consumption in the following period is compared to the consumption during prior period. The difference between results measures energy efficiency increase. If similar calculations are made for all energy devices, and results sum up, precise result of energy efficiency growth is obtained. When making calculations, it should be remembered also in this case to take into account climate corrections and other factors outnumbered in the description of the method „top-down".

Energy savings can result, apart from increasing energy efficiency actions, from changes in behaviour and lifestyle (the latter can or can not mean changes of services level), uncontrollable weather conditions, as well as structural changes (e.g. production decrease of more energy intensive industrial branches). Unless correction is made, such structural changes impact the energy efficiency improvement.

To correct energy intensity level calculations it should be taken into account:

1) GDP size according to purchasing power of currency,

2) annual changes of temperatures (climatic changes),

3) structural changes of production.

Corrections eliminate significant amount of factors influencing energy consumption changes not connected with energy efficiency improvement.

In directive on energy end-use efficiency it is suggested to use „bottom-up" method to calculate energy savings, In case when such data is not available for several sectors combination of „bottom-up" and „top-down" methods should be used.

[1] In calculations „bottom-up", in case there is no possibility to measure energy consumption earlier, the base level can be reconstructed using parameters of types and share of technologies, which were used when given action was not applied.

2. The project: „Evaluation and monitoring of Energy Efficiency in the New EU Member Countries and the EU-25" in framework of Intelligent Energy Europe EC program

Energy efficiency and CO_2 indicators are increasingly used for the evaluation and monitoring of annual energy efficiency performances and CO_2 emissions. Development of energy efficiency measuring is necessary for the effective implementation of new energy policies and also imposed by Directive 2006/32/EC.

The 18 months lasting project "Monitoring of energy efficiency in new EU Member Countries (NMC's) and EU 25" aiming at monitoring energy efficiency and CO_2 trends and evaluation of the national energy efficiency policy measures, started on January 1st 2006 with participation of national energy agencies and statistical offices from EU countries. From the Polish side Central Statistical Office (GUS) and the Polish National Energy Conservation Agency (KAPE) are participating in this project coordinated by ADEME[2].

The direct objectives of the project are the following:

- monitoring of energy efficiency and CO_2 emissions in New Member States, utilising aggregated indicators;
- comparison between NMS and EU-15 on energy efficiency indicators;
- evaluation of the measures conducting by EU countries aiming at energy efficiency improvement.

The results expected from the project are the following:

- Assessment and analysis of the energy efficiency improvement and CO_2 abatement (energy related) at the EU-25 level and for each of the New Member States and Bulgaria over the last 10 years through updated and harmonized indicators;
- Comparison of the relative energy efficiency performance of each New EU Member country through adjusted indicators with the EU-15 and EU-25 average and positioning of New EU countries in comparison to benchmark values. These comparisons will be made on indicators that are adjusted from the quantifiable differences among countries:

[2] Agence de l'Environement et de la Maitrise de l'Energie

in the climate, in the cost of living (use of purchasing power parities) and in the economic and industry structures;

- Presentation in graphs, accompanied by comments, of energy efficiency of countries economy sectors, including trends (relevant website);
- Extension of the ODYSSEE[3] website on energy efficiency indicators and extension of the existing MURE[4] data base on energy efficiency measures.
- Project publications.

The CSO and KAPE tasks comprise of

- Working out the energy efficiency indicators for Polish economy;
- Extension the MURE data base by adding the energy efficiency measures, which are undergoing in Poland;
- Evaluation of energy efficiency trends of Polish economy;
- Report on energy efficiency in Poland;
- Publication on energy efficiency trends and policies on energy efficiency improvement and CO_2 emission reduction in EU-25;
- Publication on energy efficiency policy implementation in Poland;
- Organizing the seminar in Poland.

[3] www.odyssee-indicators.org
[4] d'Utilisation Rationelle de l'Energie, www.mure2.com

3. Energy efficiency indicators for Polish economy and its sectors

Indicators presented below are the result of continuation of works connected with the European Commission program – SAVE II and actual prepared in frames of Intelligent Energy for Europe program. These indicators were calculated using "top-down" method.

3.1. Macro-economic development

In years 1992-2004 private consumption of households was steadily growing. In years 2001-2002 value added of industry decreased (Figure 1), what was partly connected with recession all over Europe. Decrease of value added in other sections and divisions of economy (in constructing, hotels and restaurants, financial intermediation) made GDP growth slower (Figure 2) in these years. This situation did not impact the private consumption of households, which pace of growth was exceeding those of GDP. Since 2003 the upturn of declining trend concerning value added in industry in years 2001-2002 can be observed. Main reason was the growth of production sold of industry by 8,1% in comparison to previous year.

Figure 1. Macro-economic development in Poland: 1992-2004

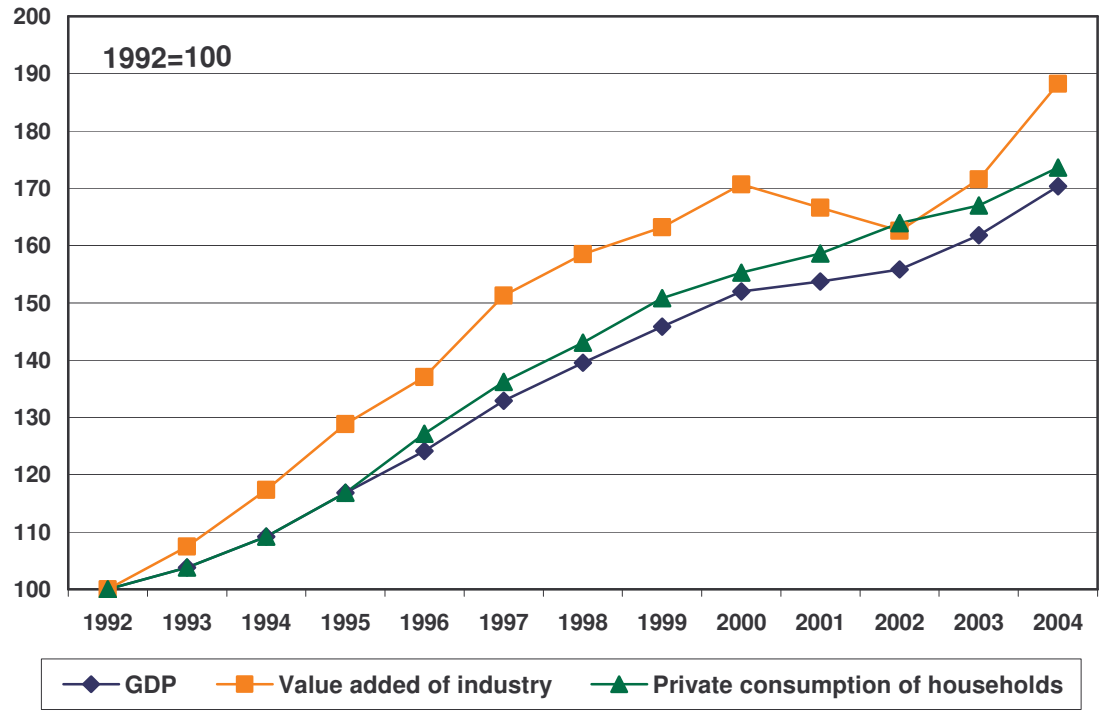
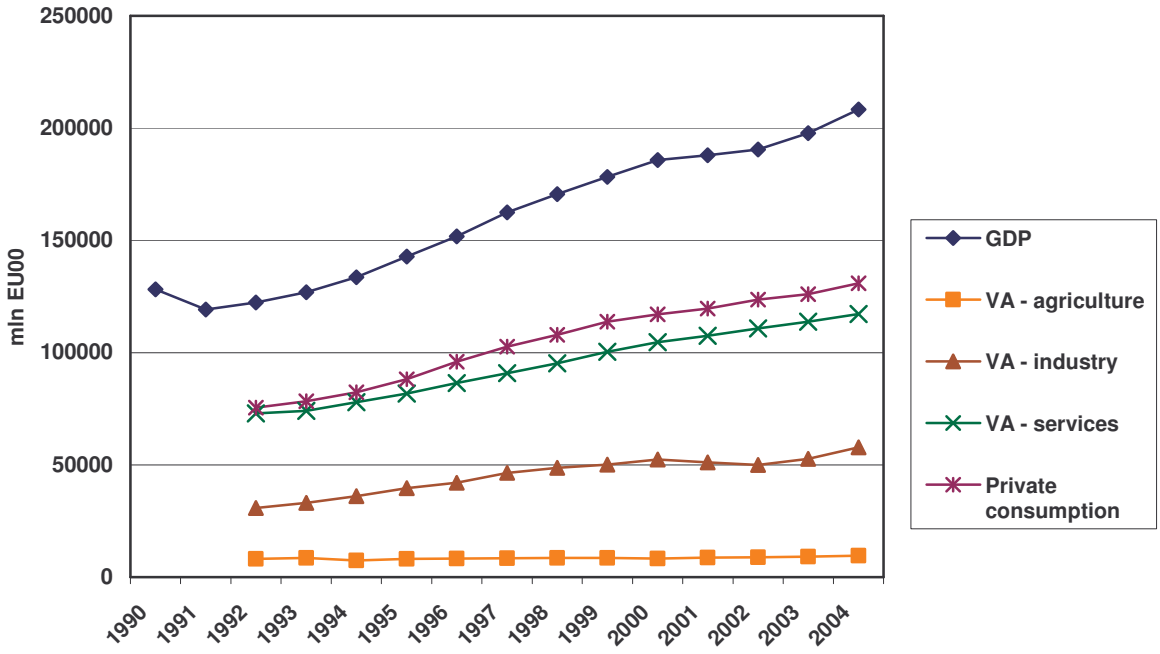


Table 1: Economic and industrial growth in Poland

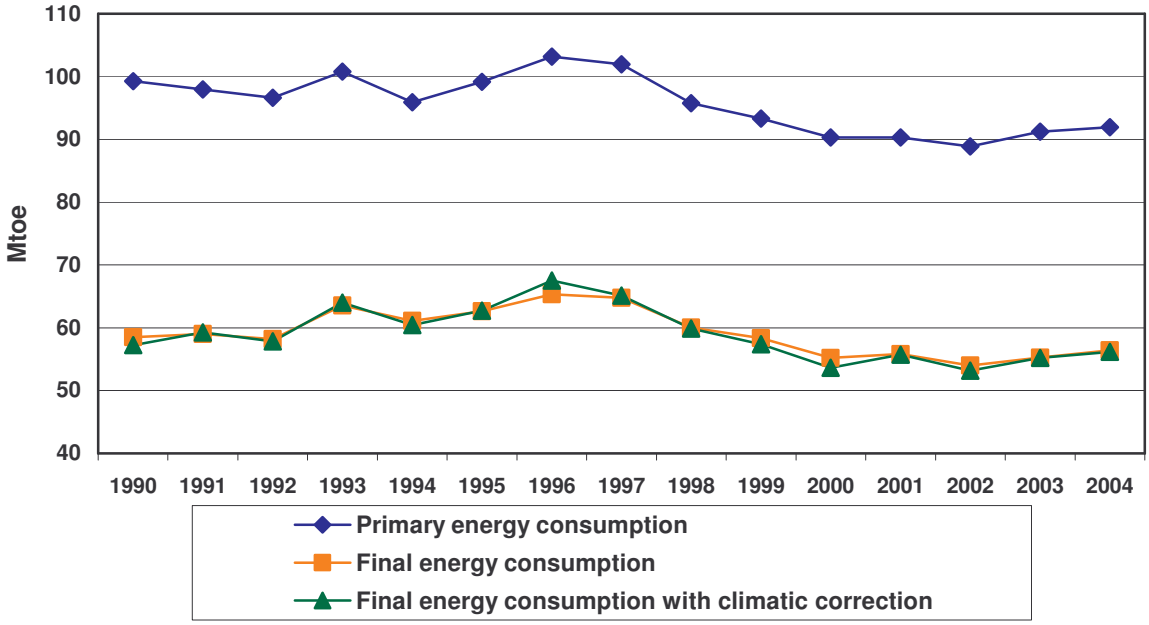
%	1992-2000	2000-2004	1992-2004
GDP	5,08	2,89	4,54
Value added in industry	6,73	2,48	5,41
Private consumption	5,40	2,83	4,70

Figure 2: Macro-economic developments in Poland: 1990-2004 at 2000 Euro



After growth in first half of the 90's and reaching top in 1996, total primary and final energy consumption have got decreasing trend between 1996-2002, then slightly rose in 2003 and 2004 (Figure 3).

Figure 3: Total primary and final energy consumption



Function of final energy consumption is slightly modified by climatic correction which increases its value for winters characterized by lower degree days value (warmer). Climatic correction concerns households and service sector. Energy consumption with climatic correction describes its theoretical value for a given year, if the weather conditions were similar to long-term average.

