Energy Efficiency in Croatia (1992-2004)

Report prepared by:

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1. Executive summary

This report presents an analysis of energy efficiency trends in Croatian on the basis of energyefficiency indicators based on the ODYSSEE methodology. This analysis focuses on the period 1992-2004[1]. Most of data are available for this period; in all calculations where this is not the case, the indicators and comparisons are made with available data.

The report starts with a review of general context of energy efficiency, i.e. economic and energy consumption development, the policy background on energy efficiency, energy law, policy instruments, international obligations on environmental protection (Chapter 2). In Chapter 3, the energy consumption and trends in energy intensity are presented, in total and at sectoral level, including the energy efficiency by sector.

The main results and conclusions of the report are:

- Over the period 1992-2004, the final energy consumption has grown up by 3,3%/year. The highest growth rate was in tertiary (services) sector of 6,8%/year and after this in transport sector (5,7%/year) and households (3,9%/year). Industry sector had the smalest growth rate in this period (0,5%/year), while agriculture had negative growth rate (-1,3%/year).

- The primary intensity decreased more than the final intensity: -0,6%/year compared to -0,3%/year.

- In the period 1995-2004 energy efficiency of the whole economy, as measured with the energy efficiency index (ODEX) improved by 11% ,compared to 8% for the EU-25. Especially the industrial sector (cement and paper) and transport sector (rail and trucks&light vehicles) contributed to this development.

- Direct CO_2 emissions (emissions from final consumers) in Croatia have increased by 54% since 1992. The highest increase was in transport sector (99%), followed by households, services and agriculture sectors (60%). The emissions increase in industry sector was 12%.

2. The background of energy efficiency

The economic growth in the period from 1992 to 2004 in Croatia was 3,4%/year (Table 1); the highest economic growth was during the period 2001-2004 (5,1%).

The industrial activity (as measured by the value added at constant price) increased by 3,1%/year, with the highest growth in the period 2001-2004 (6,4%). Data for private consumption (household`s expenditures) are available from 1995; average growth rate for the period from 1995-2004 was 3,9%/y, with the highest growth in the period 2001-2004 (5,7%). Because the data for private consumption is available from 1995, Figure 1 presents

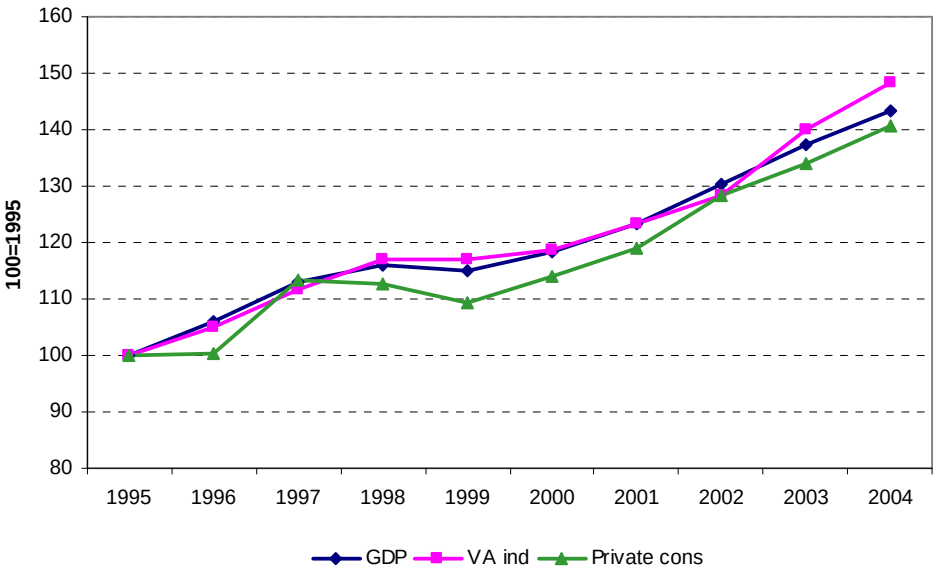
[1] The choice of 1992 for the starting year is because of war situation and relating energy consumption in 1990-1991.

relative values for GDP, value added of industry and private consumption of households relative to 1995.

Table 1: Economic and industrial growth in Croatia

%/year	**1992-1996**	**1996-2001**	**2001-2004**	**1992-2004**
GDP	2,4%	3,1%	5,1%	3,4%
Industry	0,4%	3,3%	6,4%	3,1%
Private consumption	na	3,5%	5,7%	3,9%[2]

Figure 1: Macro-economic development in Croatia: 1995-2004



The policy background to energy efficiency

The organised and systematic care about energy efficiency will be carried out in the Republic of Croatia on the basis of national energy programs, which the Croatian Government initiated in 1997. Very important programs for this area are $KUEN_{zgrada}$, MIEE, KOGEN, $KUEN_{cts}$, and TRANCRO. They encompass all-important areas of energy consumption where efficient energy use can be improved.

The basic aim of energy efficiency measures in the framework of the $KUEN_{zgrada}$ program, which relates to house construction, is reducing the energy needs through designing, construction and use of new buildings and settlements, as well as to create favourable microclimate parameters in the already existing buildings through their rehabilitation. The aim is also to reduce negative environmental impacts.

In the sectors of industry and services, the energy efficiency improvement strategy is to establish the organised structure in the framework of MIEE program. Within the industry, the principle goals of the industrial sectors and strategic goals of the community can be defined as:

- Reduction of specific energy consumption and thus, reduction of production costs,

[2] For the period 1995-2004.

- Avoiding demanding investments in energy and decreasing dependence on energy purchase,
- Optimisation of technological processes,
- Opening possibilities to use renewable energy sources, especially energy utilisation of waste and industrial (technological) waste,
- Ecological benefits from harmful emission reduction and water harmful emission reduction and water consumption decrease.

In commercial services sector, the main goals of energy efficiency care are:

- Reduction of service prices,
- Enabling the extending of activity time (in tourist services),
- Enabling the systematic use of renewable energy sources, especially of solar energy,
- Water consumption reduction and other environmental benefits.

In non-commercial activities, like health sector facilities as largest energy consumers, primary interests of the community is to free substantial financial resources used for energy spending, relieve non-technical staff from dealing with energy issues, reduce water consumption, and improve accommodation standard.

In the mentioned consumption sectors, an essential strategy element is the education of personnel for implementation of energy conservation measures.

In the area of cogeneration (Program KOGEN), the main goal is to stimulate the construction and use of cogeneration plants in all those facilities where the proper technological and economic conditions are in place. Given a permanent need for construction of new electric power and thermal-technical facilities, with increasingly demanding requirements of energy management and environmental protection, cogeneration plants are often used for heat and electricity generation, due to their energy and economic but also ecological advantages when compared to conventional energy generation. The realisation of this program includes forming favourable legal, economic and technical and technological framework for construction of cogeneration plants.

In heat energy, steam and hot water generation, (Program $KUEN_{cts}$), it is necessary to encourage development and improvements of centralised heat systems, and efficiency improvements of the existing systems in large settlements and towns where heat consume density is high enough or where there is a need to provide heat and electricity at the same time:

- replace obsolete equipment and installations,
- improve fuel combustion technology and use of smoke gases waste heat,
- introduce automatic control of processes and facilities,
- introduce heat energy consume regulation and metering at customer level,
- improve insulation of installations and facilities,
- encourage CHP facilities,
- encourage use of surplus of industry's heat capacities,
- connect local heat plants systems in centralised systems of heat energy supply,
- build heat energy accumulations,
- loss reduction and heat load and demand management,
- reduction of emissions of harmful compounds and protection of environment,

- setting efficient price relations and tariff systems, etc.

Efficiency Measures in the transport sector - LPG & CNG Incentives

At the moment, in Croatia there is lack of support by local or national policy as for the CNG market development. Public transport companies favor diesel (or biodiesel as possible alternative fuel) and there is a strong LPG competition from focused LPG companies, primary daughter company of Croatian national oil and gas company interested to increase LPG demand in domestic market and reduce export (Croatia exports 70% of its LPG and imports 40% of natural gas needed).

Key drivers that might push the LPG & CNG market forward are: proximity of developed markets like (Italy) and fact that CNG and LPG vehicles are exempt from, so called, "Eco-test" during annual technical vehicle inspection, which makes it interesting for older, more polluting vehicles, but on the other hand, this is influencing more increase in the number of LPG then CNG vehicles. International standards are accepted by national legislation and there are no obstacles for import of OEM vehicles.

In 2005, new Fund for Environmental Protection and Energy Efficiency, financed mostly from fees from automotive sector, announced strategy to return part of the Fund income back to automotive sector (probably in the form of grants) instead of using them entirely for stabilization of landfills, which is case today. Fund recently introduced favorable loans for projects aiming to decrease air pollution: loans up to (226 500 EUR) with 5 years repayment period + 2 years grace period or subsidy of interest rate of commercial loans up to 2%.

Energy efficiency improvements in buildings

With the adoption of Technical regulation concerning heat energy savings and thermal protection in buildings (OG 79/05) in Croatia the level of thermal protection is enlarged and the annual heat energy consumption is limited depending on the form factor of the building and is between 51,31 kWh/m^2 and 95,01 kWh/m^2 for residential buildings and between 16,42 kWh/m^3 and 30,40 kWh/m^3 for non residential buildings. This is the first step of implementing the 2002/91 EC Directive on the energy performance of buildings.

Energy Institute Hrvoje Požar conducted a large number of energy audits of family houses and residential buildings. For each house, according to specific location, infrastruction availability and specific demands, measures for efficient use of energy are calculated with preview of total investment and simple pay-back period.

The Energy Law

Legal and institutional framework for the Croatian energy sector is made up of Constitution of the Republic of Croatia, a number of laws and numerous by-laws.

In 1997 Croatian Parliament ratified the Energy Charter Treaty (Official Gazette - International agreements 15/97) which assumes introduction of long term European co-operation concerning energy in the context of market-oriented economy. With this Croatia gained access to international energy developments, and at the same time Croatia took obligation to ensure access to its energy systems. In 1998 the Government brought **Decree**

on confirming Energy Charter Protocol on energy efficiency and relevant environmental issues (Official Gazette, international agreements 7/98), which encourages the participants to pursue energy efficiency and consistent reduction of negative environmental impacts and provides incentives to cooperation in the field of energy efficiency.

Energy Law (Official Gazette 68/01) regulates measures for safe and reliable energy supply, establishing and implementation acts for energy policy and energy development planning and performance of energy activities as either market activity or public services. The Law took effect on 1 January 2002.

Croatian parlament ratified Kyoto protocol in May 2007, with the obligation for GHG emission reduction for 5% until 2012.

3. Overall assessment of energy efficiency trends

3.1. *Energy consumption*

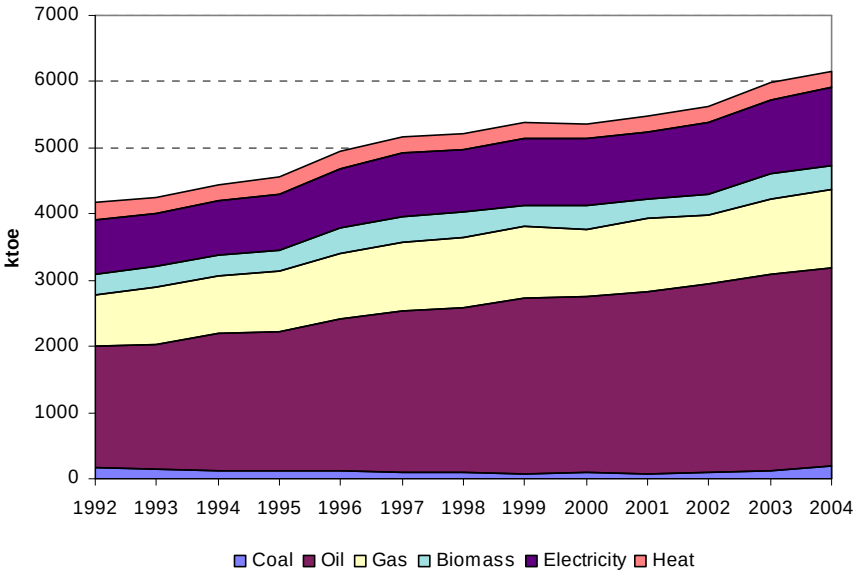
Over the period 1992-2004, the final consumption has grown up by 3.3% per year (at normal climate). The growth in the final consumption was the most dynamic for the services sector (6,8%/year). Transport sector and households sector had lower growth rates (5,7%/year and 3,9%/year), while the growth rate for industry was the lowest (0,5%/year). The only sector with the negative average growth rate was agriculture (-1,3%/year). Evolution of the final consumption by sector in Croatia is shown in Table 2. Figure 2 presents the final energy consumption by sector in Croatia.

Table 2: Evolution of the final consumption by sector (normal climate)

	1992-1996	**1996-2001**	**2001-2004**	**1992-2004**
Industry	-2,2%	1,5%	2,8%	0,5%
Transport	8,6%	3,5%	5,5%	5,7%
Households	7,1%	1,2%	4,2%	3,9%
Services	11,7%	3,7%	5,6%	6,8%
Agriculture	-2,1%	1,2%	-4,3%	-1,3%
Total	4,3%	2,1%	3,9%	3,3%

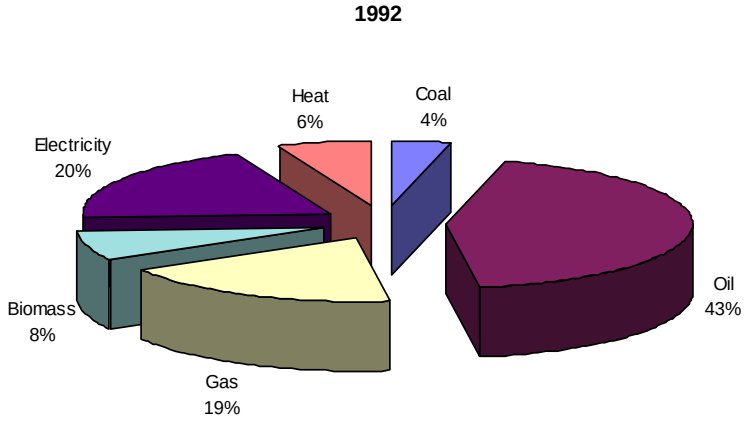
The industry sector had the highest share in total final energy consumption in 1992 (35%) and in 2004 its share decreased to 24%, because of the dominance of transport sector (23% in 1992 to 30% in 2004). Share of households and tertiary consumption increased from 28% to 30% and from 7% to 11% respectively. Final energy consumption of agriculture sector decreased from 7% in 1992 to 4% in 2004. Figure 4 presents the final energy consumption by sector in Croatia in 1992 and 2004..

Figure 2: Final energy consumption by sector in Croatia



Final energy consumption of oil increased from 43% in 1992 to 49% in 2004 (Figure 3). The market share of electricity in the final consumption remains stable (around 20%) together with coal (around 4%) and gas (19%). Share of heat consumption decreased from 6% in 1992 to 4% in 2004 and biomass from 8% to 6% in 2004.