Final energy consumption with climatic correction is counted by deducting from final energy consumption the energy consumption in households and service sector and adding energy consumption in these sectors with climatic correction. The same methodology of energy consumption in households and service sector was used in chapter 3.4.

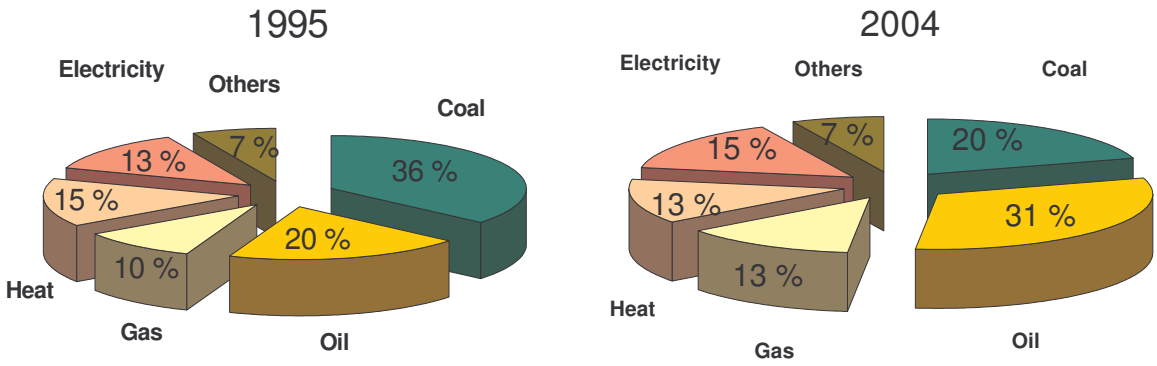
Decrease of energy consumption results from realization of modernization programs, restructuring of economy and seasonally lower economical activity. Programs of energy efficiency improvement and liberalization of energy prices also had their share.

3.2 Consumption and prices of energy

In the energy field, Poland has traditionally been a supply-oriented country with important hard coal and lignite sector. However, the share of coal in country energy consumption had decreased systematically from 36% in 1995 to 20% in 2004 (Figure 4). Comparison of final energy consumption by energy carriers between 1995 and 2004 shows the increase role of oil fuels which became dominant in the balance with the share of 31% in 2004. Gas consumption

slightly rose and reached 13% of energy consumed in 2004. Similarly, consumption of electricity increased during this period and amounted to 15% in 2004.

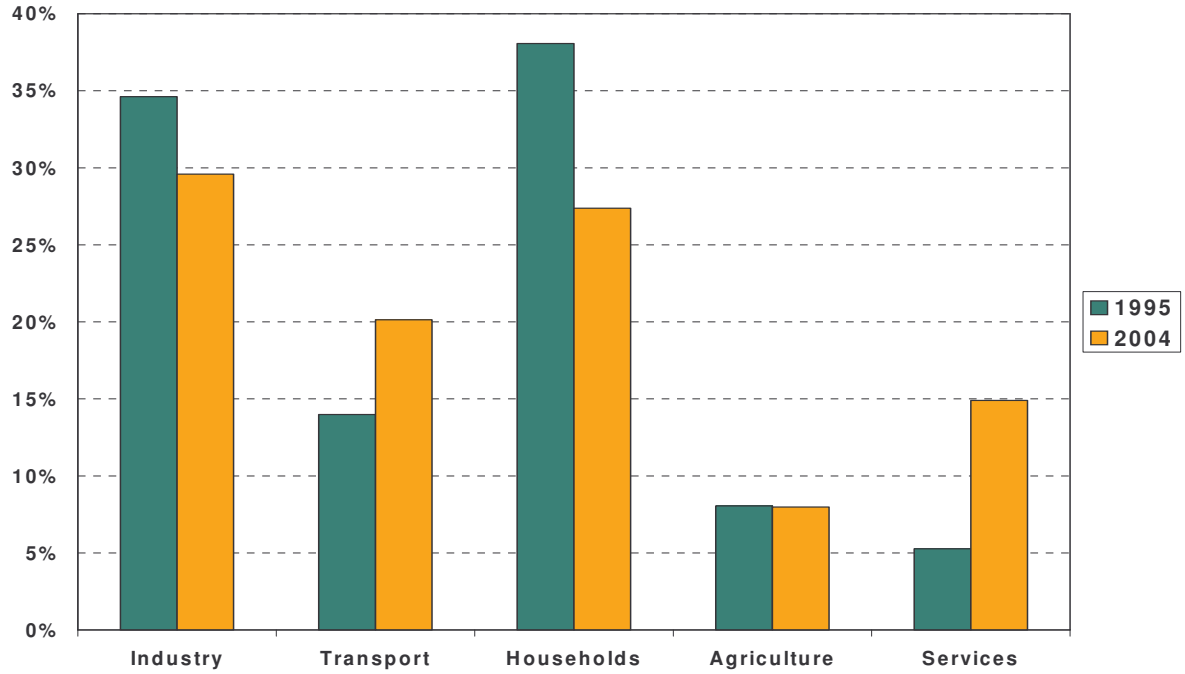
Figure 4: Final energy consumption by energy carrier in Poland



The final energy consumption by sectors (Figure 5) reflects the changes and trends in national economy. Restructuring of industry affected the energy consumption reduction, which was also accompanied by energy saving measures in companies. The development of road transport and services influenced the increase of energy consumption of these sectors. The households experienced the activities as thermo-modernization, improving efficiencies of heating systems and totally obtained almost 28% reduction of its energy consumption during 1995-2004, what pushed this sector into second place among biggest energy consuming sectors.

Changes in agriculture sector, consisting in privatization of state-owned agriculture holdings, and building modern farms, did not contribute to save energy, which consumption stays on stable level.

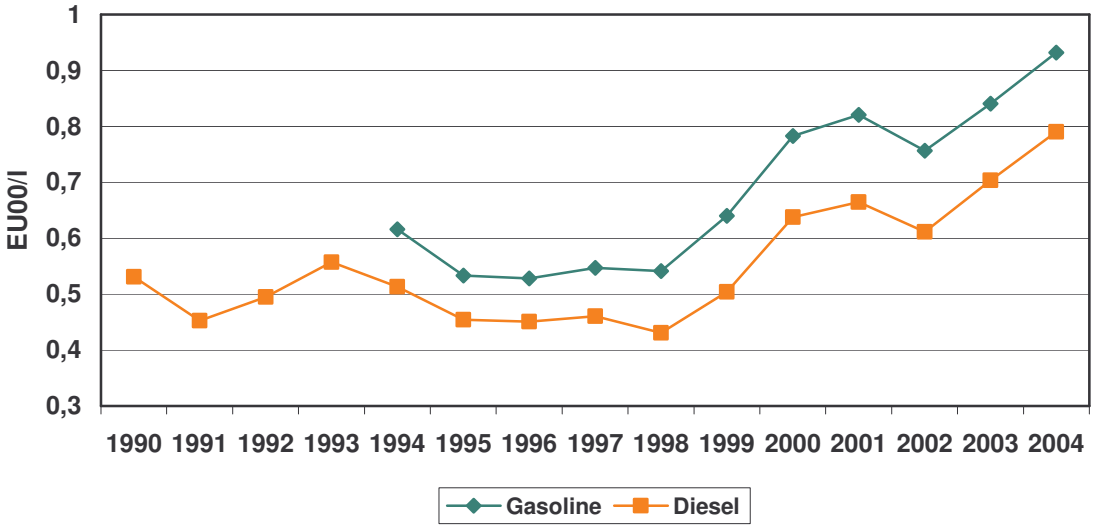
Figure 5: Final energy consumption by sector in Poland



Year 2004 brought additional growth of crude oil prices.

Prices of gasoline and diesel reflect tendencies observed on the oil market. They sharply grew in 2003 and 2004 (at constant Euro 2000) joining the rising trend started in 1999 (Figure 6).

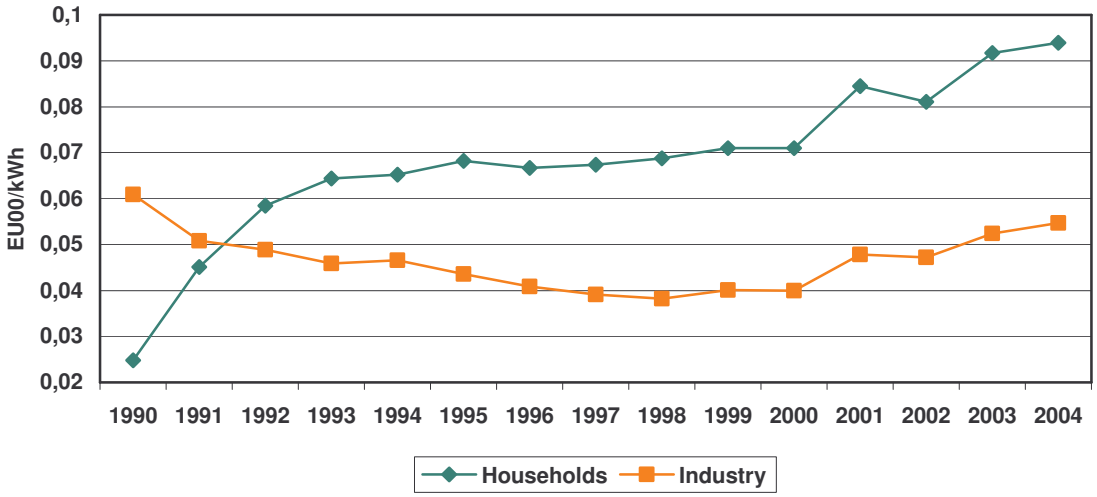
Figure 6: Gasoline and diesel prices



Poland has completed the difficult task of cross subsidies in the electricity sector elimination, which has been achieved by increasing the tariff for household from 0,0248 in 1990 up to 0,0664 in 1993: 160% of growth. And also for next years the price of household electricity has been increasing slowly up to 1999 and more sharp growth again is observed for 2001.

Electricity for industry faced opposite trends during the years 1990-2000 decreasing of –4,12%/year. The increase occurred in 2001: growth of 19,5% in 2001 compared to 2000. In 2002 price remained stable to grow by 11% in 2003 and 4,4% in 2004.

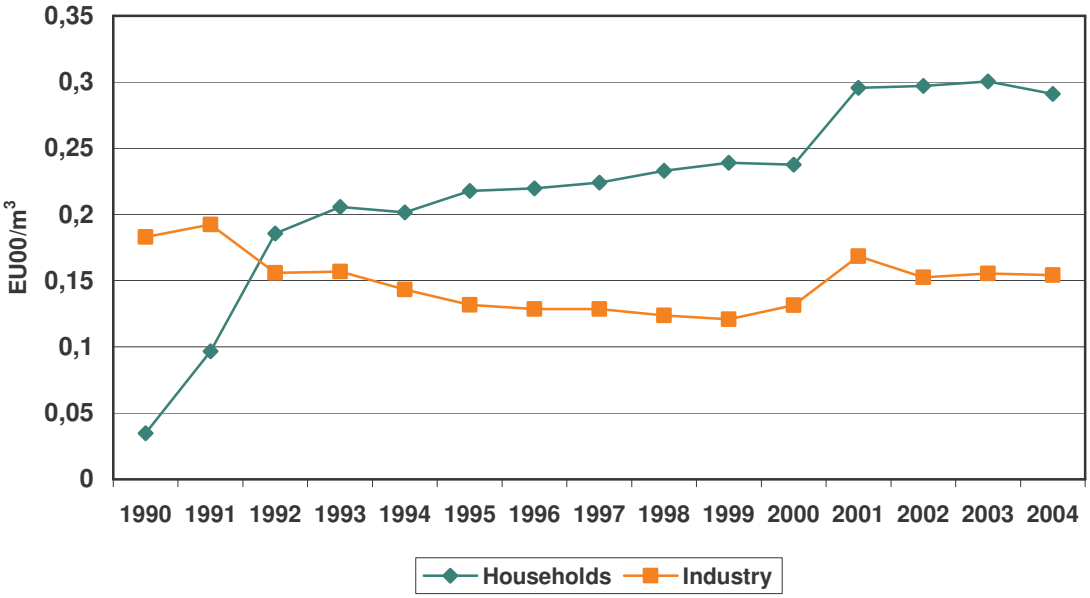
Figure 7: Electricity prices for households and industry



The prices of gas reflected the tendencies observed for electricity prices with the elimination of cross-subsidies at the beginning of nineties except the price growth for industry in 2000 and 2001. In case of gas prices the growth for households was much sharper from 0,0349 in 1990 up to 0,2058 in 1993: 490% of growth at constant Euro 2000 (see in Figure 8). Up to year 2000 price was steadily growing, in 2001 it jumped.

In years 1990-1999 gas price for industry declined systematically, then it jumped similar to gas price for households. Since 2002 these prices have slowly increased.

Figure 8: Gas prices for households and industry



Figures 9, 10, 11 present tendencies of indicators changes in years 1990-2004:

- Figure 9: Primary and final energy intensities
- Figure 10: Final energy intensity: actual, with climatic correction
- Figure 11: Ratio final/primary energy intensities

Indicators concerning energy consumption with climatic correction are calculated according to EUROSTAT and IEA methodology. Climatic correction aims to eliminate influence of different weather conditions in different years on energy consumption and related energy efficiency indicators.

Figure 9: Primary and final energy intensities

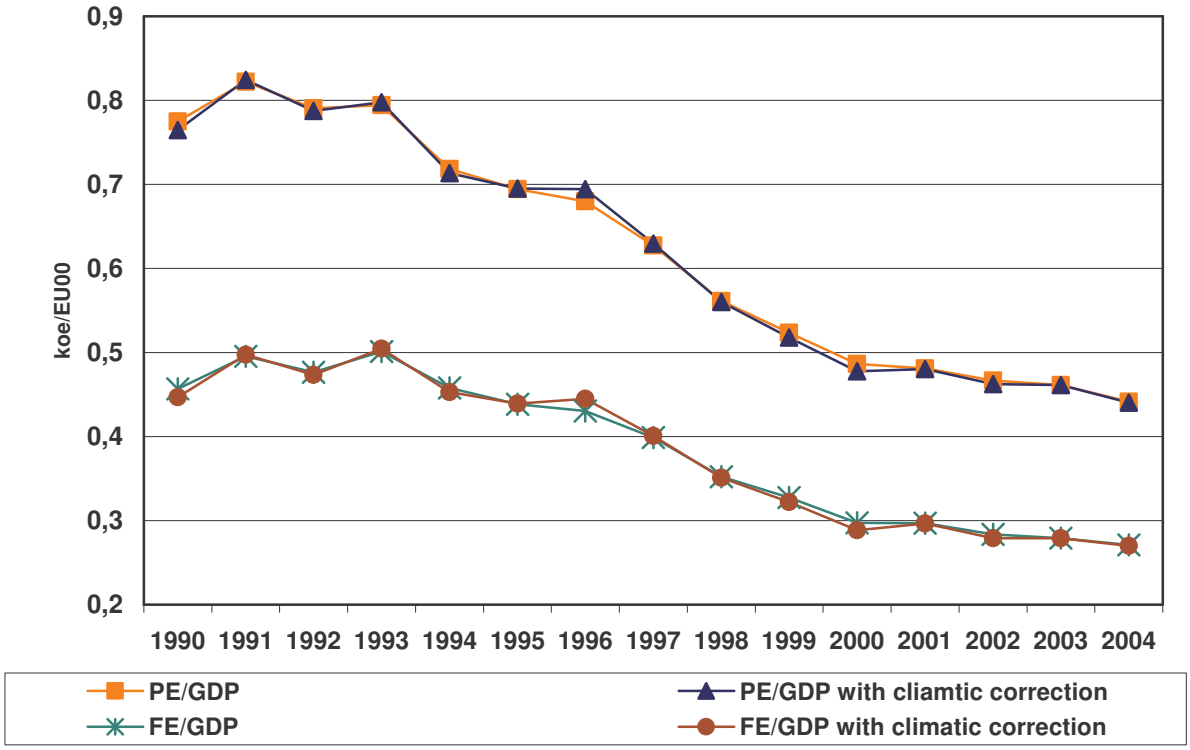


Figure 10: Final energy intensity: actual, with climatic correction

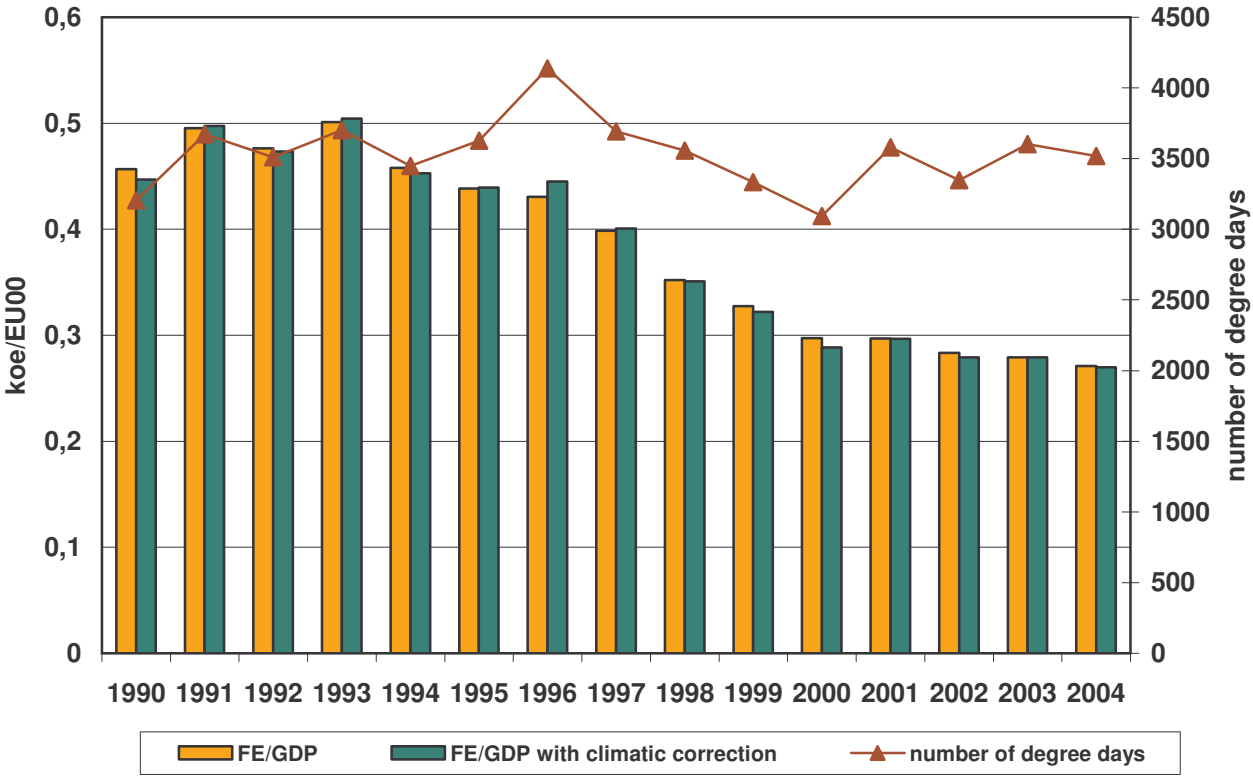
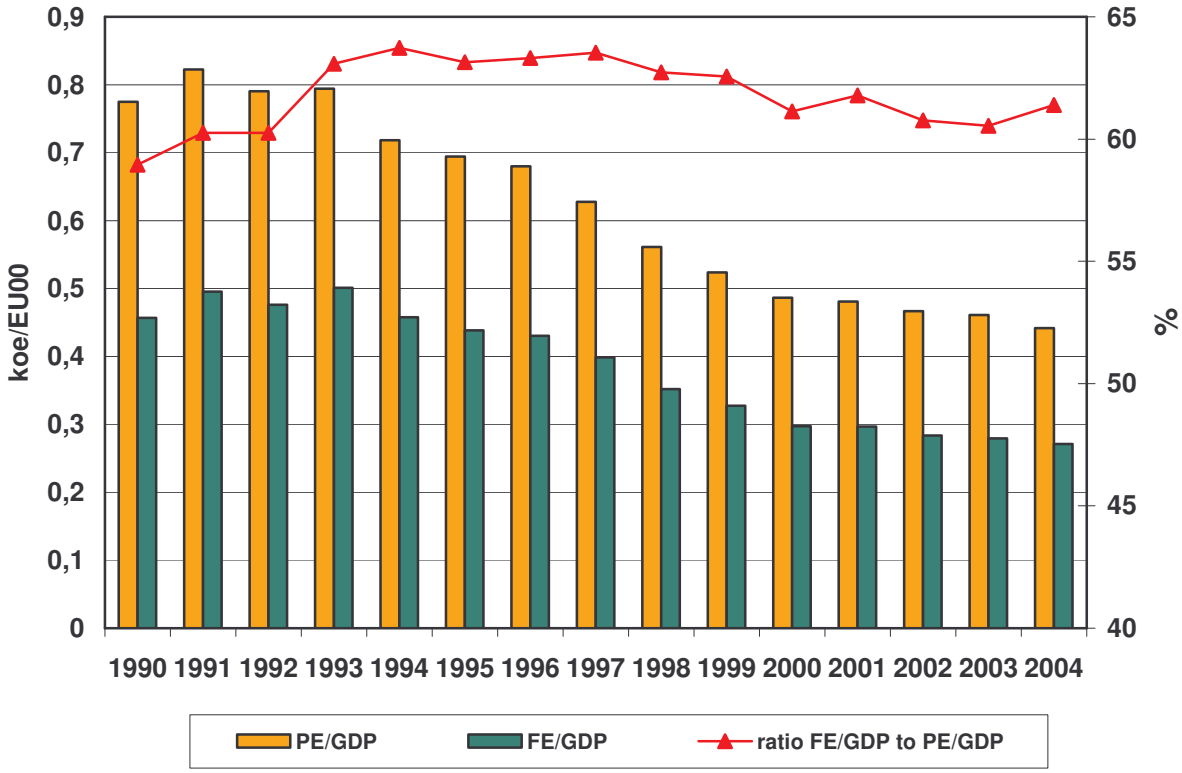


Figure 11: Ratio final/primary energy intensities



It is necessary to bear in mind the specific situation before 1990s in the former Eastern Block countries, including Poland. In those countries of the central planning, energy prices were very low, which resulted in energy wastage reaching in extreme cases even 60 to 70% of the energy consumed. This caused a habit of excessive energy consumption, which is very difficult to overcome but creates the possibilities to utilise this potential.

In the period of 1990-2004 primary and final energy intensity tended to decrease. It resulted from both energy consumption decline and rising GDP. Data on variations in primary and final energy intensities are presented in table 2.

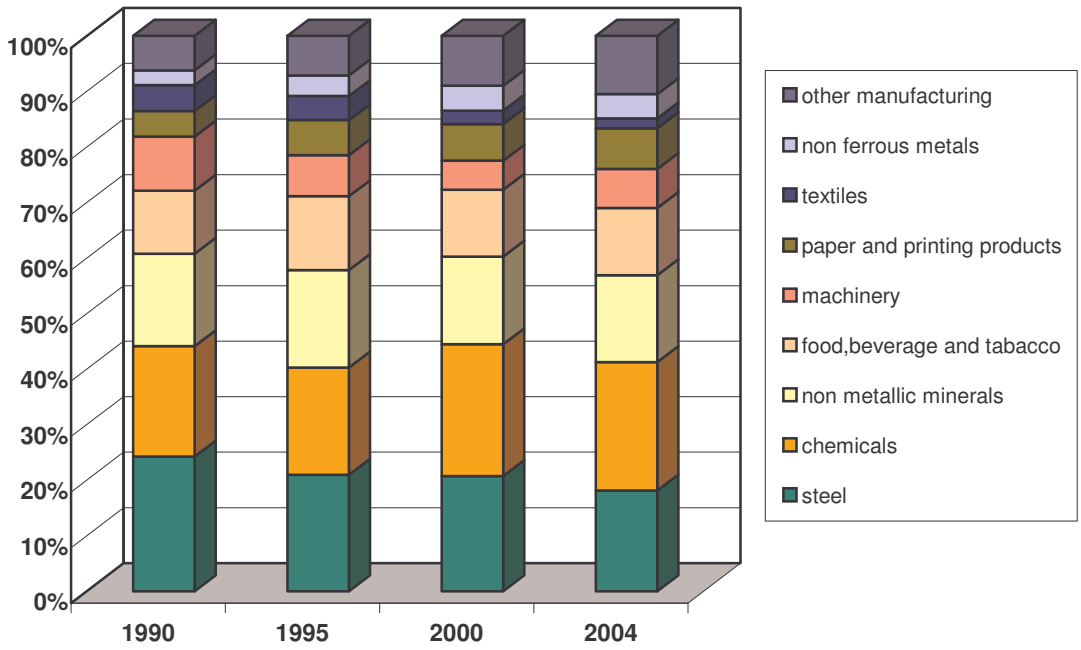
Table 2: Variations in primary and final energy intensities (%/year)

%/year	1990-1993	1993-1996	1996-2004	1993-2004	1990-2004
Final energy intensity of GDP	3,14	-4,94	-5,61	-5,43	-3,66
Primary energy intensity of GDP	0,84	-5,06	-5,25	-5,20	-3,94

3.3. Industry

Energy consumption of manufacturing by branch presents Figure 12. More than 60% of energy is consumed by following industrial branches: primary metals; chemicals; non metallic minerals. Consumption of energy by sectors of textiles, minerals, machinery and equipment slightly declines. Significant drop of energy consumed was observed in case of steel industry. The drops are caused mainly by limiting production (steel, sulphur), and not by modernization of enterprises. There occurred significant jump of shares of other industry divisions (optical industry, computers, etc.) and food. Structural changes are rather slight and do not exceed few percentage points.