Figure 3: Final energy consumption by energy in Croatia in 1992 and 2004



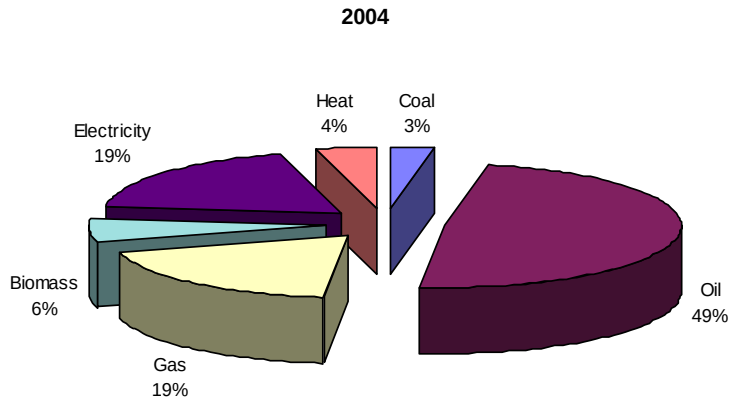
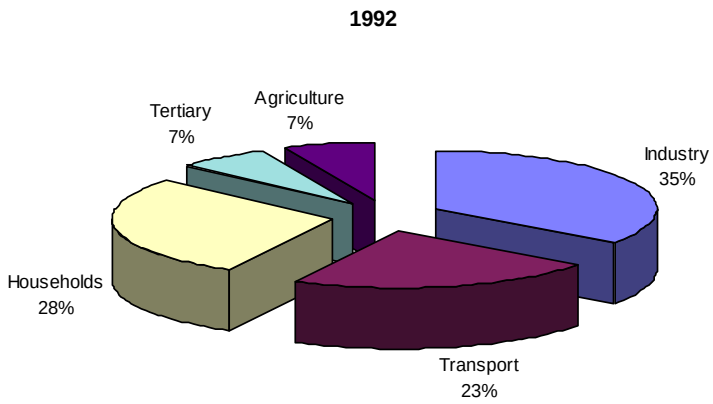
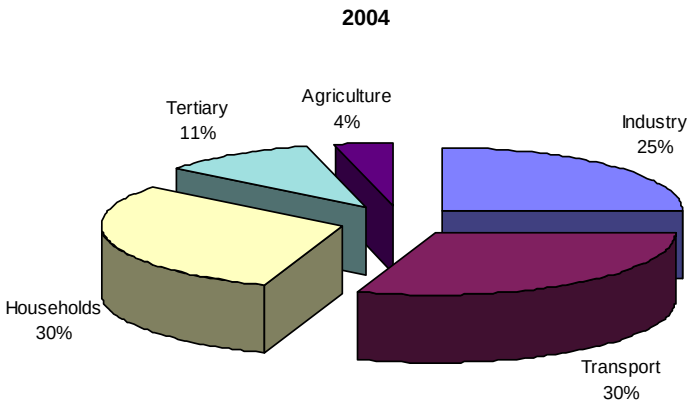


Figure 4: Final energy consumption by sector in Croatia in 1992 and 2004





3.2. *Energy intensity*

3.2.1. Overall trends

In Croatia, primary energy consumption developed from 6,61 Mtoe in 1992 to 8,83 Mtoe in 2004, i.e. by 34%. From 1990 to 1992 primary energy consumption increased (because of the war situation in Croatia) and after that remained relatively stable until 1996 at the level of 6,82 Mtoe. Up to 1999 primary energy consumption was increased at the level of 7,97 Mtoe, and in the next year decreased again and increased from 2000 to 2003 (8,80 Mtoe) and 2004 (8,83 Mtoe).

There are two general indicators which are often used to characterise the overall energy efficiency of an economy: the primary energy intensity (i.e. the ratio primary consumption over GDP) and the final energy intensity (i.e. ratio final consumption over GDP).

Between 1992 and 2004, the primary energy intensity decreased much more than the final intensity (Table 3): -0,6%/year on average compared to -0,3%/year. The strongest reduction in primary intensity was in the period from 2001 to 2004 (-1,6%/year), and for the final intensity in the same period (-1,1%/year). Energy intensity is the indicator of energy productivity (energy efficiency from an economic view point). The reason for strongest reduction (faster decrease) of primary intensity in the period 1992-2004 comes from an improvement in the efficiency of thermal power generation (higher efficiency).

The development of primary (or final) energy intensity over time is often used as an indicator for the overall energy efficiency of all final consumers. These indicators can be distorted by climatic variations from year to year. The influence of climatic variations on the development of final energy intensity in Croatia is shown in Figure 5 and 6. In years with warmer winters than the long-term average year (in terms of degree days), the climate corrected final energy intensity is above the real intensity (eg 1992, 1994, 1999-2002). The coldest year was 1996 (13% colder than average) so the climate corrected final intensity is below the real intensity.

Table 3: Variations in primary and final energy intensities in Croatia (normal climate)

	1992-1996	**1996-2001**	**2001-2004**	**1992-2004**
Primary	0,3%	-1,1%	-1,6%	-0,6%
Final	0.7%	-1,0%	-1,1%	-0,3%

Figure 5: Final energy intensity: actual, with climate corrections and degree-days

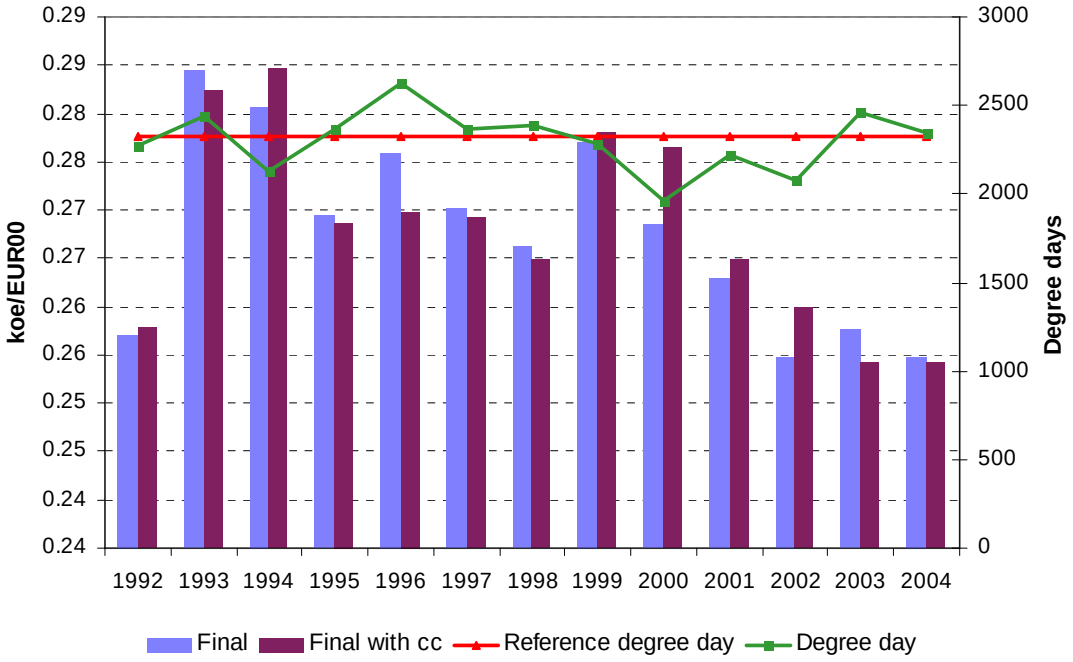
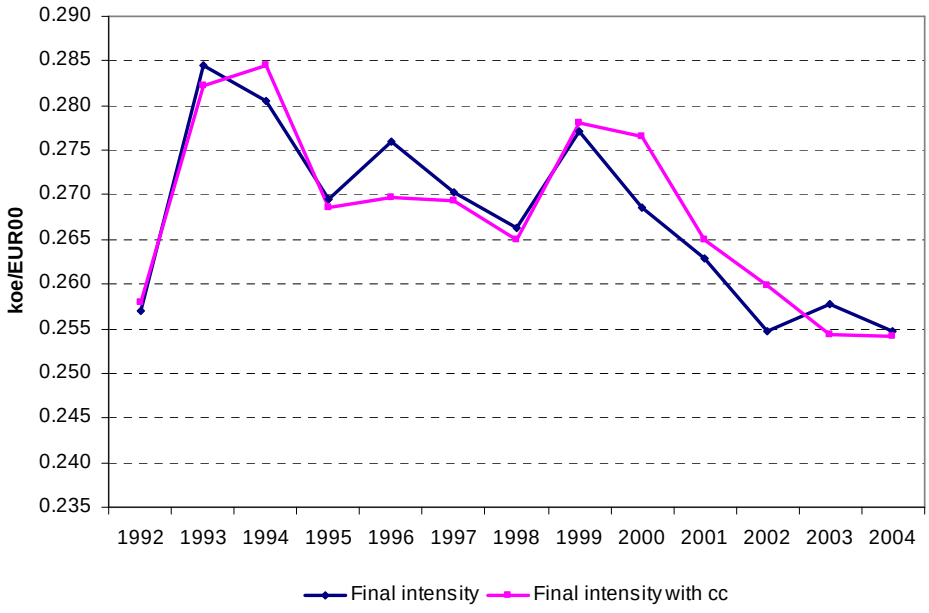


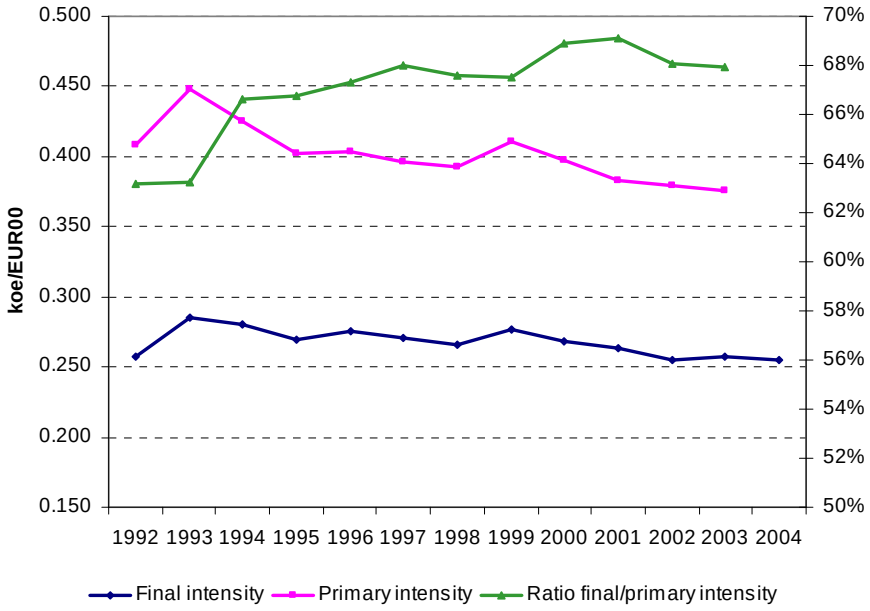
Figure 6: Final energy intensity in Croatia, role of climate variations



The different variations between primary and final intensities are captured by the ratio final to primary intensity (Figure 7). This ratio has increased for Croatia from 63% in 1992 and 1993 to the value of 67% in 1994. This ratio was stable in the period from 1994 to 1996 and after that increased to 68% from 1997 and remained stable to 2004. The reason for decreasing of the ratio final to primary intensity in Croatia in 1992 and 1993 was because the increased share of primary energy consumption is not going to consumers (final energy consumption);

it is consumed in energy sector – losses in energy transformations and energy sector own use.

Figure 7: Primary and final energy intensity in Croatia (normal climate)



3.2.2. Industry

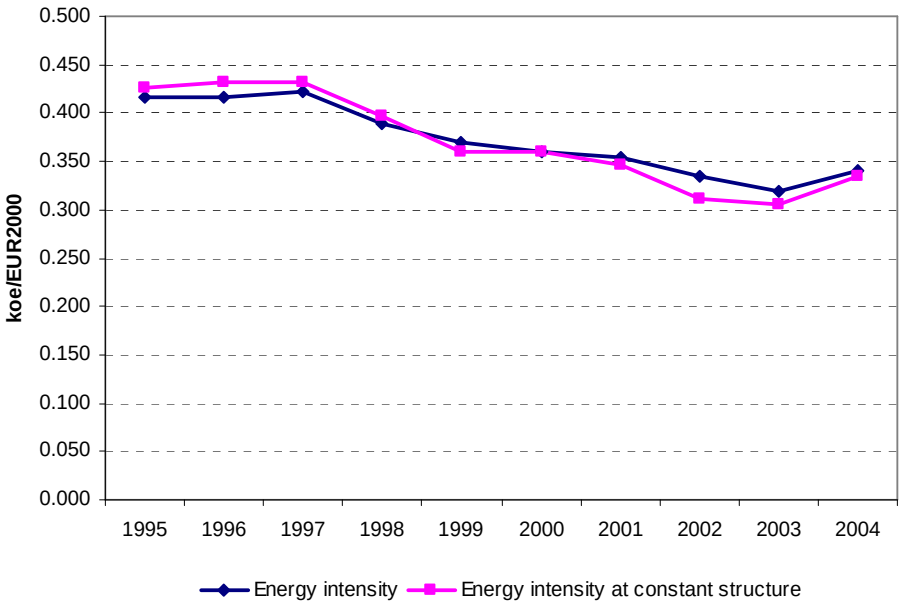
The energy intensity (actual intensity) in manufacturing has decreased by -2,2%/year from 1995 to 2004, with the highest decrease in period 1995-2001 (-2,6%/year). The energy intensity at constant 2000 structure (energy intensity without structural changes) for the period 1995-2004 has value is of -2,7%/year. For both energy intensities data for 1992-1994 period are not available so the results are presented for the most recent period from 1995 to 2004. The energy intensity in manufacturing is shown in Figure 8.

Table 4: Energy intensity in manufacturing

	1995-2001	**2001-2004**	**1995-2004**
Energy intensity	-2,6%	-1,3%	-2,2%
Energy intensity at constant 2000 structure	-3,4%	-1,2%	-2,7%

Part of the reduction in energy intensity in manufacturing may be linked to changes in the structure in industrial activity, with a reduction of the share of energy intensive branches (primary metals or non metallic minerals that require 29 and 15 times more energy to produce one unit of value added than equipment). In the case of Croatia, there was increase in energy consumption for non metallic minerals, but the energy consumption for iron and steel branch has decreased. The changes in iron and steel had occurred due to closing of capacities, not because of energy efficiency improvements.

Figure 8: Energy intensity in manufacturing



Analysis of the thermal uses in industry is broken by principal fuels and is shown in Figure 9, while the electricity consumption is shown in Figure 10.