Figure 12: Energy consumption of manufacturing by branch



Figures 13 and 14 present energy intensity of selected industrial branches in years 1993-2004.

Figure 13: Energy intensities of energy intensive manufacturing branches

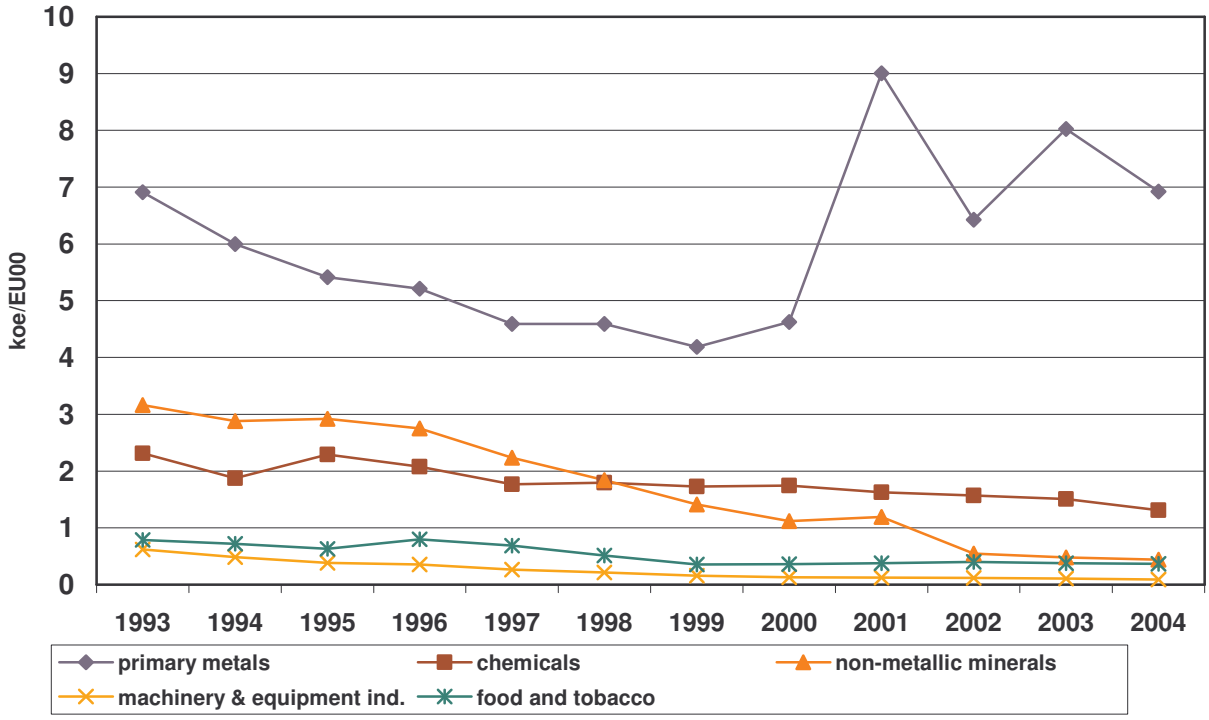


Figure 14: Energy intensities of non energy intensive manufacturing branches

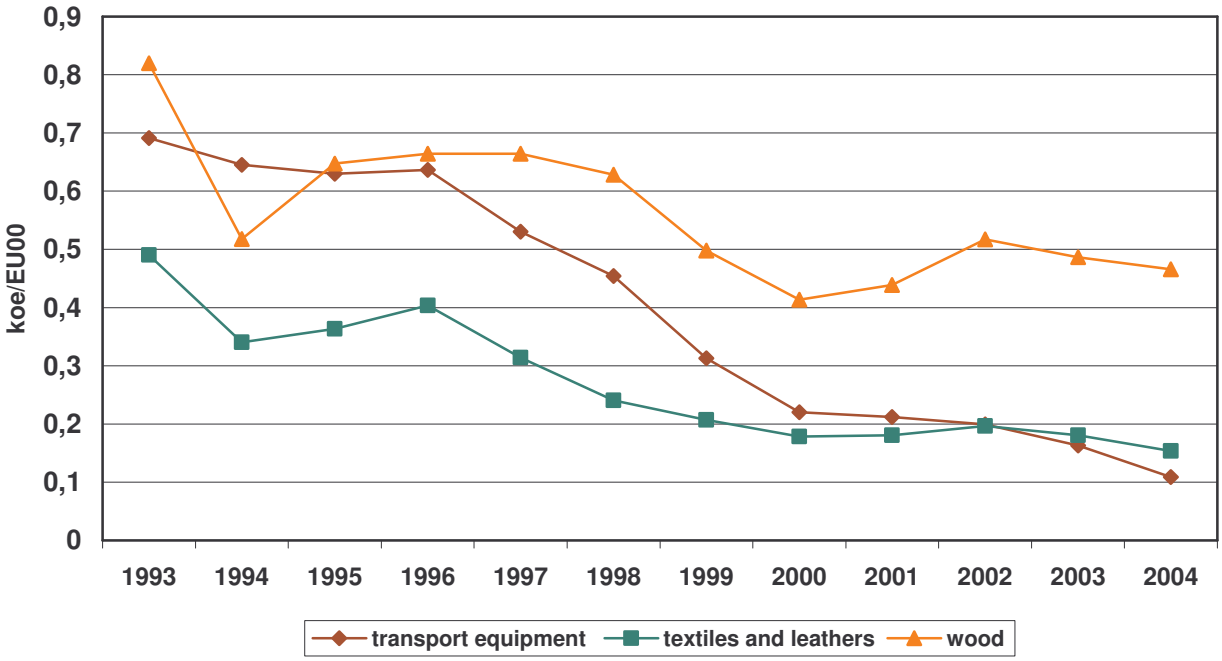


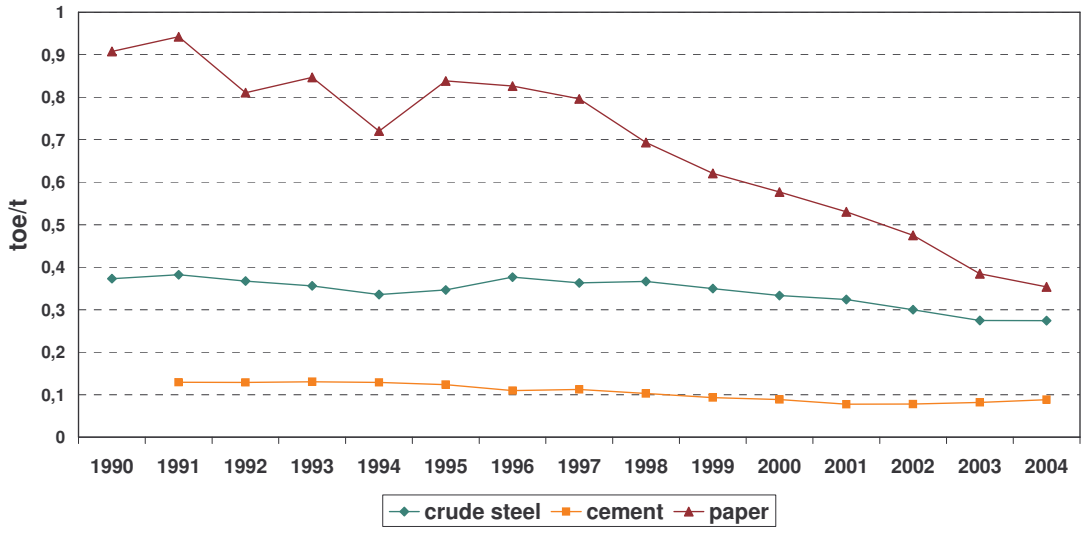
Table 3. Dynamics of energy intensity

%/year	2004/1994 [%]	Dynamics [%/year]
Industry	52,61	-6,22
Manufacturing	41,24	-8,48
Chemicals	70,07	-3,49
Minerals	15,30	-17,12
Machinery and equipment	18,03	-15,74
Food and tobacco	50,72	-6,56
Paper and printing	56,19	-5,60
Textiles and leathers	45,24	-7,63

In most cases improvement of intensity indicator can be observed, however the pace of changes is different. It is connected, among others, with new investment, which results from stable activity conditions of enterprises.

Figure 15 presents energy intensity of steel, cement and paper production in years 1990-2004. Energy intensity of cement production declines systematically. Old-fashioned wet method of production was stopped that resulted in achieving almost EU average result of 0,09 toe/t in 2004. Little decline of energy intensity of steel production results from delays in privatization process and modern technologies implementing. Paper industry was thoroughly modernized after privatization, what resulted in further decrease of intensity to level of 0,35 toe/t in 2004. In years 1990-2004 energy intensity of crude steel production declined by 27,03% (2,23%/year), paper by 61,54% (6,60%/year) and cement by 30,77% (2,79%/year).

Figure 15: Unit consumption trends of energy intensive products



Changes in structure of industry had significant impact on energy intensity changes (Figures 16 and 17): the lowest in years 1993-1996 and the highest in years 2000-2004. Structural changes decreased energy intensity of manufacturing by 2,67%/year.

Methodology of taking structural changes of manufacturing into account to calculate its energy intensity is as follows:

energy intensity of manufacturing in year "k" at constant structure of 2000 („E^{k}_{2000}") is counted as follows:

$$E^{k}_{2000}=\sum_{i}^{n} E^{k}_{i}*VA_{i}^{2000}/VA^{2000}, \text{ where:}$$

E – intensity, VA – value added, i – industry division, k – year, n- amount of divisions of manufacturing.

Table 4: Variations of the energy intensity of manufacturing

%/year	1993-1996	1996-2000	2000-2004	1993-2004
Intensity (1)	-5,87	-13,07	-7,00	-8,95
Intensity at constant structure (2)	-5,44	-12,19	-0,64	-6,28
Impact of structural changes (1)-(2)	-0,42	-0,88	-6,35	-2,67

Figure 16: Energy intensity variation of manufacturing: role of structural changes

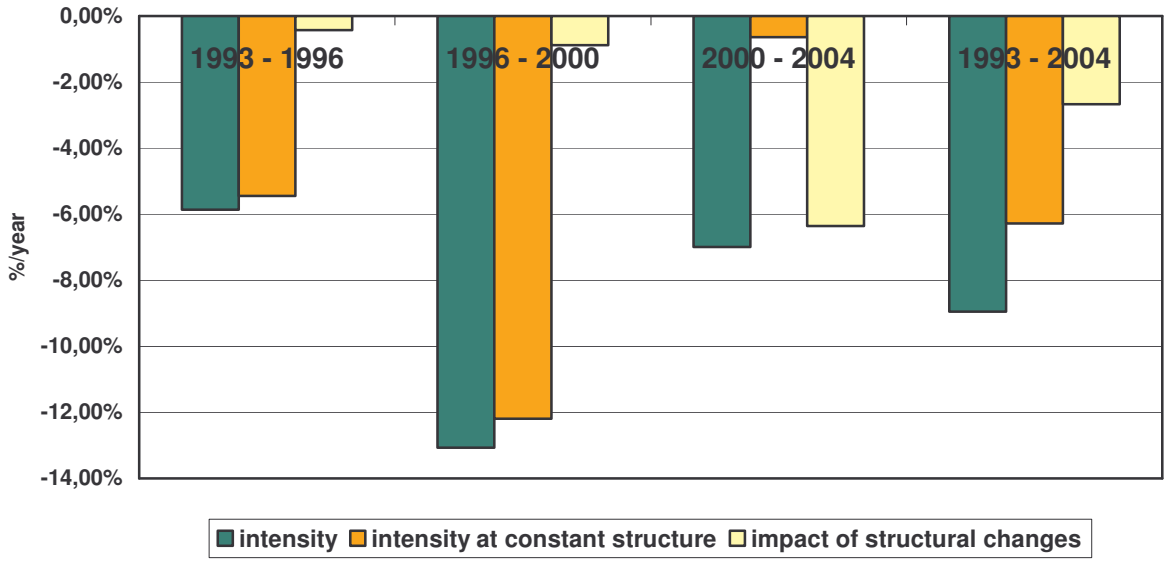
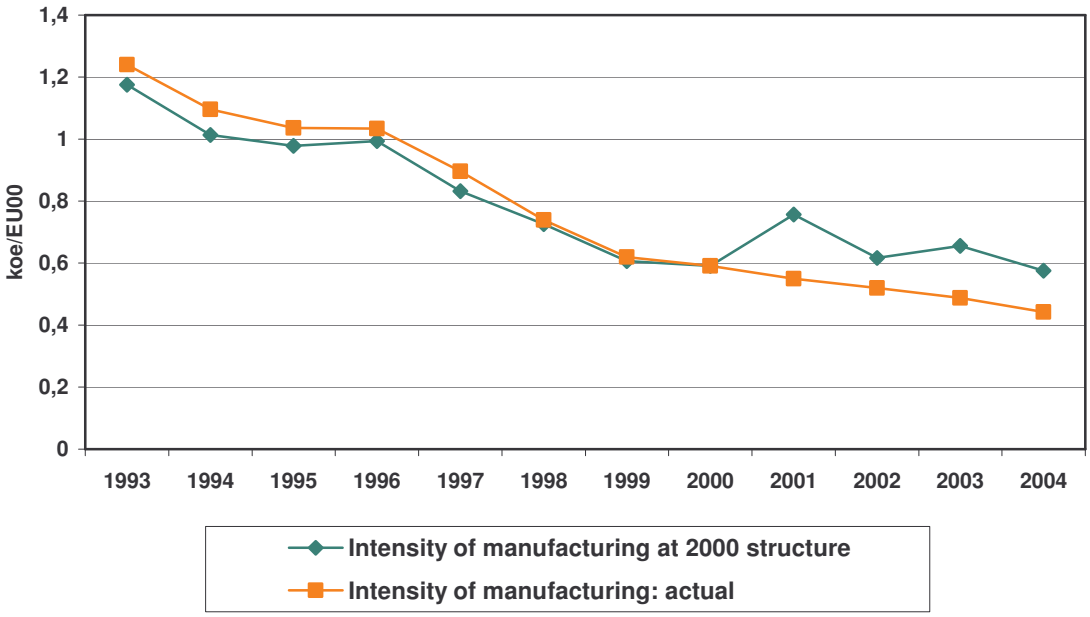


Figure 17: Energy intensity of manufacturing



3.4. Households

Share of energy consumption in households in final energy consumption amounts to 32-33% and tends to grow. The structure of consumption surveyed by CSO in 1993 and 2002 presents Figure 18 and Table 5. Decreasing share of cooking results from replacing coal with gas and electric ovens. Growth of consumption by electrical appliances is connected with richer equipment of households and behaviour changes.

Figure 18. Structure of energy consumption in households

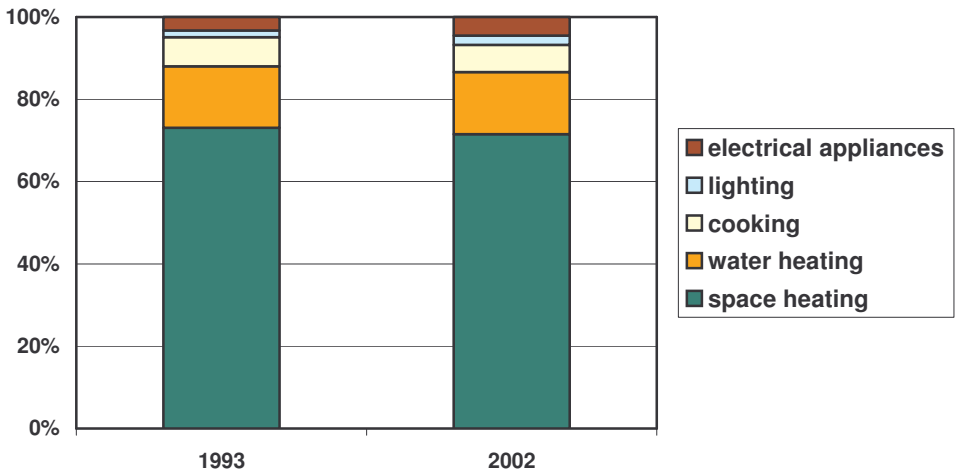
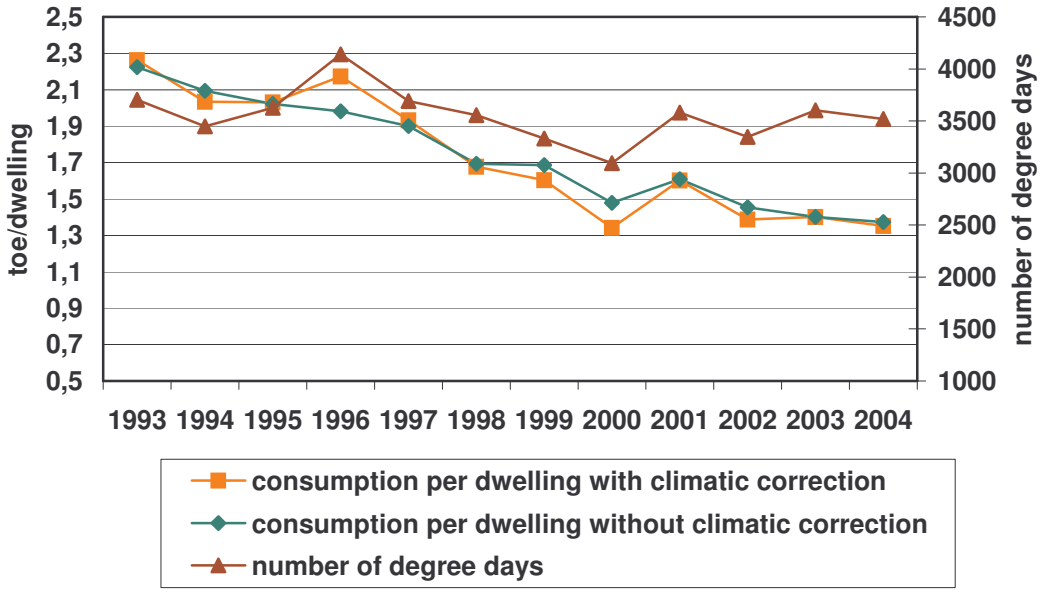


Table 5. Structure of energy consumption in households

%	1993	2002
Total	100,0	100,0
Space heating	73,1	71,2
Water heating	14,9	15,1
Cooking	7,1	6,6
Lighting	1,6	2,3
Electrical appliances	3,3	4,5

Figure 19 presents changes of energy consumption per dwelling. The value of indicator with climatic correction decreases by 3,89% annually. It is connected with buildings thermo-modernization, reduction of losses in central heating nets, improvement of efficiency of newly installed devices.

Figure 19: Unit consumption per dwelling with climatic corrections



The method for the climatic correction of final energy consumption 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.

Heating Degree Days express the severity of the cold in a specific time period taking into consideration outdoor temperature and room temperature. To establish a common and comparable basis, Eurostat proposes the use of the following method for calculation of heating degree days:

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

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 the days per year. Accordingly the Eurostat assumption, the mean temperature of the heating day should be less than 15^{o}C.

The values of heating degree days (*SD*) for 1990-2004 and long-term average are presented in the table below.

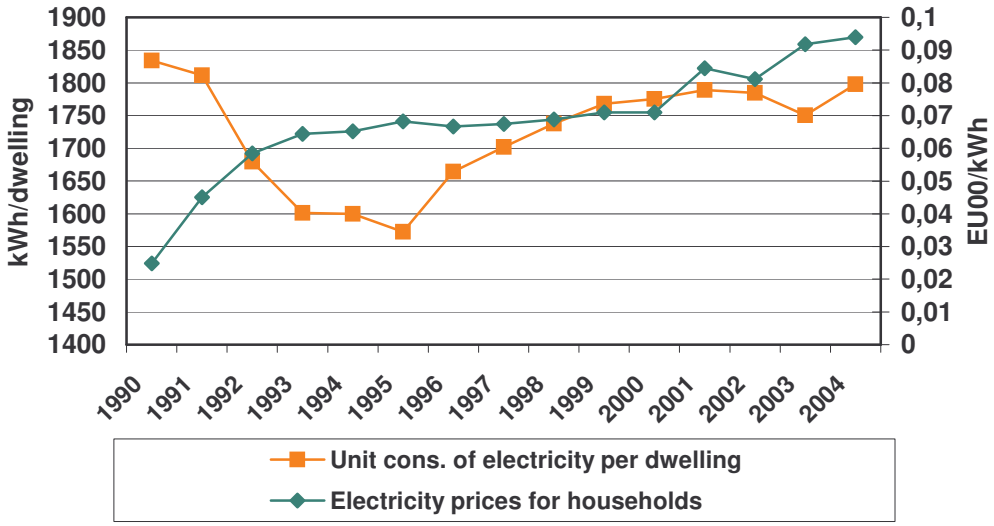
Tabl.6. Heating degree days for 1990-2004

SD	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Actual *SD*	3204	3673	3509	3703	3448	3627	4139	3693	3556	3332	3094	3580	3347	3602	3518
Long-term average *SD*	3605	3605	3605	3605	3605	3605	3605	3605	3605	3605	3605	3605	3605	3605	3605

Energy prices for households

In 2002 electricity prices for households at constant Euro 2000 decreased, but in 2003 they significantly surged (Figure 18), trend of light growth remained in 2004. Change of prices during last period is connected with introducing excise for electricity. New fare is in force from the beginning of second quarter of 2002. The impact of excise for unit consumption is also seen, new tax caused fall of consumption until 2004, when trend returned to growth.

Figure 20: Unit consumption and price of electricity



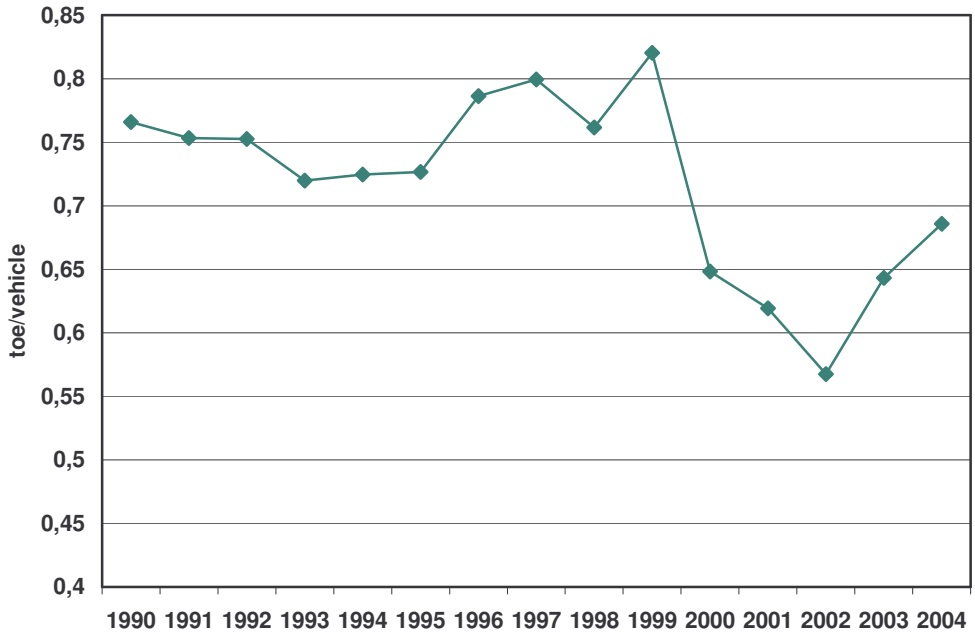
3.5. Transport

In Poland about 89% of energy consumed in transport consumes road transport, 5% rail transport, another 5% airplanes and the rest is consumed by inland water transport.

In years 1990-2004 steady growth of consumption in road transport (2,5% annually) is observed, accompanied by significant drop of energy consumption by rail transport.

Figure 21 presents unit consumption of fuels by vehicle. The indicator is influenced mainly by overall economical situation and increasing efficiency of new cars.

Figure 21: Unit consumption by vehicle



3.6. Services sector

In 2004 unit consumption of energy per 1 employee in service sector slightly decreased. Similar dynamics showed indicator of unit electricity consumption per employee.

Energy intensity of service sector slowly but systematically grew between 1994 and 2003, in 2004 energy intensity declined.

In case of changes of unit consumption of energy and electricity, similar trends can be observed: fall of the indicator till mid 90's (in 1994 minimum in case of energy, in 1997 in case of electricity) and then slight growth till 2003, what results from development of the sector and introducing more technologies causing higher consumption of energy, electricity in particular.