Figure 9: Industrial thermal uses in the period 1990-2005

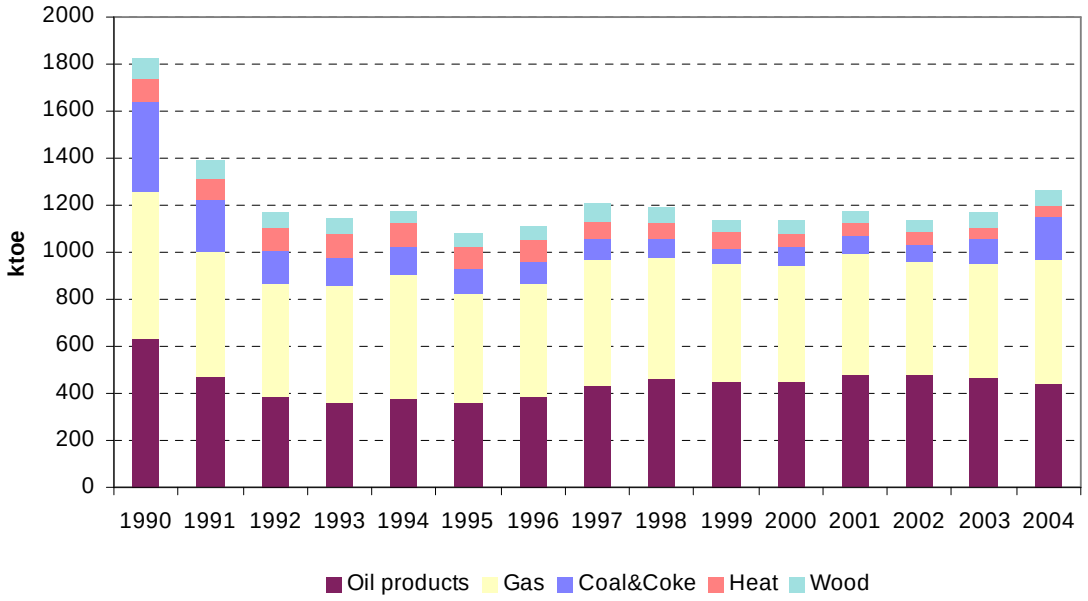
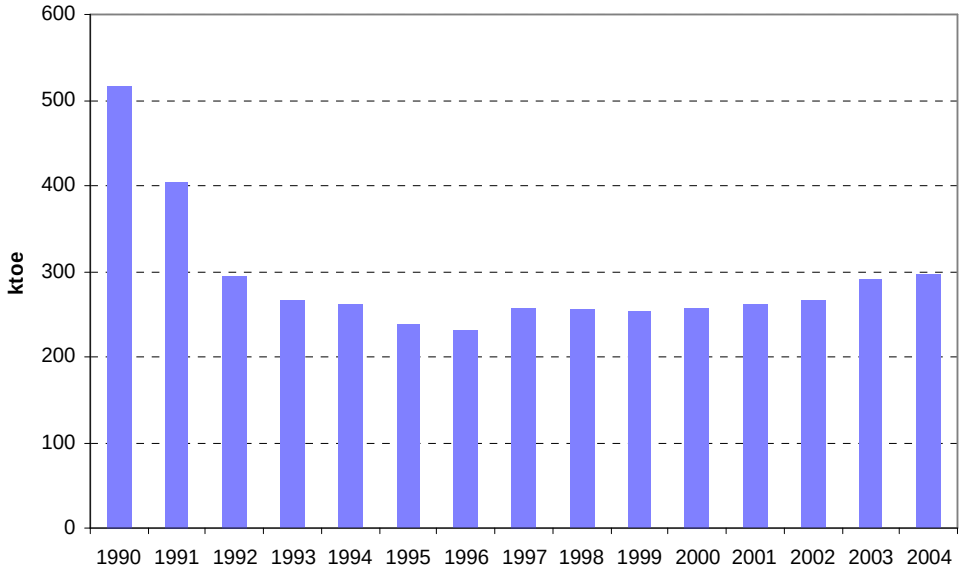


Figure 10: Industrial electricity consumption in 1990-2005



From the above, a steep decrease of energy consumption in Croatian industry after 1990 can be observed. This is clear consequence of war and transition situations. This decline lasted approximately until 1996., after which the consumption took a stable path. It is evident that the electricity consumption practically went down to half of its pre-'90 level and remains constant after 1996.

The consumption for thermal uses – regarded as the sum of consumed gaseous, liquid and solid fuels, and steam and hot water – after drop of more than 35% is being slowly increased.

The biggest change in energy consumption by branch was for non metallic industry, with increasing share from 26% in 1992 to 35% in 2004 and steel industry with changes from 12% to 2%. The next one is food industry with increasing in share from 14% in 1992 to 18% in 2004 (Figure 11). Because of the rapid energy decrease in period from 1990 to 1992, the structure of shares for industrial branches are given starting from 1992.

The only energy intensity wich has increased is the one in chemical industry, rating 25%. All other energy intensities of manufacturing branches have decreased, for primary metals (-43%), non metallic minerals (-29%), paper (-12%), equipment (-19%), food (-27%) and textile (-42) (Figure 12).

Figure 11: Energy consumption of industry by branch

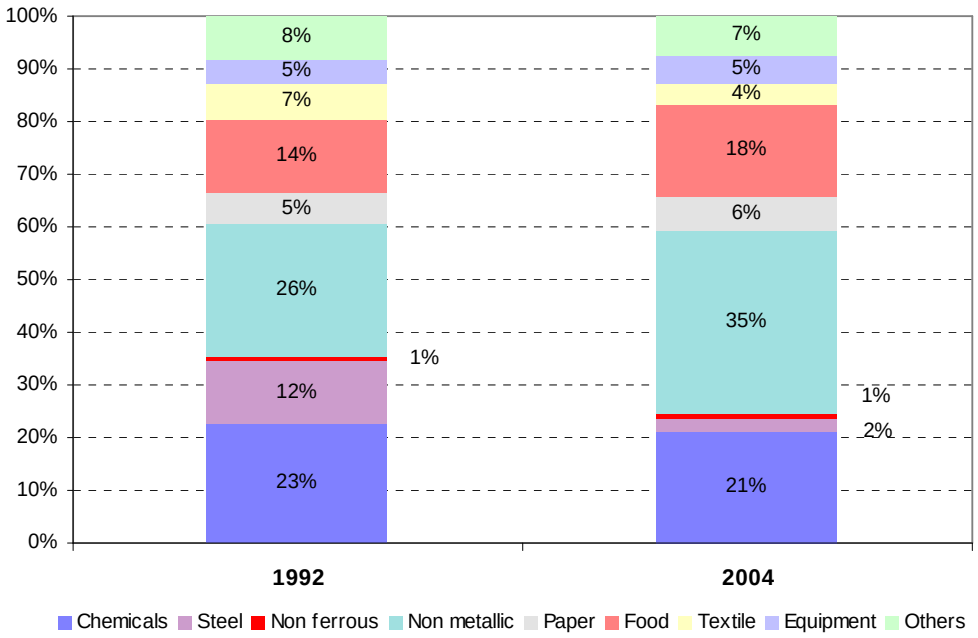
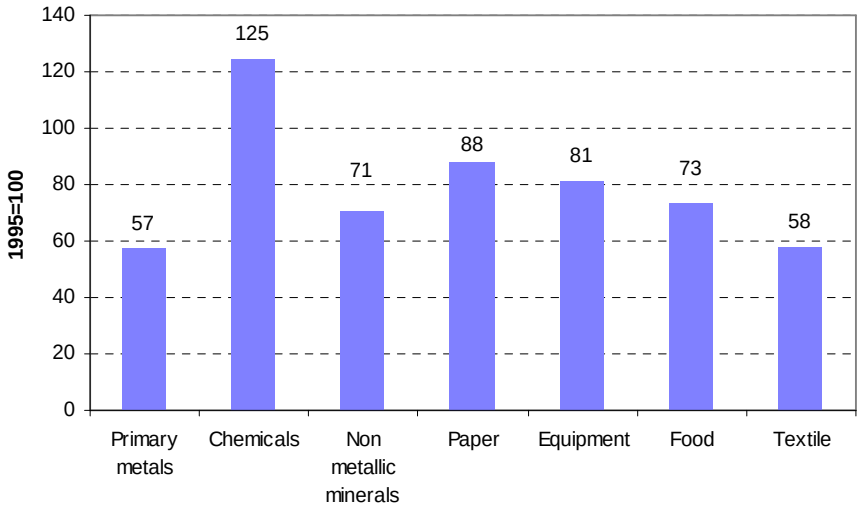
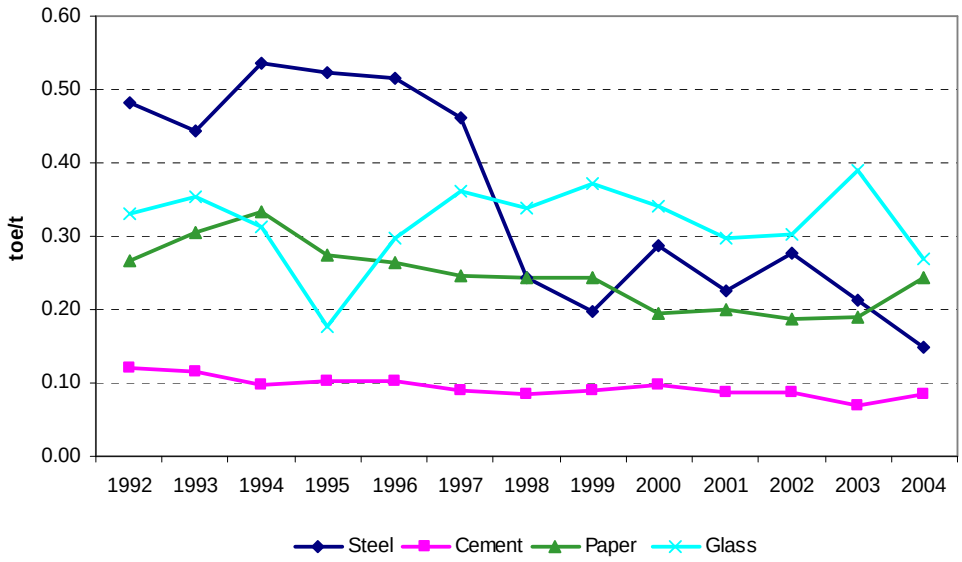


Figure 12: Energy intensities of manufacturing branches (2004, index 100 in 1995)



The unit consumption for all energy intensive products decreased in 1992-2004 has dropped; steel -9,4%/year, cement -2,9%/year, paper -0,7%/year and glass -1,7%/year (Figure 13).

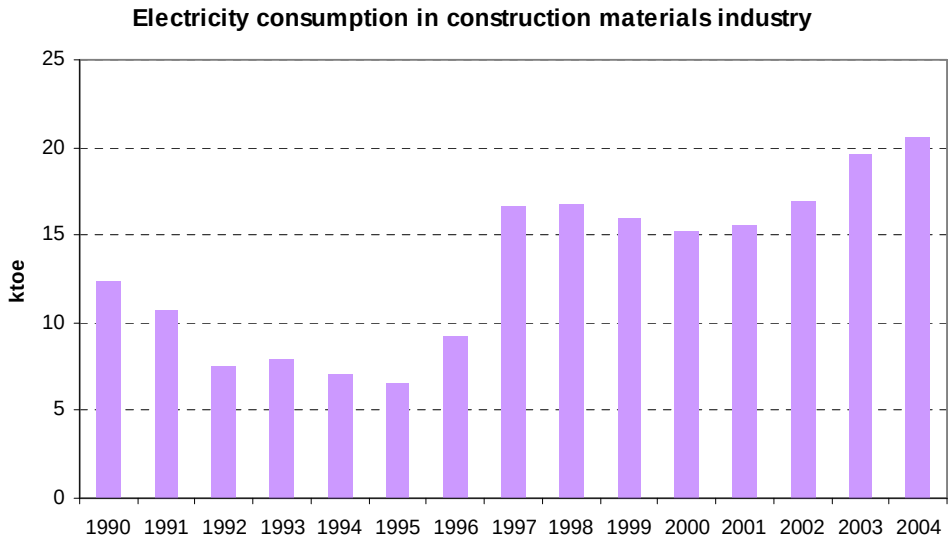
Figure 13: Unit consumption trends of energy intensive products



Groups that represent the largest energy consumers can be described separately.

Industry of construction materials: This group has very evident increase in energy consumption after 1996. Electricity consumption has reached its pre-war levels, while heat consumption has gone above 15% of that level. This decrease is connected with the production for post-war reconstruction and for larger investment projects. It should be said though that the largest part of consumption here is caused by the cement works. Electricity consumption in the industry of construction materials is shown in Figure 14.

Figure 14: Electricity consumption in the industry of construction materials



Potentials for the energy efficiency improvement here comprise waste heat utilization, fuel switch, improvement of machinery and technology, application of more efficient motors etc. Estimated potentials for savings here are some 800 TJ/year for thermal uses, and some 50-60 GWh/year in electricity.

Food processing industry: After the post-1990. decline this group reached its pre-war energy consumption level relatively quick. At using of thermal energy, by far the largest part goes to the consumption of steam and hot water, up to 83%. For the electricity consumption, meat processing industry is most important. The thermal consumption in the food industry is shown in Figure 15 and electricity consumption in Figure 16.

Figure 15: Thermal consumption in the food industry

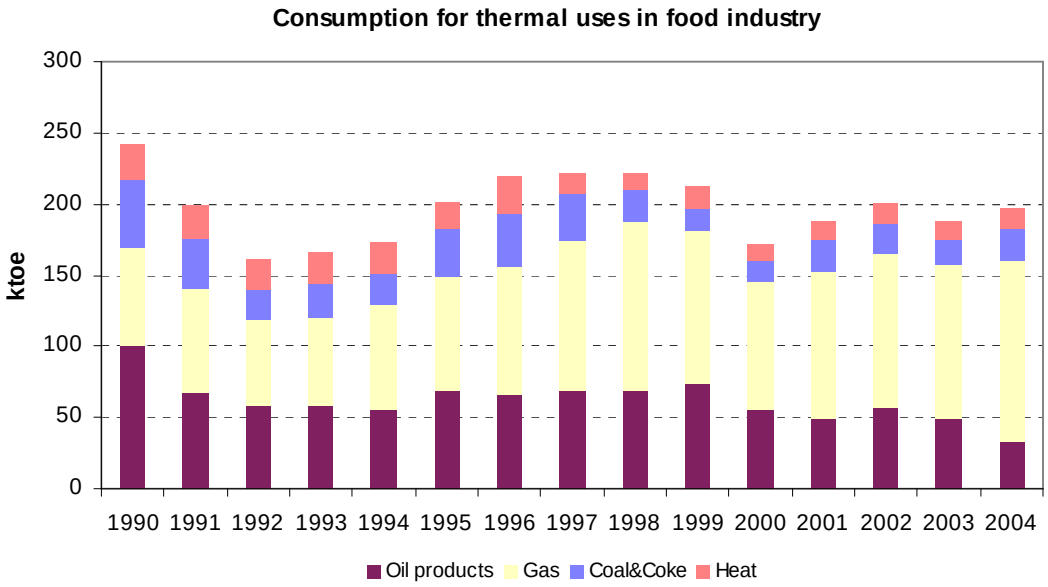
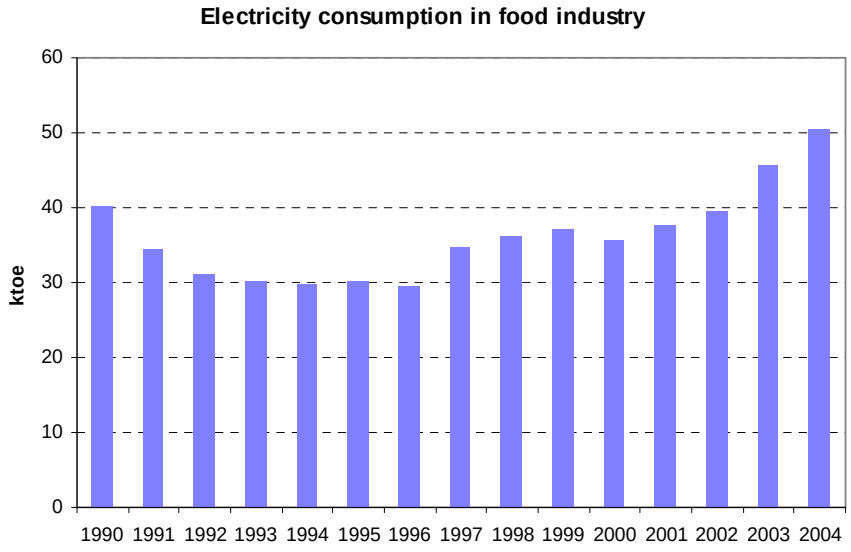


Figure 16: Electricity consumption in the food industry



Energy efficiency improvement potentials include applying of efficient motors and el. consumers, improvement of technology processes, machinery and other, for the electricity; for the heat, process rationalisation, use of waste heat, condensate and technology water re-use, and other measures should be considered.

Taking that in the account, in the food processing industries it would be possible to save annually some 50 GWh of electricity and some 800 TJ for thermal uses.

Chemical industry: The consumption of heat in this group is about 4 times larger than electricity consumption, regarded in same measuring units. The share of steam and hot water is significant, but after 1990 it decreases and approaches gaseous and liquid fuels. Natural gas has the most obvious growth in the fuel mix here. The thermal consumption in the chemical industry is shown in Figure 17 and electricity consumption in Figure 18.

Figure 17: Thermal consumption in the chemical industry

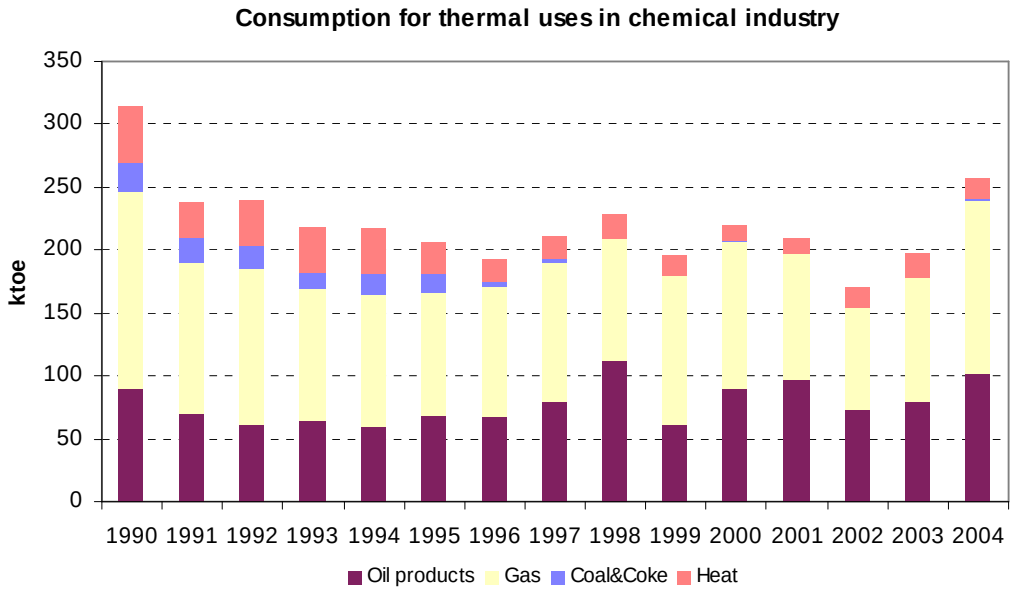
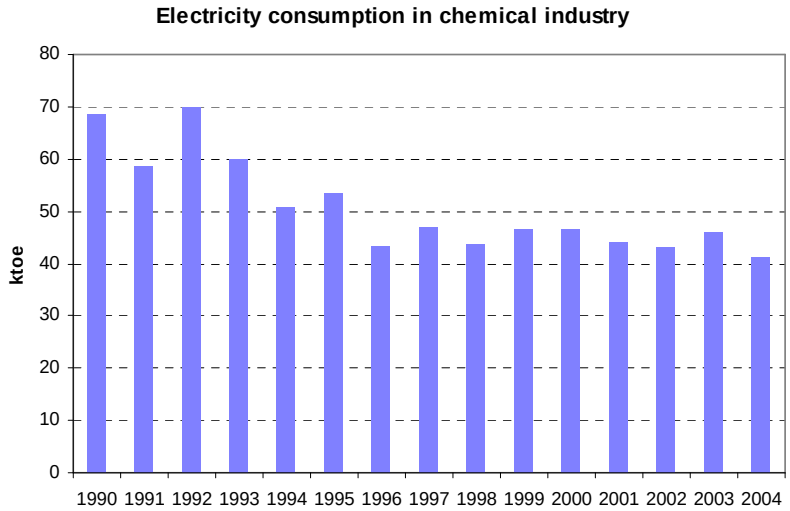


Figure 18: Electricity consumption in the chemical industry



Energy efficiency improvement potentials: process rationalization, waste heat recovery, boiler improvement and other measures for heat; for electricity, similar measures as in other industries, but it should be emphasized that the broader application of efficient motors and variable speed drives, at pumps and other devices, has great potentials.

Saving potentials in chemical industry are conservatively estimated to some 200-300 TJ/year for thermal uses and some 50 GWh/year of electrical energy, possible significantly higher.

In the 1995-1999 period, the final energy consumption (actual change) has increased by 0,3%/year with the growth of the added value by 2,3%/year (activity effect), as is shown in Figure 19. In the 1999-2004 period the share of energy intensive branches (chemical industry) was higher. Energy intensity effect (intensity with constant structure and without structural changes) has decreased by - 2,7%/year in period 1995-2004 while the actual intensity (intensity with structural changes) has increased by 1,6%/year in same period (Table 5). Structural effect is calculated as the difference between the regarded energy intensity and the energy intensity at constant structure.

Figure 19: Explanatory factors of the energy consumption of industry

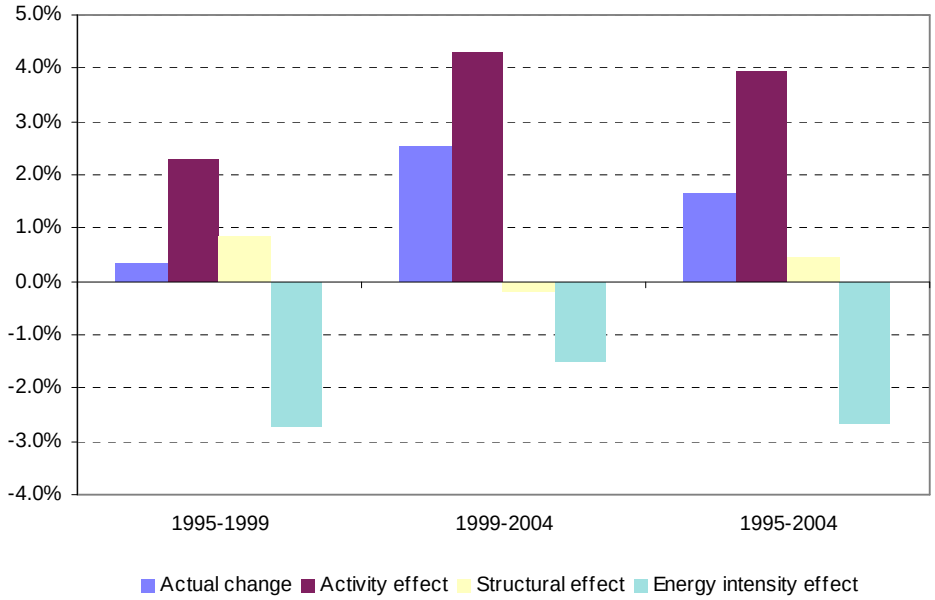


Table 5: Explanatory factors of the energy consumption of industry

	1995-1999	**1999-2004**	**1995-2004**
Actual change	0.3%	2.5%	1.6%
Activity effect	2.3%	4.3%	3.9%
Structural effect	0.8%	-0.2%	0.5%
Energy intensity effect	-2.7%	-1.5%	-2.7%

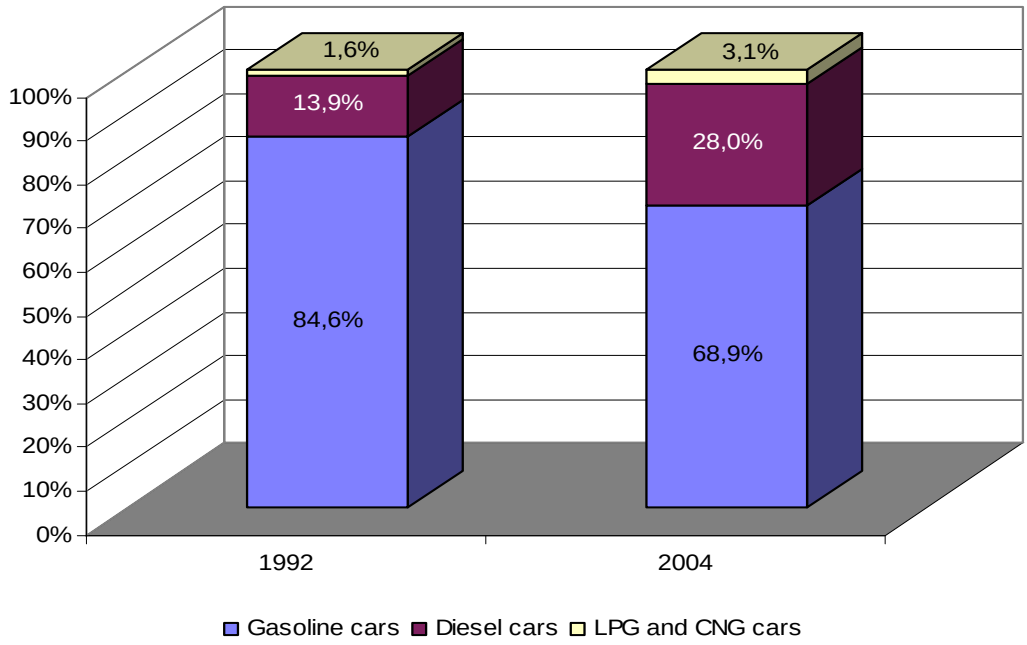
3.2.3. Transport

Energy Intensity in transport

The stock of cars recorded almost a continous and high growth since 1996 with an average yearly increase of 7,4%. The stock of cars doubled over the period, from 669 760 to 1 337 537.

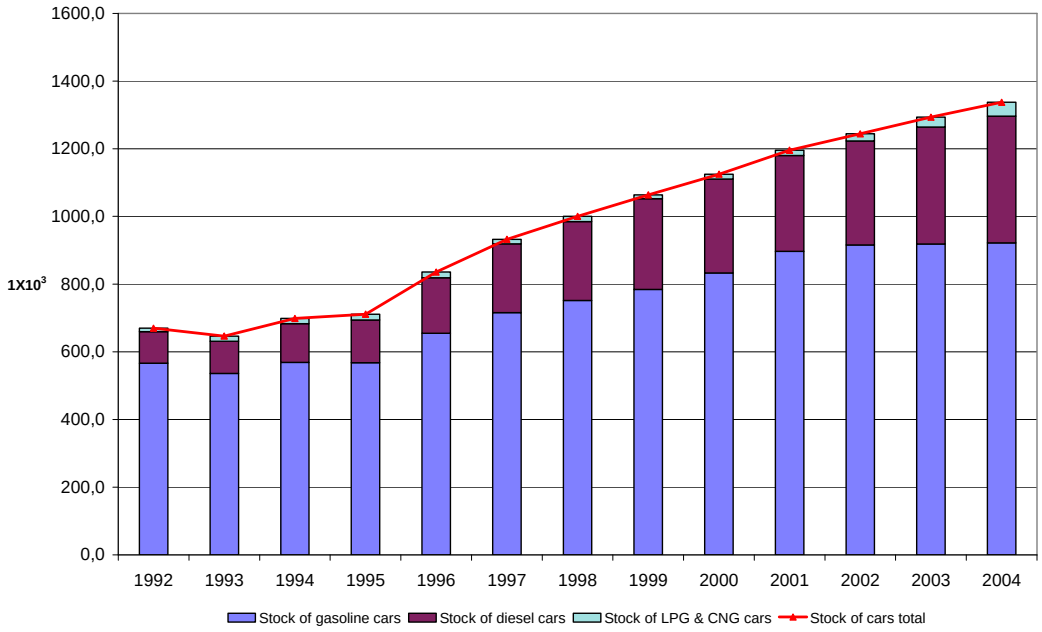
Also, as in the rest of Europe, there is a large increase, with further upward trend, in a number of new diesel personal cars (overall increased 303%). The share of gasoline cars decreased from 85% in 1992 to 69% in 2004, while share of gasoline cars increased from 14% up to 28% in 2004. The share of CNG and LPG cars doulbled, from 2% up to 3%, as it is shown in the following figure.

Figure 20: Structure of the cars by fuel type



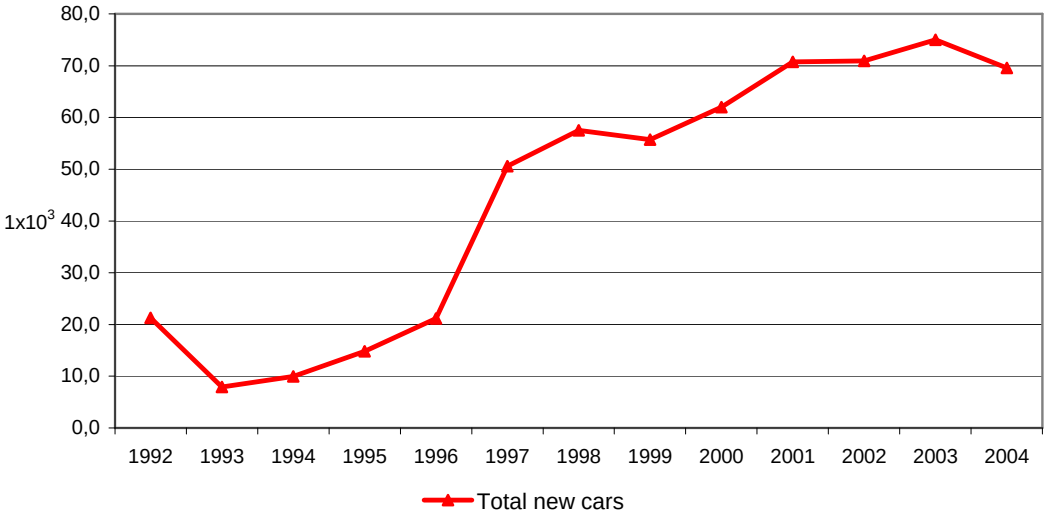
CNG is at the moment used mainly by the fleet (LDVs) of main gas distribution company of City of Zagreb, which is also the owner of only fuelling station in Croatia. Price difference is very favorable, but potential customers consider the price of CNG equipment still too high. Total number of CNG cars in 2004 amounted around 75, while total LPG number was around 41 000.

Figure 21: Stock of cars



The registration of new cars increased rapidly since 1996 from 20 000 new cars per year to 70 000 in 2001. It is almost stable since 2001.

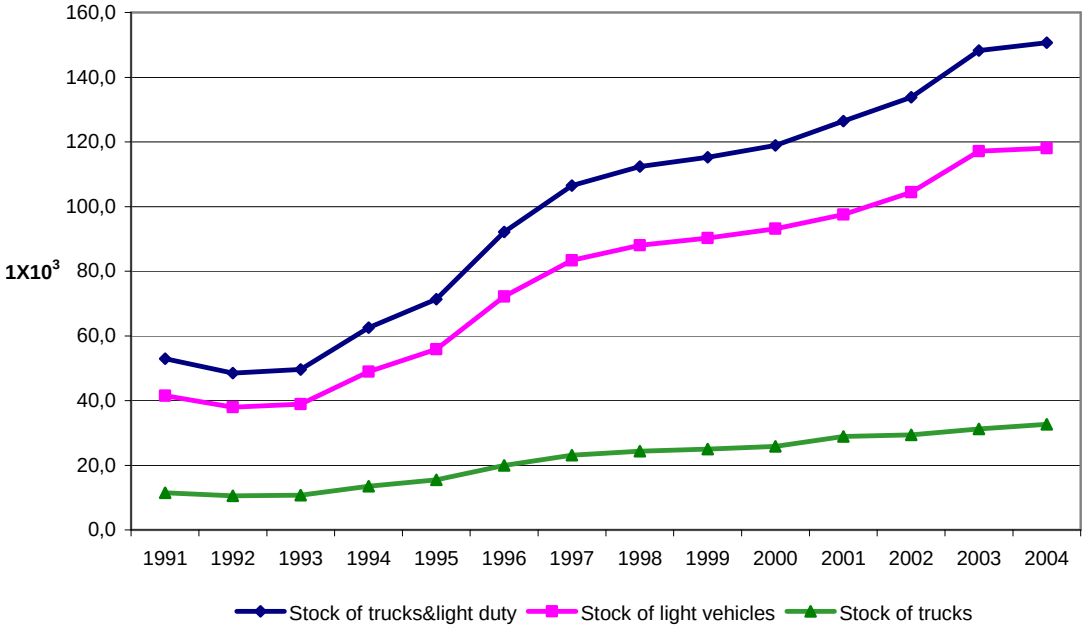
Figure 22: Stock of new cars



Stock of buses slightly increased within 1995 and 1996 (for about 18%) and than remained almost stabile.