Figure 22: Energy intensity of services sector

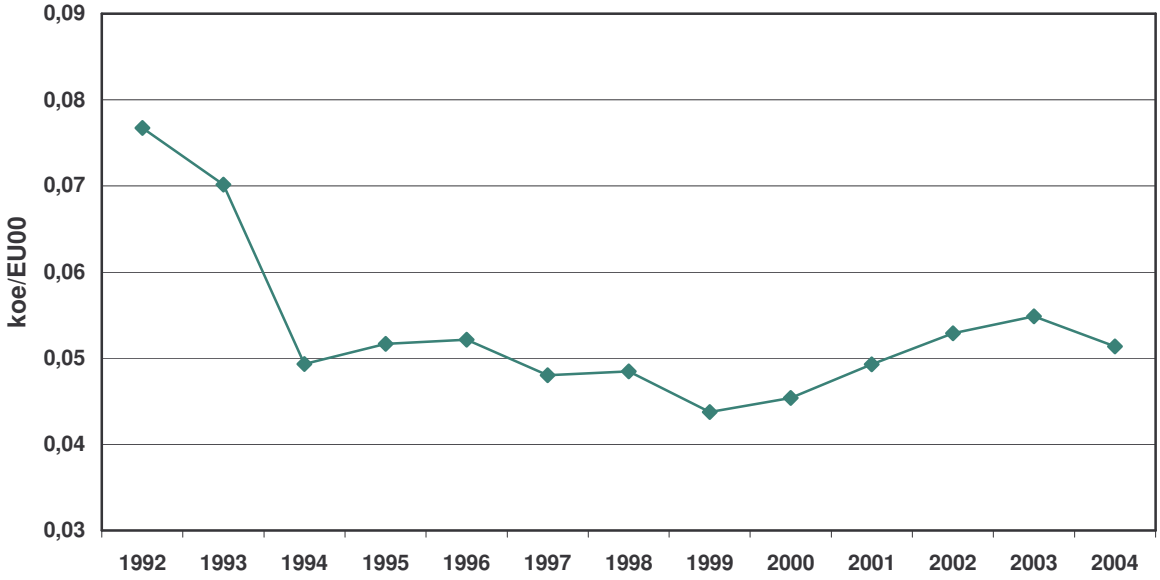


Figure 23: Electricity intensity of services sector

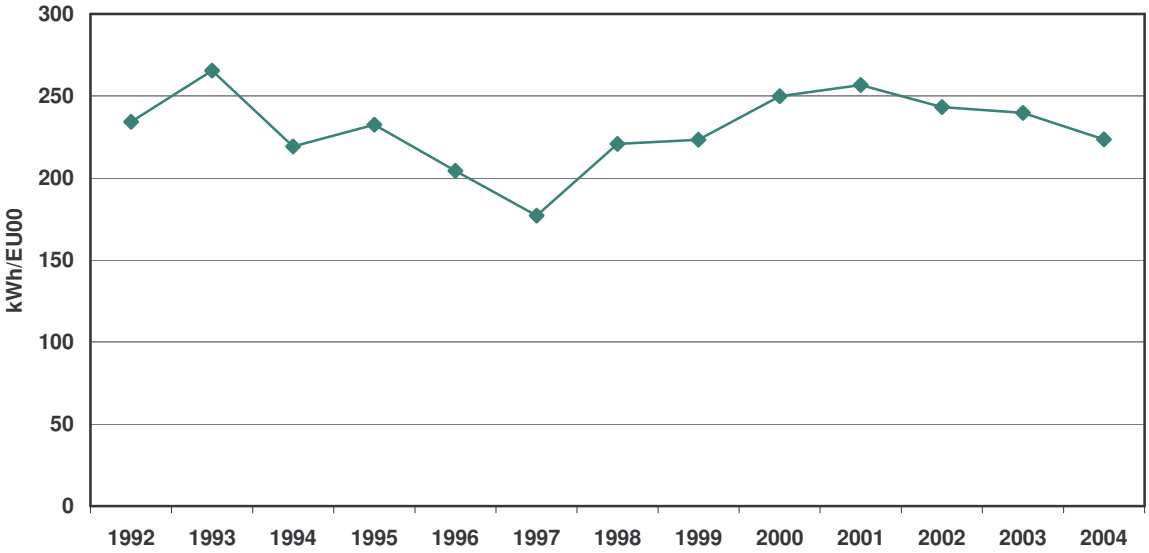


Figure 24: Unit consumption of services sector per employee

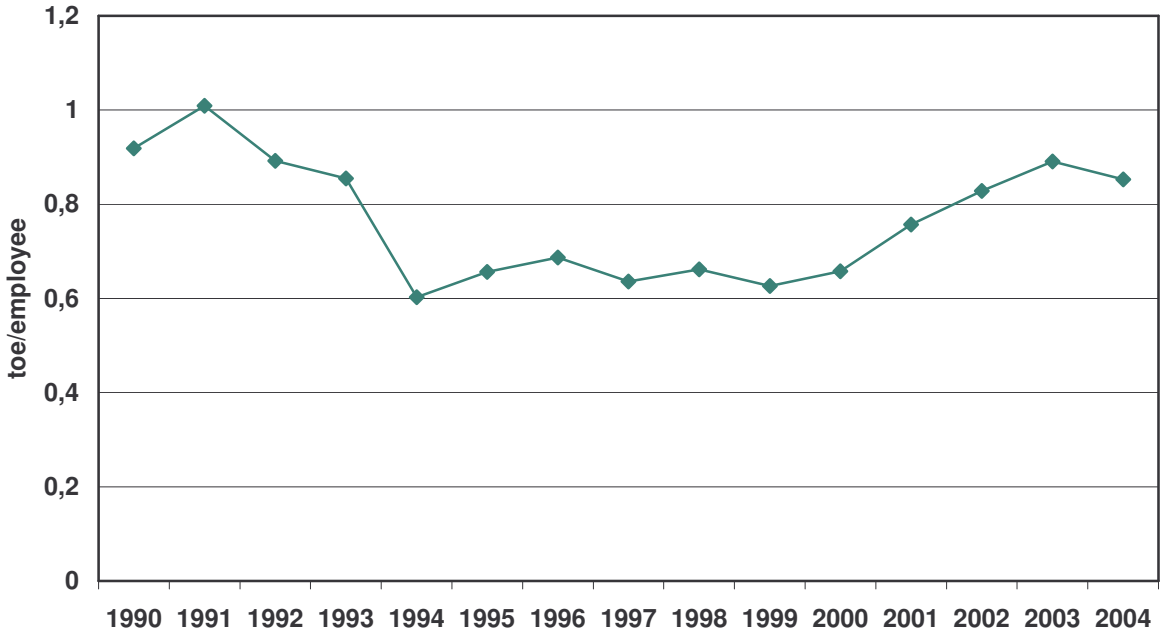
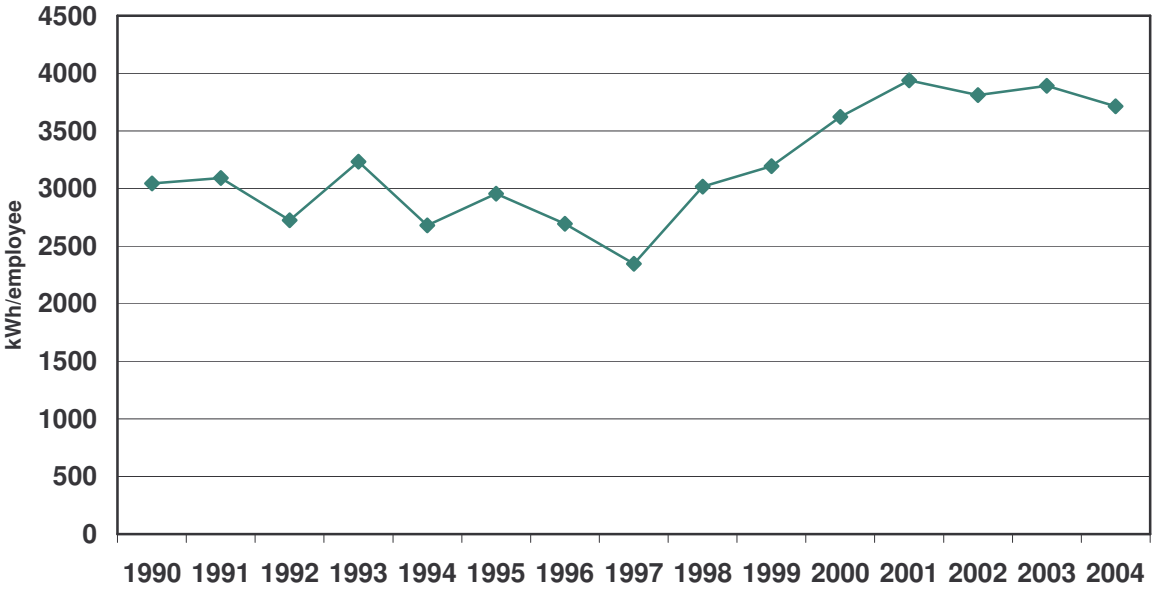


Figure 25: Unit consumption of electricity of services sector per employee



3.7. Transformation

Figures 26 and 27 present changes of efficiency of thermal plants and combined heat and power plants. In 2004, similar to previous two years a decline of efficiency was observed. In CHP after 3 years of growth, indicators fall in 2004.

Earlier, in effect of modernization the growth of efficiency of thermal plants (years 1992-2001) and CHP (years 1995-2003 without 1999-2000) can be observed.

Figure 26: Energy efficiency of district heating

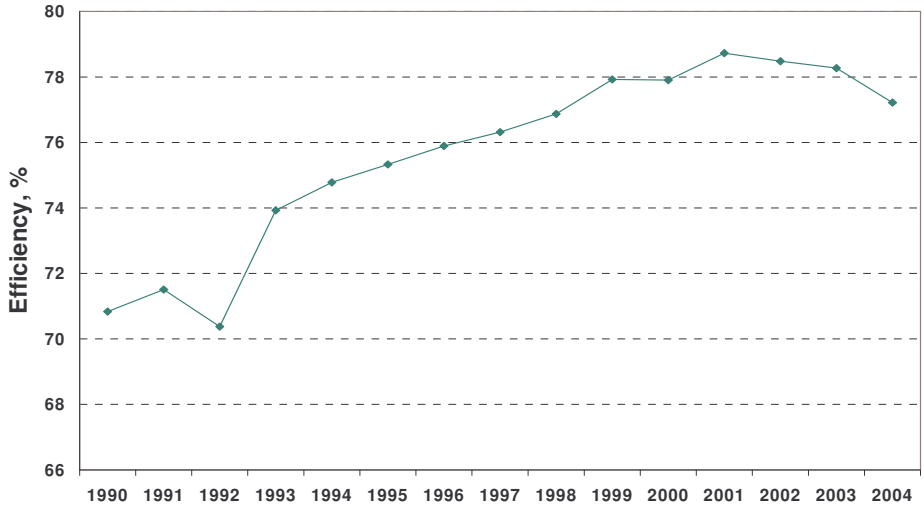
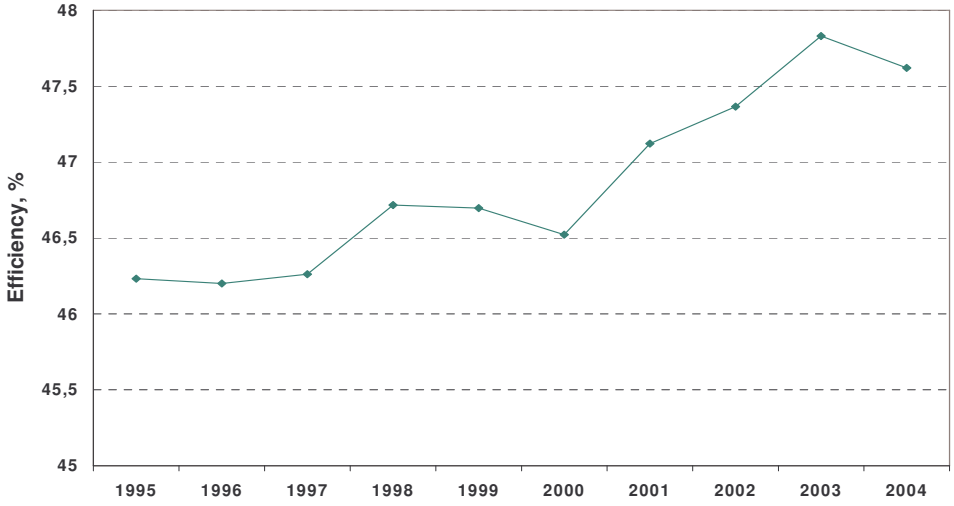


Figure 27: Energy efficiency of cogeneration



4. Conclusions

New policy of the EU, expressed through new directives, especially directive on energy end-use efficiency and energy services, obliges to monitor energy efficiency. According to the articles energy savings should be counted as decrease of energy consumption as a result of realization of investments or modernizations.

At the present, statistical data obtained in frames of public statistics statistical surveys, do not allow to calculate all proposed in the directive indicators.

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 enlarge subject and object scope of surveys, as well as to supplement administrative data bases.

Works carried in the European Union and Poland on further harmonization in scope of energy efficiency indicators, prepare necessary tool to asses realization of sustainable development policy and sustainable energy policy with energy and environment protection taken into account.

5. List of figures

6. List of tables

7. List of energy efficiency indicators

The presented below priority list of indicators were selected by EUROSTAT from the 250 indicators, which had been worked out by SAVE I programme. These priority indicators enable coherent and complete presentation of the achievements in the field of energy efficiency and enable the overall evaluation of energy efficiency measures.

The indicators can be gathered in 3 groups:

- Headline indicators that mainly describe overall energy efficiency trends, from a macro-economic point of view, and are calculated from usual official economic and energy statistics, as a direct ratio between energy consumption and a macro-economic variable.
- Issue indicators, that go into more details and aims at explaining trends observed for the headline indicators.
- Comparison indicators that go into more details adjusted for structural differences between countries to enable more accurate cross-country comparisons. The reference level, necessary for calculations, could be arbitrary set although average EU is commonly adopted.