The stock of trucks and light duty vehicles increased rapidly (211%).

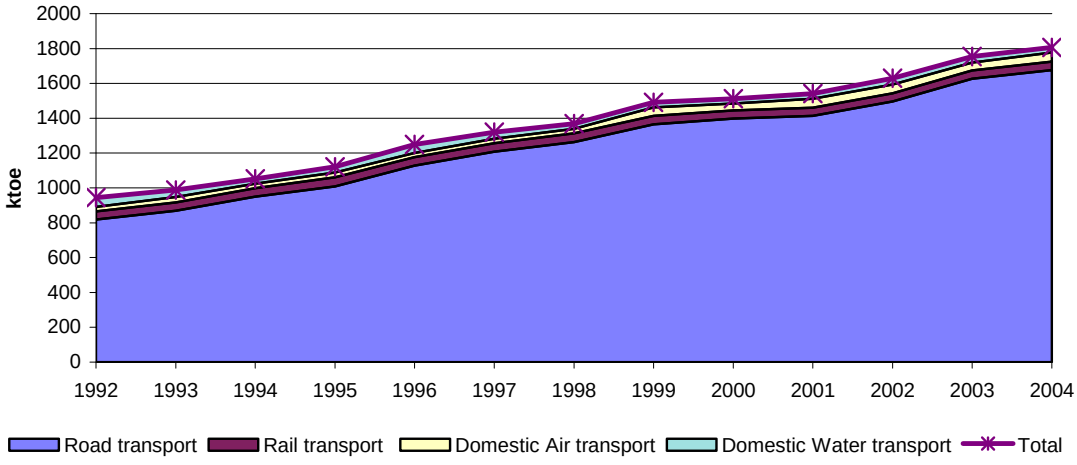
Figure 23: Stock of trucks & light duty vehicles



Energy consumption - Overall context

In the Republic of Croatia, between 1992 and 2004, total energy consumption in the transport sector increased by about 91%, from 0,95 Mtoe up to 1,81 Mtoe with an average yearly growth of 5,6 %. The consumption has increased quite linearly over the period.

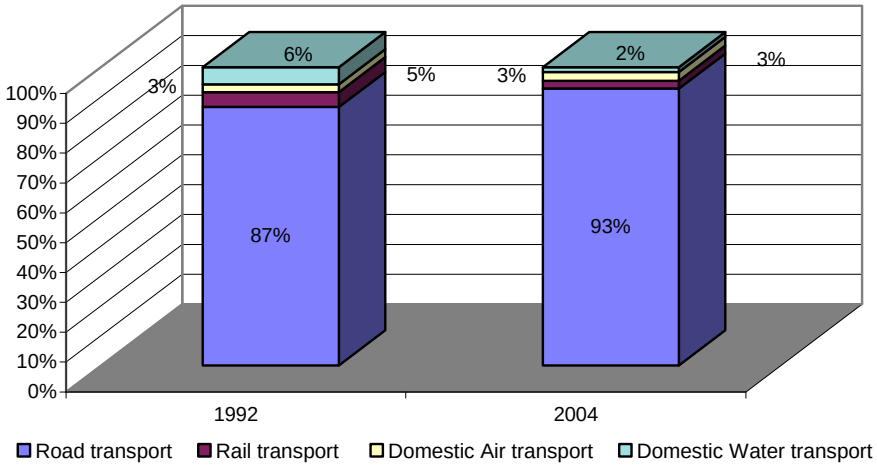
Figure 24: Overview of the consumption within period 1992-2004



Energy consumption trends

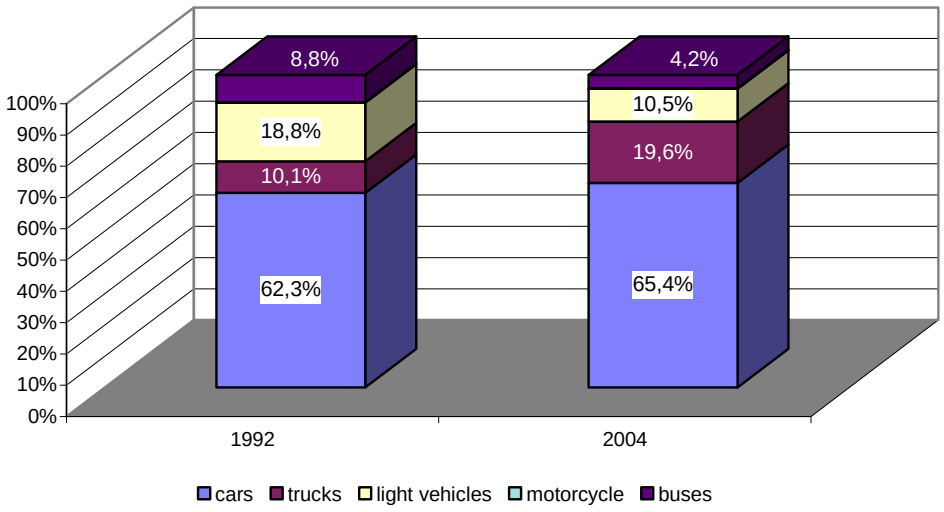
Road transport represents 87% of total consumption in 1992, while its share increased up to 93% in 2004. Share of rail transport decreased from 5% in 1992 to 3% in 2004, while the share of the domestic air transport remains stable at 3% (Figure 25).

Figure 25: Transport energy consumption mode



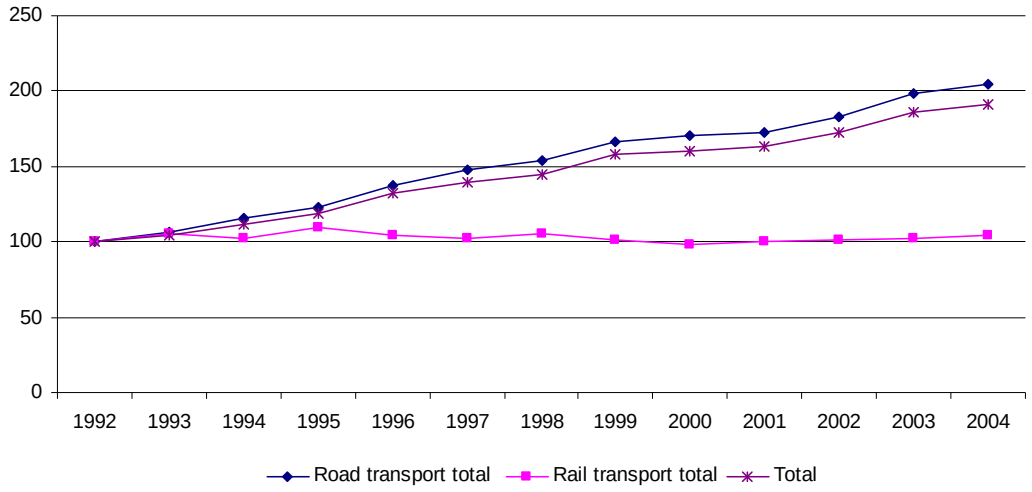
The share of cars in the road transport consumption slightly inreased over the period from 62% in 1992 up to 65% in 2004. Biggest change over occurred in the share of trucks which increased from 10% in 1992 up to almost 20% in 2004. Share of light vehicles and buses respectively from 19% to 10,5% and for buses from 9% to 4%.

Figure 26: Energy consumption of road transport by type of vehicles



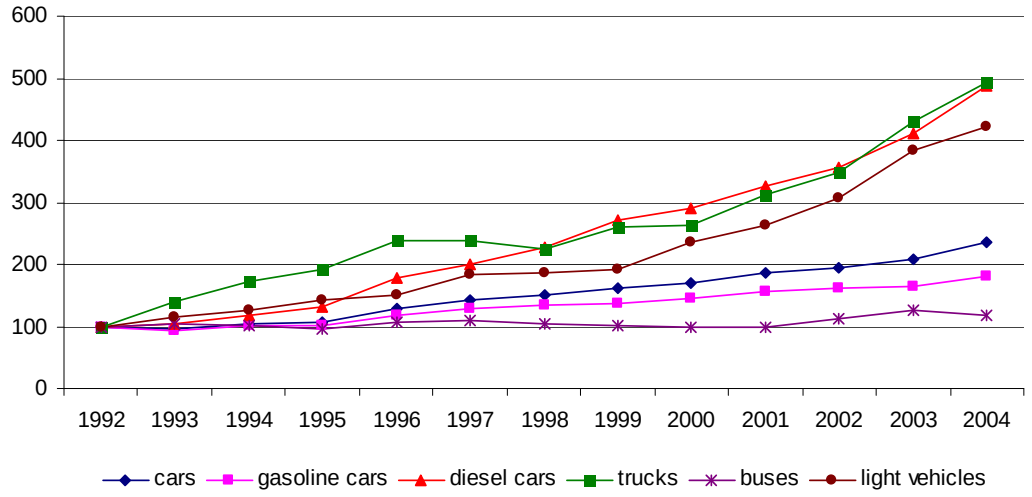
Since 1992, consumption in road transport increased by more than 100%, with average annual growth of 6,2%, where such a trend is reasonable due to almost double increase of vehicle stock as well as number of annual passed kilometers.

Figure 27: Evolution of the transport consumption by mode



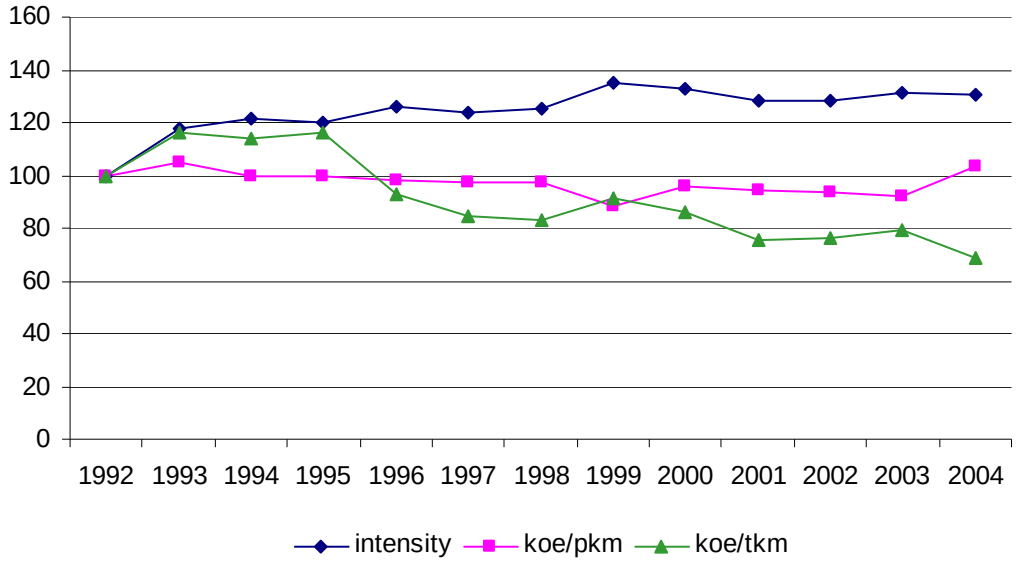
The biggest growth of road traffic in vehicle kilometers can be seen for trucks, diesel cars and light vehicles: trucks by 393%, diesel cars by 389% and light vehicles by 323%. Major reason for such development lies in enormous increase of freight traffic on road in post war period, since the Republic of Croatia has been passing through the “economy booming”. Buses seem to remain stable mode of transport all over the period.

Figure 28: Traffic of road vehicles (in vehicle kilometres)



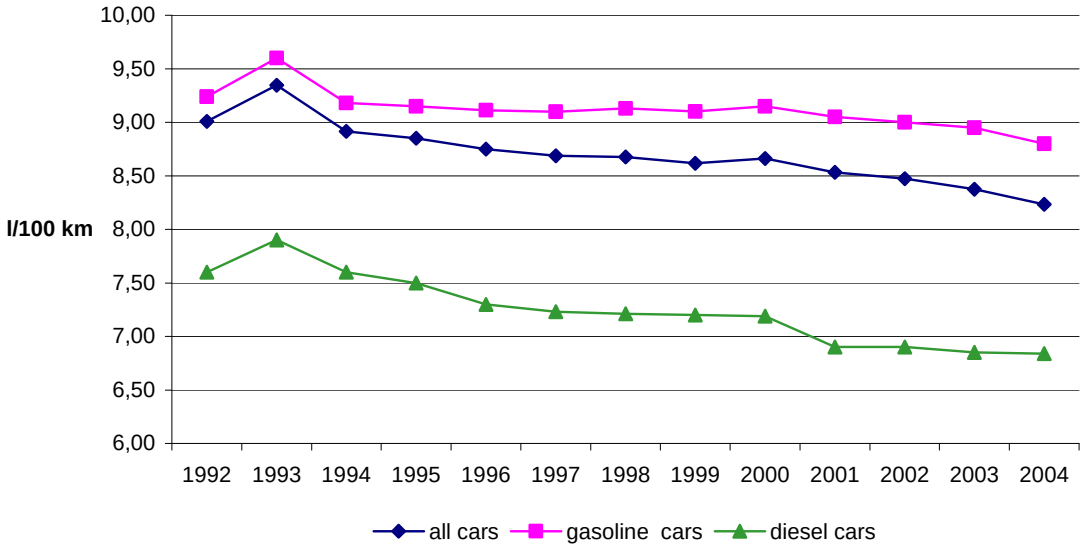
Final intensity of the transport sector (ratio of the energy consumption to the GDP in constant prices) has increased by 2,4%/year over the period. On the other hand, unit consumption per passenger - km almost remains stable, while unit consumption per tonne - km decreased for 31%.

Figure 29: Energy intensity, unit consumption per passenger-km and tone-km



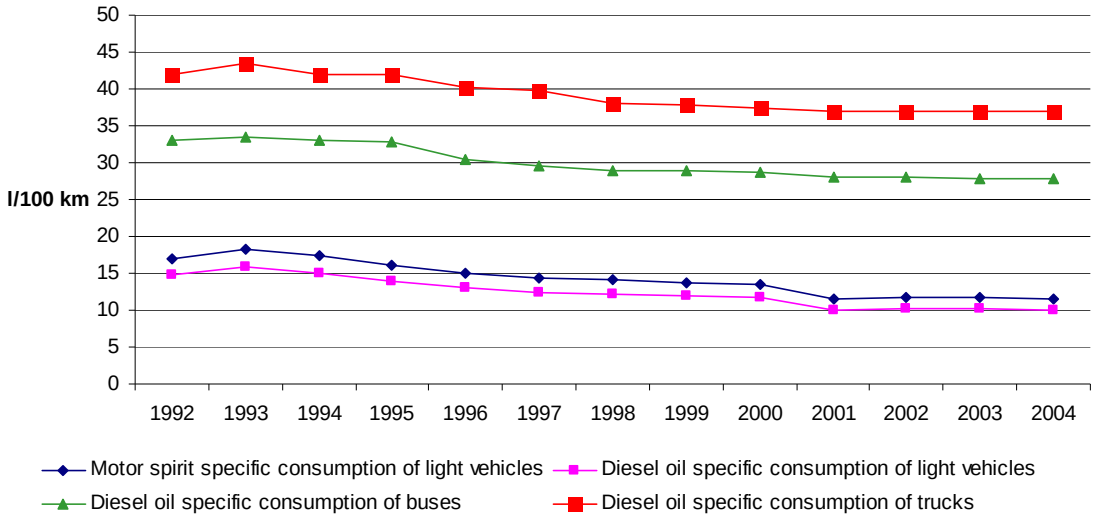
Specific consumption of cars decreased approximately by 9,5% overall , from 9 liters in 1992 to 8,2 liters in 2004. Accordingly, the specific consumption of gasoline cars decreased by 5%, from 9,2 liters to 8,8 liters and diesel cars consumption decreased by 11%, from 7,6 liters to 6,8 liters per 100 km. This trend is explained by increased availability of commercial loans for vehicles to the wider population which led to the huge substitution of old vehicles with new ones (consequently, enhanced vehicles has boosted on the market).