7.1. Macro energy efficiency indicators

Macro indicators are being used for energy efficiency overall evaluation of EU countries economies. They are calculated as a ratio between primary or final energy and Gross Domestic Product (GDP). GDP is provided in constant Euros of 2000. In case of comparison indicators the Purchase Power Parity (ppp) is used.

List of macro indicators	Unit
• Headlines indicators	
Primary energy intensity	koe/€2000
Final energy intensity	koe/€2000
Primary& final energy intensity with climatic corrections	koe/€2000
Ratio final/primary intensity	%
• Issue indicators	
Final energy intensity at constant GDP structure (with climatic corrections)	koe/€2000
• Comparison indicators	
Primary & final energy intensity at current purchasing power parities (ppp)	koe/€ppp

Primary energy intensity by sector at ppp	koe/€ppp
Final energy intensity at reference climate (EU average) at ppp	koe/€ppp
Final energy intensity at reference economic structure at ppp	koe/€ppp
Final energy intensity at reference economic structure and climate at ppp	koe/€ppp

Data required for calculation of indicators as above is being collected as the following:

- Energy consumption is being possessed from the Questionnaires: G-02a, G-02b, G-03 and from other surveys, as well as from: administrative databases of Energy Regulatory Authority; Energy Market Agency; international goods trade system; internal information system of Agency for Industrial Development; Polish Oil Company, Polish Chamber of Liquid Fuels; licensed operators and distributors of liquid and gas fuels, electricity and heat.
- Data for GDP calculation is being obtained from: reports: SP, SP-3, F-01/I-01, F-01/k, F-01/m, F-01/s, F-02, F-03, H-01s, H-01a, H-01g, R-05, R-06, R-07, R-08, R-09, R-10, SG-01, DG-1; agricultural census; SAD system; INTRASTAT system – in the scope of goods export and import; information of Ministry of Finance (questionnaires Rb); Ministry of Health (Mz-03), Agricultural Market Agency; Material Reserves Agency; National Bank of Poland.

7.2. Energy efficiency indicators for industry

List of indicators for industry	**Unit**
• Headlines indicators	
Energy intensity of industry	koe/€2000
Energy intensity of manufacturing	koe/€2000
Energy intensity of primary metals	koe/€2000
Energy intensity of chemicals	koe/€2000
Energy intensity of non-metallic minerals	koe/€2000
Energy intensity of machinery & equipment ind.	koe/€2000
Energy intensity of food and tobacco	koe/€2000
Energy intensity of paper, pulp and printing	koe/€2000
Energy intensity of textiles and leathers	koe/€2000
Unit consumption of steel	toe/t
Unit consumption of cement	toe/t
Unit consumption of paper	toe/t
Unit consumption of glass	toe/t
• Issue indicators	
Energy intensity of manufacturing at constant structure	koe/€2000

• Comparison indicators	
Energy intensity of industry at reference structure at ppp	koe/€ppp
Energy intensity of manufacturing at reference structure at ppp	koe/€ppp
Unit consumption of steel as a function of share of electric steel	toe/ton

Necessary data in scope of:

- Energy consumption – are being obtained from the same surveys as utilised for macro indicators,
- Sale values – are being obtained from reports: F-01/I-01, DG-1, SP, SP-3 and from information systems of Ministry of Finance (reports Rb-30 and Rb-31),
- Physical production outputs – are being obtained from reports: P-01, P-01m and P-02.

7.3. Energy efficiency indicators for transport

List of indicators for transport	**Unit**
• Headline indicators	
Energy intensity of transport related to GDP	koe/€2000
Unit consumption of gasoline vehicles	toe/vehicle
Unit consumption of rail transport: passenger, goods	koe/tkbr
Unit consumption of air transport	koe/pass
Unit consumption of domestic air transport	koe/pkm
Unit consumption of water transport	koe/tkm
Unit consumption of urban transport	koe/pkm
• Issue indicators	
Unit consumption of road transport per equivalent car	toe/car
Specific consumption of new cars (test values)	l/100km
Specific consumption of cars	l/100km
Unit consumption of cars	toe/car
Unit consumption of cars per passenger-km	koe/pkm
Unit consumption of diesel heavy vehicles	toe/vehicle
Unit consumption of trucks (or trucks and light vehicles)	toe/vehicle
Unit consumption of road transport of goods	koe/tkm
Unit consumption of passenger transport	koe/pkm
Unit consumption of goods transport	koe/tkm
Unit consumption of passenger transport at constant modal split	koe/pkm
Unit consumption of goods transport at constant modal split	koe/tkm
• Comparison indicators	
Unit cons. of passenger transport at reference modal split	koe/pkm
Unit cons. of goods transport at reference modal split	koe/tkm

Unit consumption of transport is being calculated on the base of data obtained from questionnaire G-03; also the necessary data is obtained from: Central Statistical Office reports: T-03, T-03r, T-04, TD-E, T-06, SG-01, ST-P, ST-W, DG-1t and SP-3; information system of Ministry of Infrastructure concerning the international transport licences; internal information system of Polish Railways Company (PKP) concerning the goods transport; and from Warsaw Subway data system.

7.4. Energy efficiency indicators for households

List of indicators for households	Unit
• Headline indicators	
Unit consumption per dwelling	toe/dw
Unit consumption of electricity per dwelling	kWh/dw
Unit consumption per dwelling with climatic corrections	toe/dw
Unit consumption per m^2 with climatic corrections	koe/m^2
• Issue indicators	
Unit cons. per dwelling for space heating with climatic corrections	toe/dw
Unit cons. per m^2 for space heating with climatic corrections	koe/m^2
Specific cons. of new dwellings (multifamily/single family dwellings	toe/dw
Unit consumption per dwelling for lighting and electrical appliances	kWh/dw
Specific consumption of electricity of new refrigerators & freezers	kWh/dw
• Comparison indicators	
Space heating consumption per m^2 (or dwelling) per degree-day	koe/dw/dd
Useful space heating consumption per m^2 (or dwelling) per degree-day	koe/dw/dd
Unit consumption per dwelling (or m^2) scaled to European average climate	toe/dw

The data concerning flats number and area is obtained from: CSO reports - M-01, M-02, SG-01, reports GKM-11 and GKM-12 on regional dwelling resources, surveys on household budgets, Ministry of Finance taxes system, and report B-07 and from municipalities' information system in the scope real estate taxes database.

Fuels and energy consumption by households, agriculture and services is evaluated on the base of households and services questionnaires. The surveys are being performed once per few years (last surveys were performer in 2002 and 2003)

7.5. Energy efficiency of indicators for services, agriculture and transformations

List of indicators for services, agriculture and transformations	Unit
• **Services**	

Energy intensity of services sector : total, electricity	koe/€2000
Unit consumption of services sector per employee : total, electricity	toe/emp
Unit consumption of services sector per m^2 with climatic corr. :total & electricity	koe/m^2
Energy intensity of services sector at ppp	koe/€ppp
• **Agriculture**	
Energy intensity of agriculture	koe/€2000
• **Transformations**	
Efficiency of thermal power plants	%
Efficiency of district heating	%
Efficiency of cogeneration	%

Data necessary for indicators calculations is obtained from:

- The same sources as for GDP calculation presented before,
- Energy reports as before presented,
- Questionnaires Z-03 and Z-06 and from information systems of Ministry of Interior and Administration of the Republic of Poland and from experts evaluation concerning the energy consumption by services and agriculture.

8 List of variables necessary to calculate energy efficiency indicators

1. General data

Gross Domestic Product at constant and current prices (in PLN)

Value added at constant and current prices in sectors (in PLN):

- Agriculture, forestry and fishing
- Industry (sections C+D+E+F)
- Services

Private consumption at constant and current prices (PLN)

Ranking exchange rate of EURO

Purchasing power of EURO

Population

Primary energy consumption divided into:

- Hard coal and lignite *
- Crude oil *
- Natural gas
- Wood, biomass, wastes (industrial and municipal)
- Electricity trade balance
- Nuclear energy **
- Water energy **
- Solar and wind energy**

Caution:

* Including foreign trade balance and stock change of derived carriers (coke, briquettes, oil products)

**Value calculated according to IEA-OECD, UN and EUROSTAT methodology

Final consumption divided into:

- Oil products (gasoline, oils, liquid gas, etc.)
- Natural gas
- Hard coal and lignite (including derived fuels)
- Electricity
- Heat
- Wood, biomass, industrial and municipal wastes

In following sectors:

- Industry (excluding non-energy use and transformation)
- Transport
- Small users sector
- Households
- Services (public and private)
- Agriculture

Number of degree days in year (base 18°C)

Long term average of degree days (base 18°C)

2. Industry

Value added at constant prices for:

- Mining and quarrying (NACE 10-14)
- Manufacturing (NACE 15-37)
- Energy sector (NACE 23, 40, 41)
- Construction (NACE 45)

And following classes of manufacturing:

- Food, beverage, tobacco (NACE 15, 16)
- Textiles, leathers, clothes (NACE 17, 18, 19)
- Paper and printing (NACE 21, 22)
- Chemicals (NACE 24)
- Rubber and plastics (NACE 25)
- Non-metallic minerals (NACE 26)
- Steel (NACE 27.1, 27.2, 27.3, 27.5)
- Non ferrous metals (NACE 27.4)
- Metal products and equipment goods (NACE 28-35)
- Others (NACE 36, 37)
- Non energy mining (NACE 13, 14)
- Construction
- Cement (NACE 26.51 or 26.5)
- Glass (NACE 26.1)

Production size:

- Crude steel

- Martin and converter steel
- Electric steel
- Cement
- Paper
- Glass

Energy consumption divided into:

- Electricity
- Heat
- Natural gas
- Liquid fuels
- Solid fuels
- Wood, wastes, biomass

For sections and classes mentioned above

Caution: Consumption of solid, liquid and gaseous fuels excluding non-energy consumption

Consumption

- Fuels (solid, liquid, gaseous, others and heat)
- Electricity

For production of:

- Electric steel
- Other steel and pig iron

3. Transport

Stock of cars

Stock of heavy and light trucks

Stock of light trucks

Stock of heavy trucks

Stock of buses:

- total
- gasoline
- diesel
- gas

Stock of motorcycles

Annual distance covered by cars

Annual passenger transport in pas-km

- Cars
- Motorcycle
- Rail transport
- Buses
- In domestic air transport (number of passenger in year)
- Total air transport (number of passenger)

Annual goods transport in ton-km

- Rail transport
- Road transport
- Inland water transport

Energy consumption in transport divided into:

- Road transport
- Cars
- Rail transport
- Air transport
- Inland water transport

Energy consumption in specific types of transport divided into:

- Types of energy

  Oil products (gasoline, diesel, LPG, jet fuels)

  Electricity
- Average unit consumption per car

  Total

  Gasoline
- Average unit consumption per new car

  Total

  Gasoline

Energy consumption in municipal public transport (capital)

Energy consumption in rail transport (trams, metro)

Diesel consumption by buses

Passenger transport in municipal public transport (capital) (number of passengers)

Rail transport in capital (trams, metro) (number of passenger)

Vehicle transport in municipal public transport (capital)

Rail transport in capital (trams, metro) (vehicle/km)

4. Households and services

Dwellings

Stock of households

Stock of dwellings

Permanently occupied number of dwellings

- in multifamily houses
- in multifamily buildings

Stock of newly build dwellings

- in multifamily houses
- in multifamily buildings

Dwellings parameters

Average surface of dwelling

- new dwelling
- new family house
- new dwelling in multifamily building

Households equipment with electrical appliances

Stock of refrigerators

Stock of freezers

Percentage of households equipped with refrigerators

Percentage of households equipped with freezers

Annual sale of refrigerators

Annual sale of freezers

Dwellings heating

Consumption for heating of:

- oil
- gas
- coal
- district heat
- wood
- electricity

Consumption of heat for heating and boiling

Stock of dwellings with access to district heating

Electricity consumption in households

Electricity consumption by lighting and electrical appliances

Electricity consumption for lighting

Unit consumption of new refrigerators (weighted average of sold devices)

Unit consumption of new freezers (weighted average of sold devices)

Unit consumption of newly built dwellings in MJ/m^2

Theoretical energy consumption for heating for newly built family houses

Theoretical energy consumption for newly built dwellings in multifamily buildings

5. Energy-economical data

Energy prices of:

- gasoline (lead free)
- diesel
- electricity for households
- electricity for industry
- gas for households

6. Transformation

Oil consumption in thermal plants

Gas consumption in thermal plants

Hard coal and lignite consumption in thermal plants

Wood and wastes consumption in thermal plants

Heat production in thermal plants

Oil products consumption in CHP

Gas consumption in CHP

Hard coal and lignite consumption in CHP

Wood and wastes consumption in CHP

Heat production in CHP

Electricity production in CHP

9. Abbreviations

kgoe – kilogram of oil equivalent

toe – ton of oil equivalent

euro2000 – market value of euro in 2000

europpp – value of euro according to purchasing power parity

pkm – passenger-km

tkm – ton-km

tkbr – gross tonne-km

kWh – kilowatt hour

10. List of acquis communautaire

Documents of European Union connected with energy efficiency:

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 (PEEEREA).
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) 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.