Figure 30: Specific consumption of cars



As for the other types of vehicles, biggest reduction in the specific consumption was obtained by diesel light vehicles (15%).

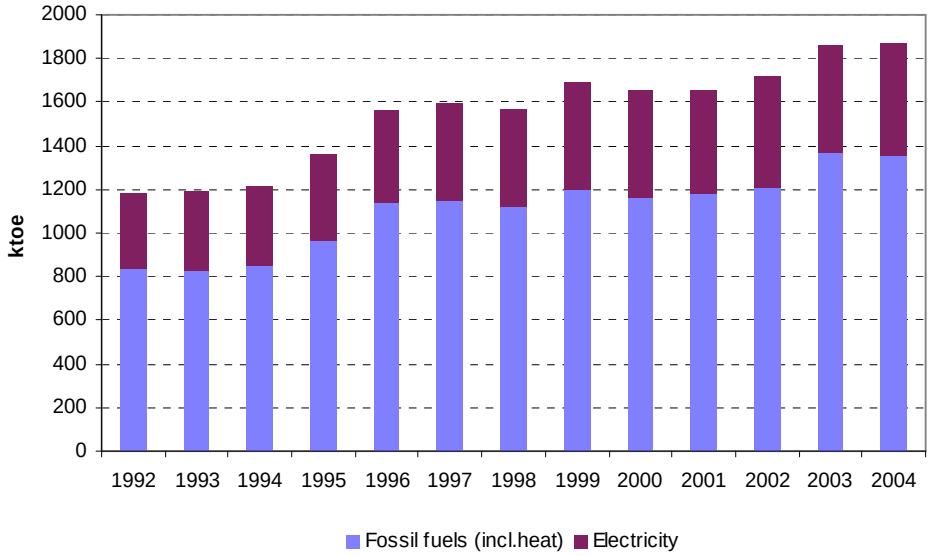
Figure 31: Specific consumption of buses, light vehicles & trucks



3.2.4. Households

Between 1992 and 2004, final energy consumption of Croatian households grew from 1,57 Mtoe to 1,87 Mtoe (not climate-corrected). The increase of energy consumption in 1996 was mainly due to the colder weather but also with the increasing of living standard, since the population size, the number of households and dwellings have not changed much in Croatia during the period. Figure 34 presents development of household energy consumption between 1992 and 2002 (because of the rapid energy decrease in period 1990-1992 due to the war operations).

Figure 32: Development of household energy consumption between 1992-2002 (not-climate corrected)



The highest market share in final consumption of households 1992 was for electricity and oil products (29%), and in 2004 their shares increased for electricity to 32% and decreased for oil (27%) (Figure 35). The share of gas increased from 17% in 1992 to 23% in 2004. Biomass consumption decreased from 15% to 11% so the share of heat (from 9% to 7%). Consumption of coal in households is very small (around 1%).

The share of space heating in total energy consumption of households incresed from 57% in 1992 to 62% in 2004, as more dwellings have central heating, which requires on average twice more energy than with room heating (Figure 36). The share of electric appliances and lighting and of water heating remained stable (11% and around 12%) in the period, while the share of cooking decreased from 16% to 12%.

Figure 33: Final energy consumption of households by energy carrier

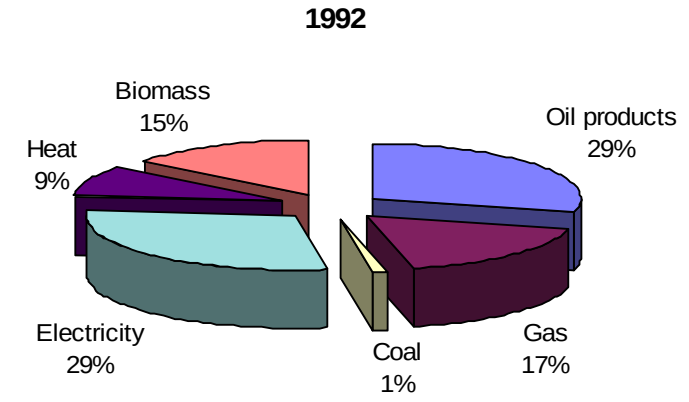
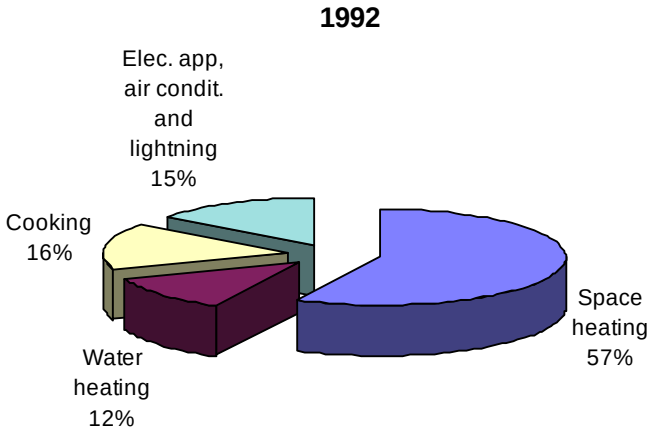


Figure 34: Households energy consumption by end-uses



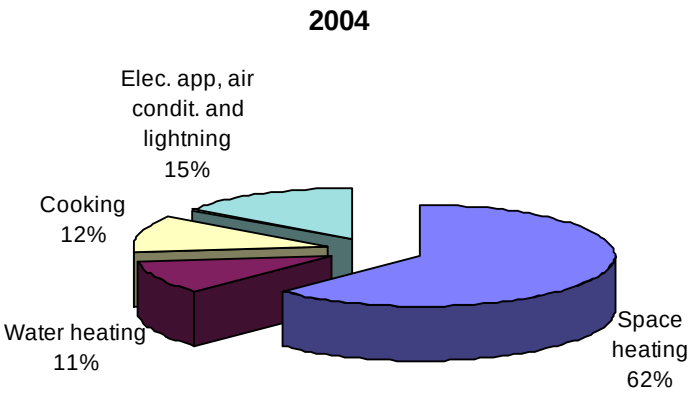
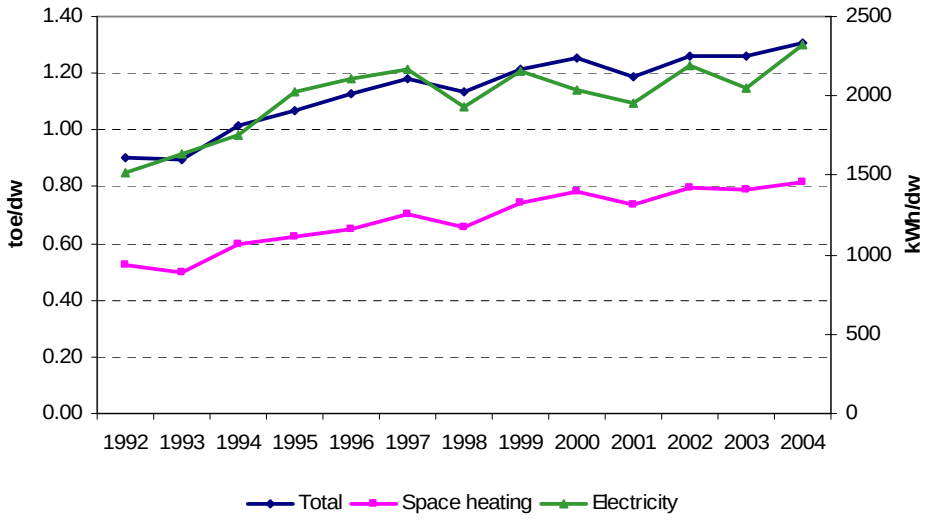


Figure 37 shows the trends in the average energy consumption per dwelling for all end-uses and space heating (both climate corrected, in toe/dwelling) and for specific uses of electricity (for electrical appliances, air conditioning and lighting, in kWh/dwelling). The average growth rate of the unit consumption per dwelling for all end-uses in the period 1992-2004 was 3,2%/year, 3,7%/year for space heating and 3,6%/year for specific uses of electricity. The rapid growth of the electricity consumption for electrical appliances, air conditioning and lighting is explained by a larger diffusion of large household appliances and the rapid penetration of air conditioning)[3]. The reason for growth in specific energy consumption for space heating in households was better living standard and increase in share of central heated apartments[4].

Figure 35: Unit consumption of households in toe/dwelling (total and space heating climate corrected and electrical appliances, air conditioning and lightning)



[3] The share of air conditioned households has changed from 2% in 1990 to 24% in 2004 (result from the model). The second influence comes from the increase in number of TV, computers and similar appliances with the average growth rate of 1,6%/year from 1994-2004 (result from the model). The similar growth rate was for refrigerators and freezers.

[4] The share of central heated dwellings has changed from 25% in 1994 to 40% in 2004 (results from the model).

3.2.5. Services

Electricity has the highest share in energy consumption in service sector with a stable value of 51% during the whole period. The most important changes in the services consumption concern oil and heat; oil increased its market share from 18% to 25% from 1992 to 2004, while there was a decrease for heat from 11% to 6%. The share of gas remained stable at around 18%, while the share of coal is very small (under 1%), as shown in Figure 38.

Because there are no available data on total energy consumption by sub-sector for the service sector in Croatia, Figure 39 presents electricity consumption by sub-sector; ther was almost no changes in share of electricity consumption by sub-sectors. Hotels represents the largest share of the electricity consumpion of the sector (around one third).

Because of statistical disruptions in available data the unit consumption per employee in the service sector is presented for the period 1998-2004, with growth rate of 0,8%/year (Figure 40). The unit consumption for electricity increased with growth rate of 2,4%/year.

Figure 36: Final energy consumption of services by energy carrier

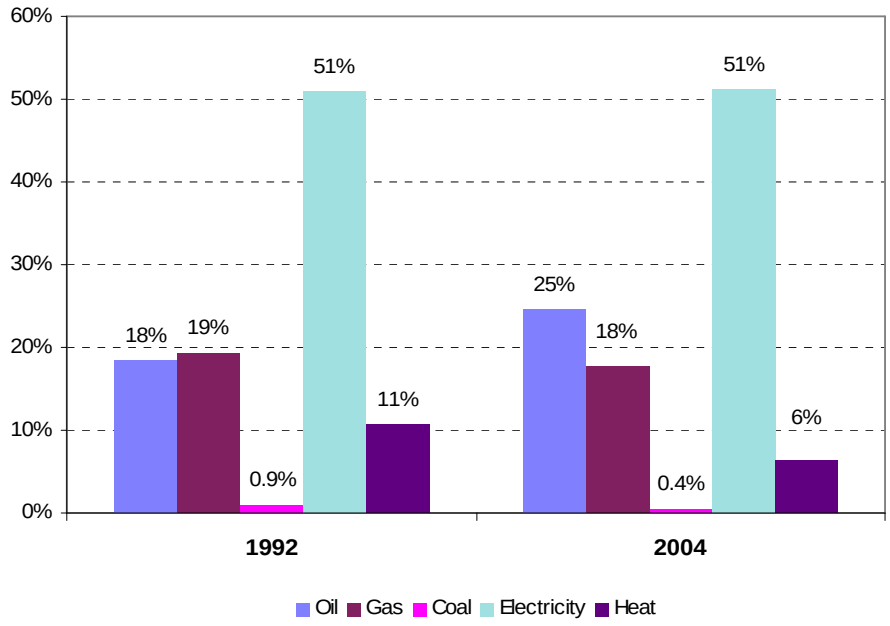


Figure 37: Electricity consumption of services by sub-sector

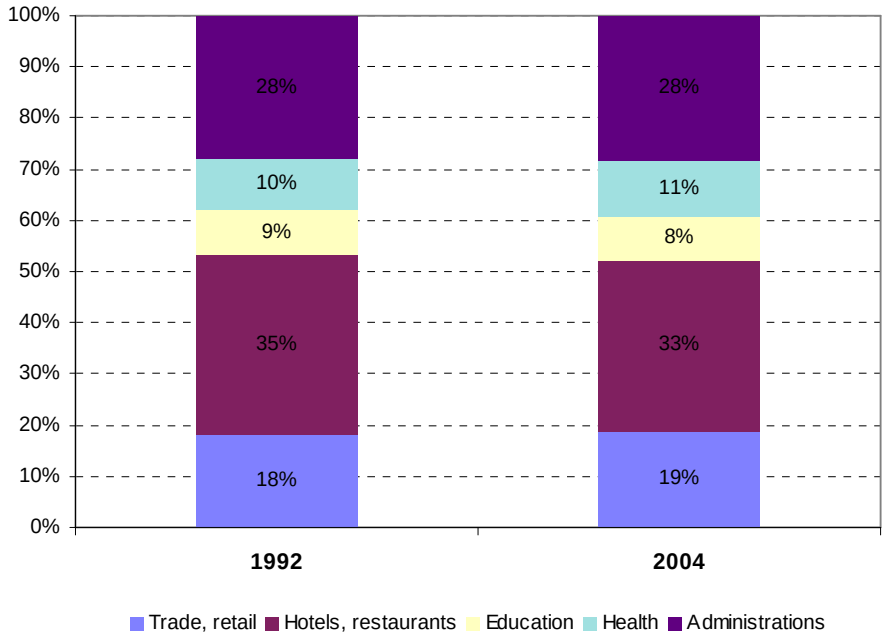
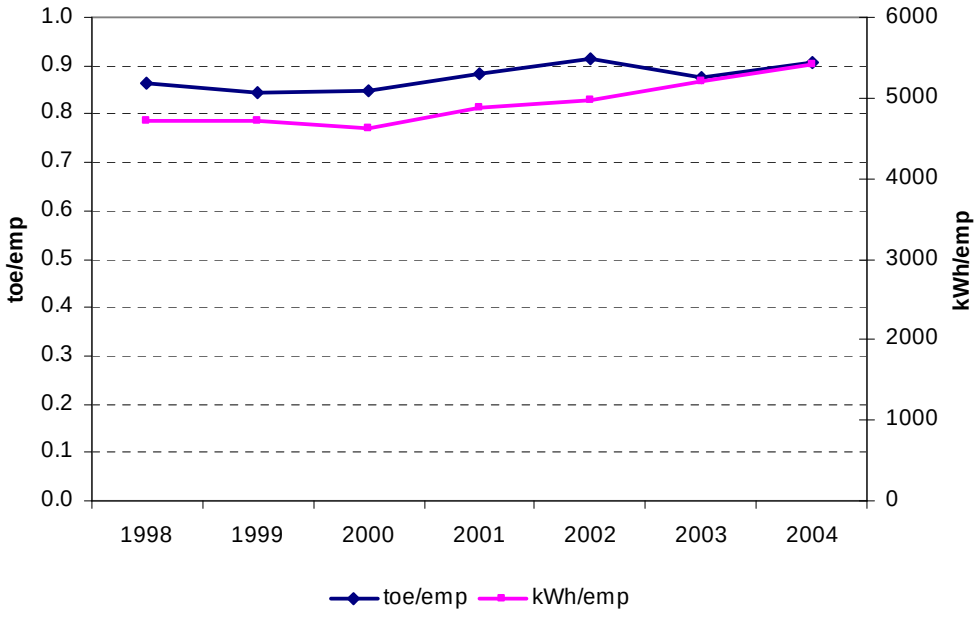


Figure 38: Energy consumption per employee in services (with climate corrections)



The energy intensity of services had different growth rates in the period; 8,2%/year in 1992-1996, 0,0%/year in 1996-2001, 0,6%/year in 2001-2004 and 2,8%/year in 1992-2004. Electricity intensity in services had growth rate of 2,9%/year in 1992-2004.