Directives concerning energy efficiency of devices:

1. Council Directive 78/170/EEC of 13 February 1978 on the performance of heat generators for space heating and the production of hot water in new or existing non - industrial buildings and on the insulation of heat and domestic hot-water distribution in new non-industrial.
2. Council Directive 79/531/EEC of 14 May 1979 applying to electric ovens Directive 79/530/EEC on the indication by labelling of the energy consumption of household appliances.
3. Council Directive 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels.
4. Council Directive 92/75/EEC on the indication by labelling and standard product information of the consumption of the energy and other resources by household appliances.

5. Commission Directive 94/2/EC of 21 January 1994 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations.

6. Commission Directive 95/12/EC of 23 May 1995 r. implementing Council Directive 92/75/EEC with regard to energy labelling of household washing.
7. Commission Directive 95/13/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric tumble driers.
8. Directive 96/57/EC of the European parliament and of the council of 3 September 1996 on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof.
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. Commission Directive 96/89/EC of 17 December 1996 r. amending Directive 95/12/EC implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines.
11. Commission Directive 97/17/EC of 16 April 1997 implementing Council Directive 92/75/EEC with regard to energy labelling of household dishwashers.
12. Council Directive 98/11/EC of 27 January 1998 implementing Council Directive 92/75/EEC with regard to energy labelling of household lamps.
13. Directive 2000/55/EC of the European Parliament and of the Council of 18 September 2000 on energy efficiency requirement for ballasts for fluorescent lighting.
14. Commission Directive 2002/31/EC of 22 March 2002 implementing Council Directive 92/75/EEC with regard to energy labelling of household air-conditioners.
15. Commission Directive 2002/31/EC of 22 March 2002 implementing Council Directive 92/75/EEC with regard to energy labelling of household air-conditioners.
16. Commission Directive 2003/66/EC of 3 July 2003 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations.

11. Handling of 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.

11.1. Foundations

The need to improved energy end-use efficiency, energy supply managing and supporting of renewable sources production are the main reasons for Directive 2006/32/EC. It results from the fact, that there is relatively limited scope for any other influence on energy supply and distribution conditions in the short to medium term, either through the building of new capacity or through the improvement of transmission and distribution. Additionally, it is assumed, that energy end-use efficiency improvement will also contribute to the reduction of primary energy consumption, to the mitigation of CO_2 and other greenhouse gas emissions and thereby to the prevention of dangerous climate change. It is estimated that 78% of emissions is caused by human activities in the energy sector. Growing emissions make it more and more difficult to meet the Kyoto commitments. Improved energy end-use efficiency will reduce dependence on energy imports and will have positive impact on innovativeness.

This Directive is without prejudice to customers rights to be supplied with electricity of a specified quality at reasonable, easily and clearly comparable, and transparent prices. The liberalisation of the retail markets for final customers for electricity, natural gas, coal and lignite, heating, and in some cases even district heating and cooling, has led to improved efficiency and lower costs on the energy generation, transformation and distribution side. This liberalisation has not led to significant competition in products and services which could have resulted in improved energy efficiency on the demand side. The aim of this Directive is also to increase efficiency of public sector. The change of philosophy of energy suppliers is also promoted: instead of selling as much energy as possible, it is suggested to increase sale of services connected with energy end-user efficiency improvement.

11.2. Definitions

Following definitions are used in the Directive:

- „energy”: all forms of commercially available energy,
- “energy efficiency”: a ratio between an output of performance, service, goods or energy, and an input of energy,
- “energy efficiency improvement”: an increase in energy end-use efficiency as a result of technological, behavioural and/or economic changes,
- “energy efficiency improvement measures”: all actions that normally lead to verifiable and measurable or estimable energy efficiency improvement
- “energy savings”: an amount of saved energy determined by measuring and/or estimating consumption before and after implementation of one or more energy efficiency improvement measures, whilst ensuring normalization for external conditions that affect energy consumption
- “energy efficiency improvement programmes”: activities that focus on groups of final customers and that normally lead to verifiable and measurable or estimable energy efficiency improvement
- “final customer”: a natural or legal person that purchases energy for his own end use

11.3. Purposes

The purpose of this Directive is to enhance the cost-effective improvement of energy end-use efficiency in the Member States by:

- providing the necessary indicative targets as well as mechanisms, incentives and institutional, financial and legal frameworks to remove existing market barriers and imperfections that impede the efficient end use of energy
- creating the conditions for the development and promotion of a market for energy services and for the delivery of other energy efficiency improvement measures to final consumers.

Following issues are connected with so determined aim of Directive connected are:

- improvement of energy supply security
- minimization of primary energy consumption
- reduction of CO_2 and other greenhouse gasses emission

- minimization of EU dependence on energy import
- stimulation of innovativeness and competitiveness
- managing the demand and energy efficiency instead of new sources exploitation
- environment preservation
- supporting energy services and creation of strong incentives for demand
- technological and behavioural changes
- increasing accessibility of energy services
- increasing accessibility of energy audits
- innovations stimulation using third party financing
- need of energy end-users for information on consumption data

11.4. The Annexes to Directive 2006/32/EC

The Annexes to DIRECTIVE *2006/32/WE OF THE EUROPEAN PARLIAMENT AND THE OF THE COUNCIL of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/77EEC* are described below.

The methodologies of the indicative target calculations and energy savings measuring are provided in six Annexes to the Directive.

ANNEX I contains of the methodology for calculating the national indicative energy savings target.

Member States shall use the annual final inland energy consumption of all energy users within the scope of his Directive for the most recent five-year period previous to the implementation of this Directive for which official data are available, to calculate an annual average amount of consumption. This final energy consumption shall be the amount of energy distributed or sold to final customers during the five-year period, not adjusted for degree days, structural changes or production changes. The national indicative energy savings target, expressed in absolute terms of energy, shall:

- consist of 9 % of the annual average amount of consumption referred to above;
- be measured after the ninth year of application of this Directive;

- be the result of cumulative annual energy savings achieved throughout the nine-year application period of this Directive;
- be reached by way of energy services and other energy efficiency improvement measures.

Energy savings in a particular year following the entry into force of this Directive that result from energy efficiency improvement measures initiated in a previous year not earlier than 1995 and that have a lasting effect may be taken into account in the calculation of the annual energy savings. In certain cases, where circumstances can justify it, measures initiated before 1995 but not earlier than 1991 may be taken into account. Measures of a technological nature should either have been updated to take account of technological progress, or be assessed in relation to the benchmark for such measures. The Commission shall provide guidelines on how the effect of all such energy efficiency improving measures should be measured or estimated, based, wherever possible, on existing Community legislation, such as 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 Directive 2002/91/EC.

ANNEX II provides energy content of selected fuels for end use. Member States may apply different conversion factors if these can be justified.

ANNEX III presents the indicative list of examples of eligible energy efficiency improvement measures.

To be taken into account, these energy efficiency improvement measures must result in energy savings that can be clearly measured and verified or estimated in accordance with the guidelines in Annex IV, and their impacts on energy savings must not already be counted in other specific measures. The following lists are not exhaustive but are intended to provide guidance.

Examples of eligible energy efficiency improvement measures:

Residential and tertiary sectors

(a) heating and cooling (e.g. heat pumps, new efficient boilers, installation/efficient update of district heating/cooling systems);

(b) insulation and ventilation (e.g. wall cavity and roof insulation, double/triple glazing of windows, passive heating and cooling);

(c) hot water (e.g. installation of new devices, direct and efficient use in space heating, washing machines);

(d) lighting (e.g. new efficient bulbs and ballasts, digital control systems, use of motion detectors for lighting systems in commercial buildings);

(e) cooking and refrigeration (e.g. new efficient devices, heat recovery systems);

(f) other equipment and appliances (e.g. combined heat and power appliances, new efficient devices, time control for optimised energy use, stand-by loss reduction, installation of capacitors to reduce reactive power, transformers with low losses);

(g) domestic generation of renewable energy sources, whereby the amount of purchased energy is reduced (e.g. solar thermal applications, domestic hot water, solar-assisted space heating and cooling);

Industry sector

(h) product manufacturing processes (e.g. more efficient use of compressed air, condensate and switches and valves, use of automatic and integrated systems, efficient stand-by modes);

(i) motors and drives (e.g. increase in the use of electronic controls, variable speed drives, integrated application programming, frequency conversion, electrical motor with high efficiency);

(j) fans, variable speed drives and ventilation (e.g. new devices/systems, use of natural ventilation);

(k) demand response management (e.g. load management, peak shaving control systems);

(l) high-efficiency cogeneration (e.g. combined heat and power appliances);

Transport sector

(m) mode of travel used (e.g. promotion of energy-efficient vehicles, energy-efficient use of vehicles including tyre pressure adjustment schemes, energy efficiency devices and add-on devices for vehicles, fuel additives which improve energy efficiency, high-lubricity oils and low-resistance tyres);

(n) modal shifts of travel (e.g. car free home/office transportation arrangements, car sharing, modal shifts from more energy-consuming modes of transport to less energy-consuming ones, per passenger-km or tonne-km);
(o) car-free days;

Cross-sectoral measures

(p) standards and norms that aim primarily at improving the energy efficiency of products and services, including
(a) buildings;
(q) energy labelling schemes;
(r) metering, intelligent metering systems such as individual metering instruments managed by remote, and
(b) informative billing;
(s) training and education that lead to application of energy-efficient technology and/or techniques;

Horizontal measures

(t) regulations, taxes etc. that have the effect of reducing energy end-use consumption;
(u) focused information campaigns that promote energy efficiency improvement and energy efficiency
(v) improvement measures.

ANNEX IV describes general framework for measurement and verification of energy savings.

Two methods: top-down and bottom up, used in measuring the realised energy savings, are described previously on page 6

Before 1 January 2008, the Commission shall develop a harmonised bottom-up model. This model shall cover a level between 20 and 30 % of the annual final inland energy consumption for sectors falling within the scope of this Directive.

Until 1 January 2012, the Commission shall continue to develop this harmonised bottom-up model, which shall cover a significantly higher level of the annual final inland energy consumption for sectors falling within the scope of this Directive.

In developing this harmonised bottom-up model, the Committee shall aim to use standardised methods which entail a minimum of administrative burden and cost.
If bottom-up calculations are not available for certain sectors, top-down indicators or mixtures of top-down and bottom-up calculations shall be used in the reports to the Commission, subject to the agreement of the Commission.

Data and methods that may be used (measurability)
Several methods for collecting data to measure and/or estimate energy savings exist. At the time of the evaluation of an energy service or energy efficiency improvement measure, it will often be impossible to rely only on measurements. A distinction is therefore made between methods measuring energy savings and methods estimating energy savings, where the latter is the more common practice.

Data and methods based on measurements

- Bills from distribution companies or retailers.
  Metered energy bills may form the basis for measurement for a representative period before the introduction of the energy efficiency improvement measure. These may then be compared to metered bills for the period after the introduction and use of the measure, also for a representative period of time.

- Energy sales data.
  The consumption of different types of energy (e.g. electricity, gas, heating oil) may be measured by comparing the sales data from the retailer or distributor obtained before the introduction of the energy efficiency improvement measures with the sales data from the time after the measure. A control group may be used or the data normalised.

- Equipment and appliance sales data.

Performance of equipment and appliances may be calculated on the basis of information obtained directly from the manufacturer. Data on equipment and appliance sales can generally be obtained from the retailers.

- End-use load data.
  Energy use of a building or facility can be fully monitored to record energy demand before and after the introduction of an energy efficiency improvement measure. Important relevant factors (e.g. production process, special equipment, heating installations) may be metered more closely.

There are two methods of estimations:

- Simple engineering estimated data,
- Enhanced engineering estimated data.

ANNEX V presents the indicative list of energy conversion markets and sub-markets for which benchmarks can be worked out:

1. The market for household appliances/information technology and lighting:
1.1. Kitchen appliances (white goods);
1.2. Entertainment/information technology;
1.3. Lighting.
2. The market for domestic heating technology:
2.1. Heating;
2.2. Hot-water provision;
2.3. Air conditioning;
2.4. Ventilation;
2.5. Heat insulation;
2.6. Windows.
3. The market for industrial ovens.
4. The market for motorised power in industry.
5. The market for public-sector institutions:
5.1. Schools/public administration;
5.2. Hospitals;
5.3. Swimming pools;

5.4. Street lighting.

6. The market for transport services.

ANNEX VI delivers the list of eligible energy efficient public procurement measures.