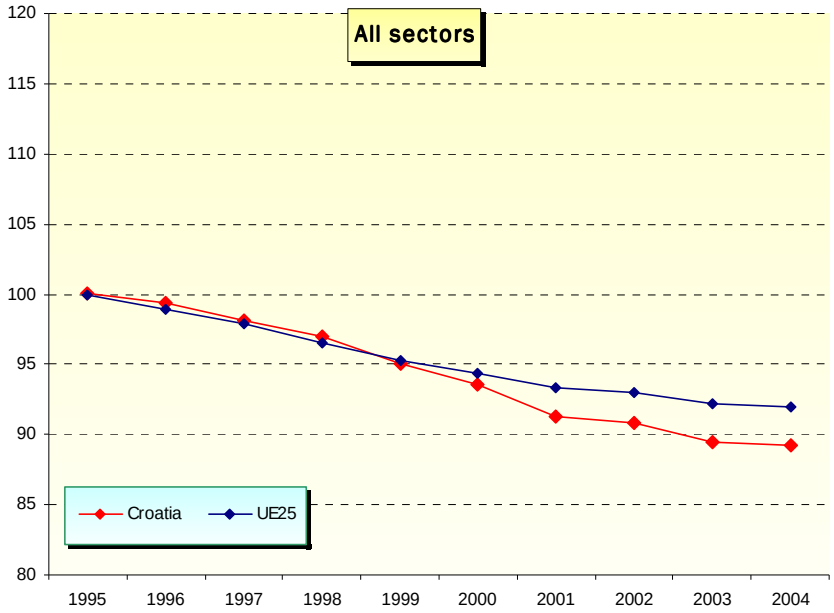
3.3. *Energy efficiency by sector*

The improvement in energy efficiency could be observed in all sectors based on the ODEX which calculates technical efficiency improvements. There were energy efficiency improvements for all sectors in Croatia, except in chemicals sector and households sector.

3.3.1. Overall energy efficiency

In the period 1995-2004 the energy efficiency index for the whole economy (ODEX) decreased by 11%, compared to 8% decrease for the EU-25. The industrial sector (cement and paper) and transport sector (rail and trucks&light vehicles) contributed the most to this development.

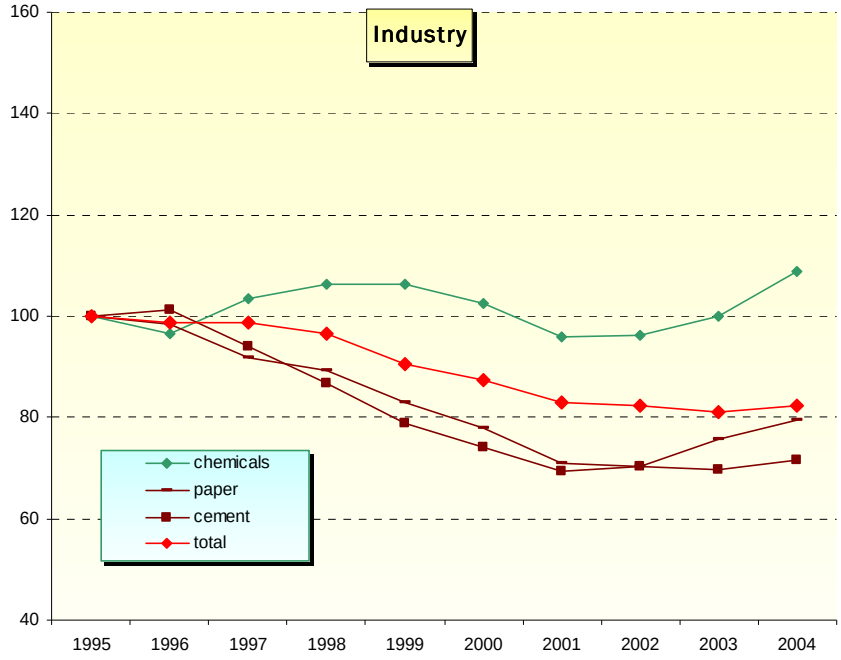
Figure 39: Energy efficiency index for all sectors



3.3.2. Industry

The efficiency in the industrial sector progressed by about 18% in 2004 compared to 1995. The paper and cement branches contributed to decrease the overall industrial efficiency index, because of decrease in specific energy consumption, while chemicals contributed to increase of the efficiency index. The values for Croatia is above the EU-25 value (11%) for energy efficiency improvement in industry. This index could only be calculated from 1995 because of data unavailability for industrial sector from 1990.

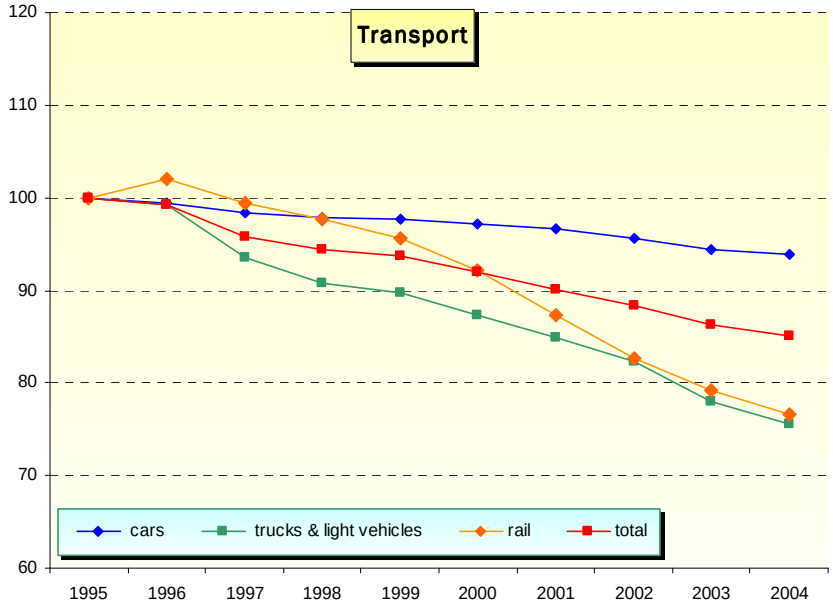
Figure 40: Energy efficiency index for industry



3.3.3. Transport

The energy efficiency index for transport sector improved by 15% in 2004 compared to the base year 1995, which is above the EU-25 level of 8%. The highest efficiency improvements was for trucks and light vehicles (25%), while cars had smaller improvement (6%).

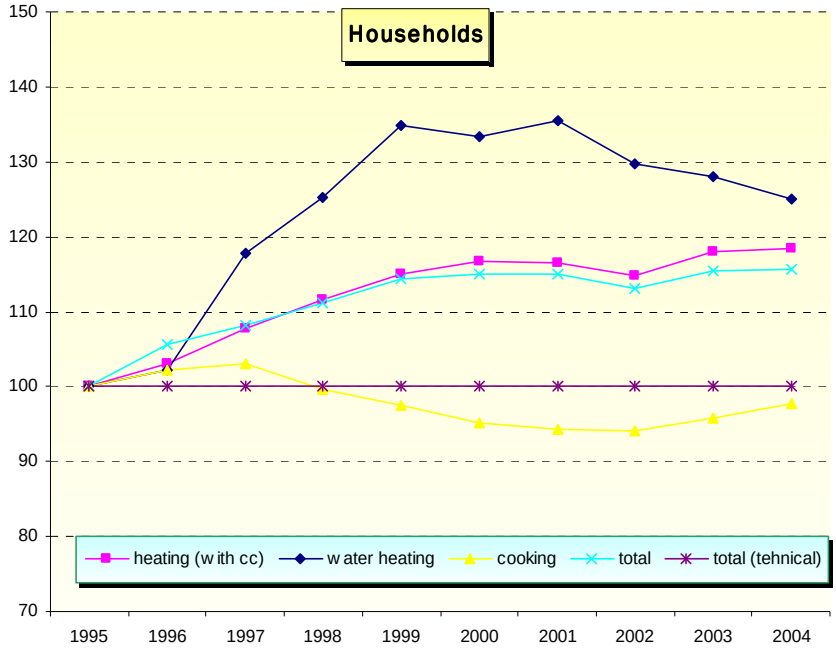
Figure 41: Energy efficiency index for transport



3.3.4. Households

Between 1995 and 2004 the technical energy efficiency index in the households sector was constant, while the trend in EU-25 showed energy efficiency index improvement for 7%; households sector in Croatia has no improvement of energy efficiency. The reason for this is increased specific energy consumption for heating per dwelling in period 1995-2004 (with the exception for years 1998 and 2001 with decreased energy consumption due to climate conditions). In the period 1995-2004 energy for heating increased, while the number of households first increased (until 2000) and after that remained stable.

Figure 42: Energy efficiency index for households



4. CO_2 emissions

In ODYSSEE, two types of emissions are considered: direct emissions and total emissions. Direct CO_2 emissions correspond to emissions generated at level of the consumers by the combustion of oil, gas and coal. Total CO_2 emissions includes in addition to the direct emissions, the indirect emissions generated at the level of power plants by the production of electricity consumed in each of the end-use sectors; total emissions show the responsibility of each end-use sector in the total emissions of the country.

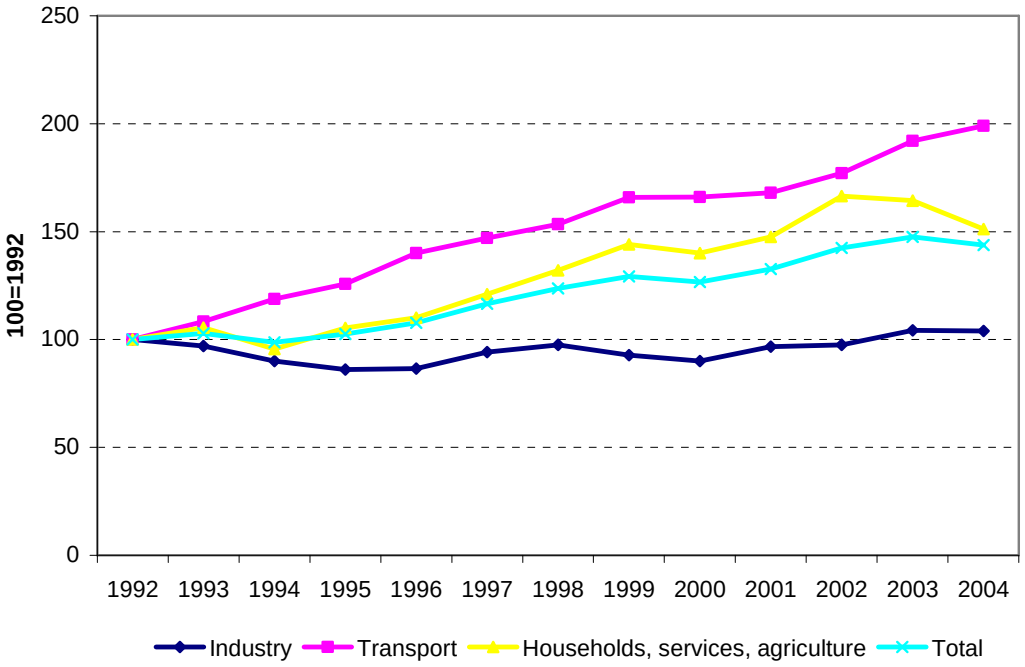
Direct CO_2 emissions

Direct CO_2 emissions (emissions from final consumers) in Croatia have increased by 54% since 1992. The highest increase was in transport sectors (99%) and after that in households, services and agriculture sectors (60%). The emissions increasing in industry sector was 12%.

Total CO_2 emissions

Total CO_2 emissions in Croatia have increased by 44% since 1992. This change differs from from change in direct CO_2 emissions because of emissions impact from electricity generation mix.

Figure 43: Total CO_2 emissions by sector (1992=100)



5. Conclusion

Between 1992 and 2004, the primary energy intensity decreased much more than the final intensity (Table 3): -0,6%/year on average compared to -0,3%/year. The strongest reduction in primary intensity was in the period from 2001 to 2004 (-1,6%/year), and for the final intensity in the same period (-1,1%/year).

The energy intensity (actual intensity) in manufacturing has decreased by -2,2%/year from 1995 to 2004, with the highest decrease in period 1995-2001 (-2,6%/year). The reason for intensity decrease was the changes in structural components.

Final intensity of the transport sector (ratio of the energy consumption to the GDP in constant prices) has increased by 2,4%/year over the period. On the other hand, unit consumption per passenger - km almost remains stable, while unit consumption per tonne - km decreased for 31%.

In households sector, the average growth rate of the unit consumption per dwelling for all end-uses in the period 1992-2004 was 3,2%/year, 3,7%/year for space heating and 3,6%/year for specific uses of electricity.

The unit consumption per employee in the service sector fluctuated inr the period 1998-2004, with growth rate of 0,8%/year. For electricity the unit consumption increased with growth rate of 2,4%/year.

6. Literature

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Matić. D. and authors: International Gas Union (IGU) – Study Group 5.3, Global Opportunities for Natural Gas as a Transportation Fuel for Today and Tomorrow – Final report, Energy Institute Hrvoje Požar, Zagreb, December 2005.

7. ANNEX 1

Review of data collection and updating

Data sources for macroeconomic data, considering economic growth and value added by economic sectors, were official publications of Central Bureau of Statistics of Republic of Croatia and World Bank's World Development Indicators (WDI) database for 2005. Since Central Bureau of Statistics of Republic of Croatia does not publish data on value added on disaggregated level needed for calculations in Odyssee Data Base, WDI Database was used. World Bank uses data collected form national statistics so the main data source is still Central Bureau of Statistics of Republic of Croatia, but publishes it on disaggregated level and based on methodology defined and required for Odyssee Data base. The only problem with WDI data set was the fact that all the data on economic activity and value added is in local currency unity in current prices. From data in current prices a set of chain indexes was constructed and based on that fact the chain indexes were recalculated in base indexes with 2000 as base year (as suggested and required by Odyssee Data Base instructions). The procedure of constructing base indexes resulted with new data set on value added by economic sector but expressed in constant prices of 2000 local currency unit.

Data sources for residential sector were National Population Survey for the Republic of Croatia from 2001 (number and structure of dwellings, number of population, share of central heated dwellings). Informations about the sales of electrical appliances by label class for 2004 is available from the report "Capacity Building Programme for the Removal of Barriers to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labelling in EU Candidate Countries". Data for the final energy consumption is available from the "Energy in Croatia - Annual Energy Report" which is national energy balance for Croatia and is prepared every year. All other data are available as the result from ENPEP model for residential sector in Croatia.

Data avilability for tertiary sector are not good as for residential sector. Croatian Central Bureau of Statistics provides data for the employement for each service sub-sector, while the final energy consumption comes from the "Energy in Croatia - Annual Energy Report".

Data for final energy consumption in agriculture is available from the national energy balances in the "Energy in Croatia - Annual Energy Report".

The most important data for transport sector has been gathered from Croatian Central Bureau of Statistics, particularly from the Statistical Yearbooks (stock of vehicles, transport of goods and passenger traffic).

The other important source of specific data about registred vehicles is Department of Statistics of Ministry of Interior and The Vehicle Centre of Croatia (VCC). Since the only institution which is monitoring annual passed kilometers of cars, buses trucks & light vehicles from year 2001 is the VCC, this data has been integrated into the model, while the rest of data of annual passed kilometers has been calculated and provided on the model basis.

Data for the overall energy consumption of the transport splitted by the sectors has been taken from Energy in Croatia, official Croatian annual energy report.

As for the energy consumption of urban public transport in Zagreb, the capital city of Croatia, as well as passenger and vehicle traffic, questionnaires had been referred to the Zagreb city transport company - ZET from whom the data were gathered.

The following explanations for sectors explain which remarks have to be made.

Industrial sector

Data for estimated potentials for savings in TJ/year for several industrial sub-sectors are taken from ”Energy Efficiency in Small and Medium Size Enterprises” report.

Residential sector

Despite the fact of good availability of data for residental sector (number of households, stock of dweelings etc.) for the period 1990-2004, there are needs to improve data collecting for:

- Annual construction of dwellings (single family houses)
- Number of dwellings connected to district heating (this data is available for 2004)
- Average size for old dwellings (single family houses/apartments) and new dwellings
- Annual sales of electrical appliances for the period 1990-1999
- Sales of electrical appliances by label class (available for 2004)
- Specific consumption of new electrical appliances
- Specific consumption for space heating for new dwellings.

Tertiary sector

Electricity consumption is the only data available for sub-sectoral energy data in tertiary sector and this data is the result from the model. There is a need to improve this model in order to obtain energy consumption for each energy type and sub-sector.

Transport sector

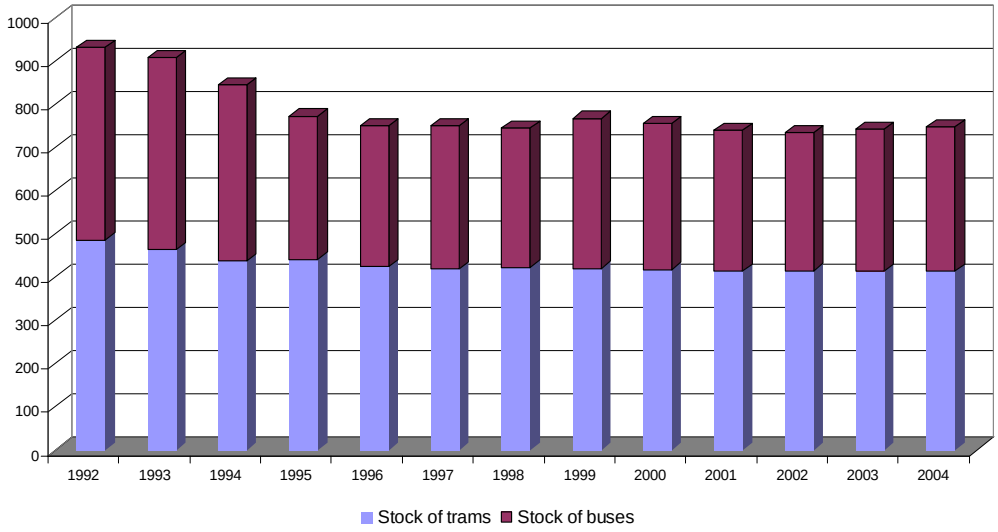
Since the transport sector has all data available for the period 1990-2004, the practice with data sources and transport model will continue for coming years.

8. ANNEX 2

Energy consumption in Zagreb public transport

The fleet of the ZET consist of buses and trams as it is shown in next figure. Share of the buses in total fleet stock adresses 48% in 1992, while in 2004 decresed for 3%.

Figure 44: Stock of trams and buses in Zagreb pubic transport company - ZET fleet



Next figure justifies over loading of the public transport fleet since 2001 onward: stock of the vehicles remained stable while energy consumtion increased. Electricity consumption of trams consumption decreased by 7% while diesel fuel consumption of buses decreased for 11% overall.

Figure 45: Evolution of the transport consumption by mode in capital city urban transport

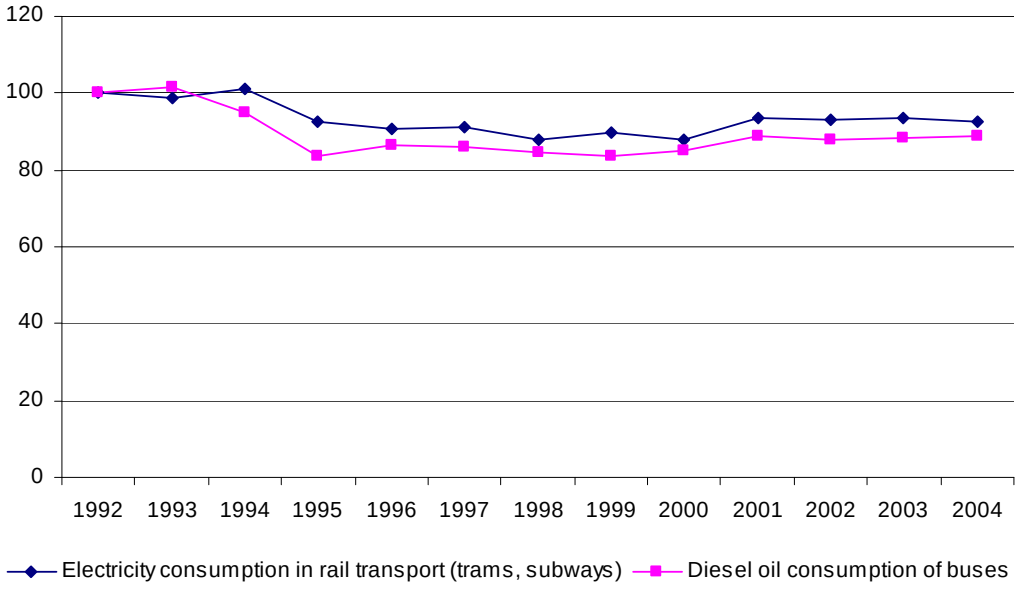


Figure 46: Vehicle traffic of urban transport in capital city (vehicle kilometers)

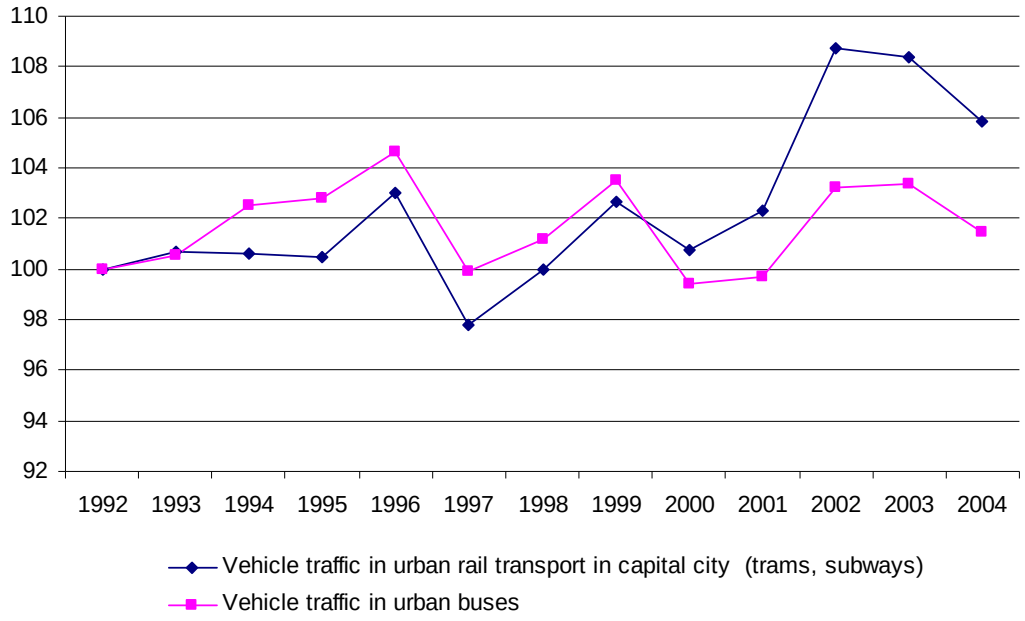
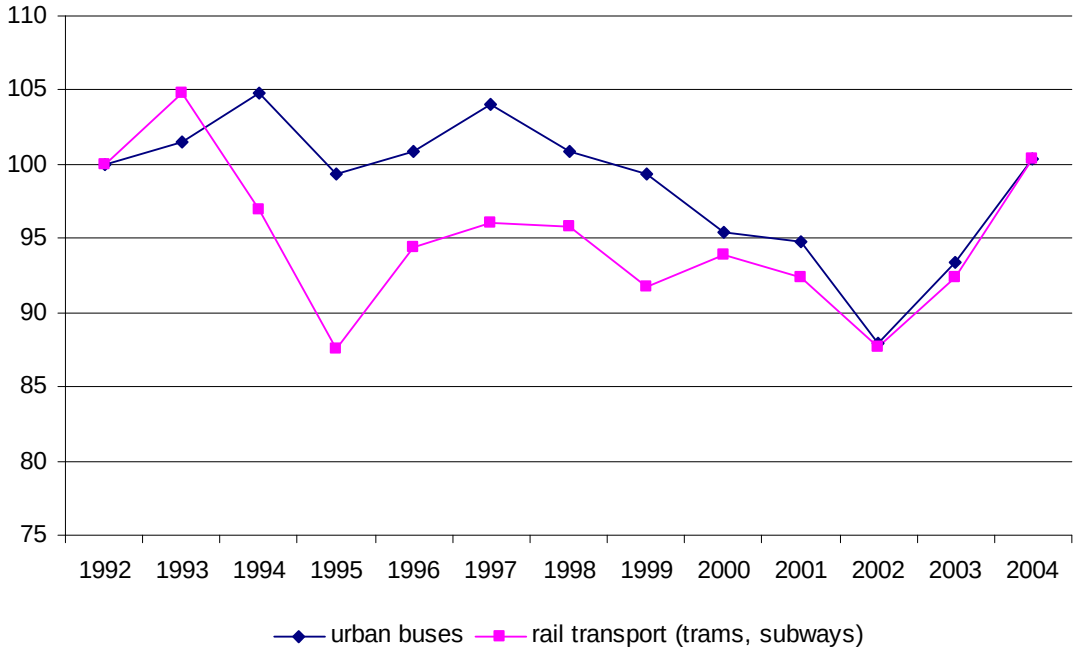


Figure 47: Unit consumption per passenger-km in capital city



9. ANNEX 3

Energy efficiency trends in EU New Member Countries (NMC`s) and Croatia

Figure 48: Primary and final energy intensities trends in NMC`s and EU-25, at normal climate (1996-2004), at normal climate

Primary intensity decreases faster ➔higher efficiency of power generation in Croatia, EU-10, Hungary (gas combined cycle), Romania, and lower electricity imports (Hungary)

Primary intensity decreases slower ➔ higher share of nuclear (Slovakia, Bulgaria), increased electricity exports (Poland, Slovakia, Bulgaria)

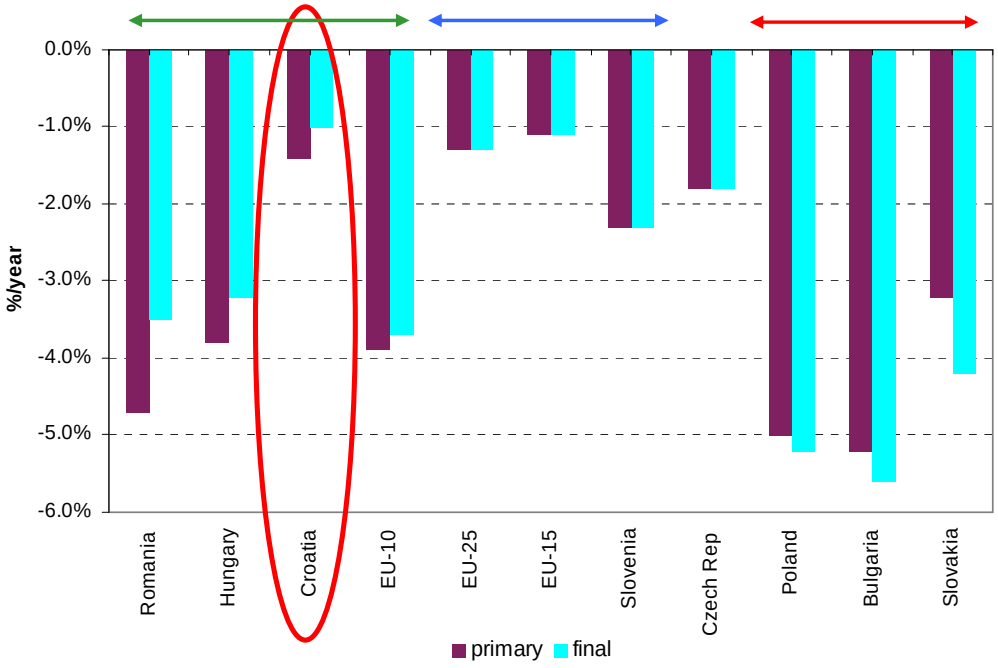


Figure 49: Trends in industrial energy intensities in NMC (1995-2004)

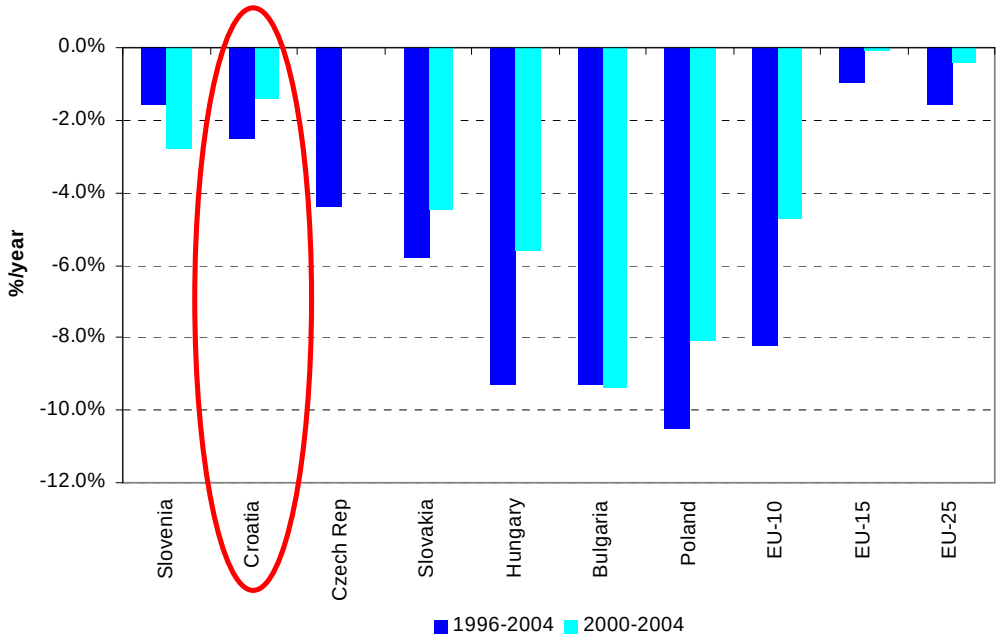


Figure 50: Comparison of energy efficiency trends in industry

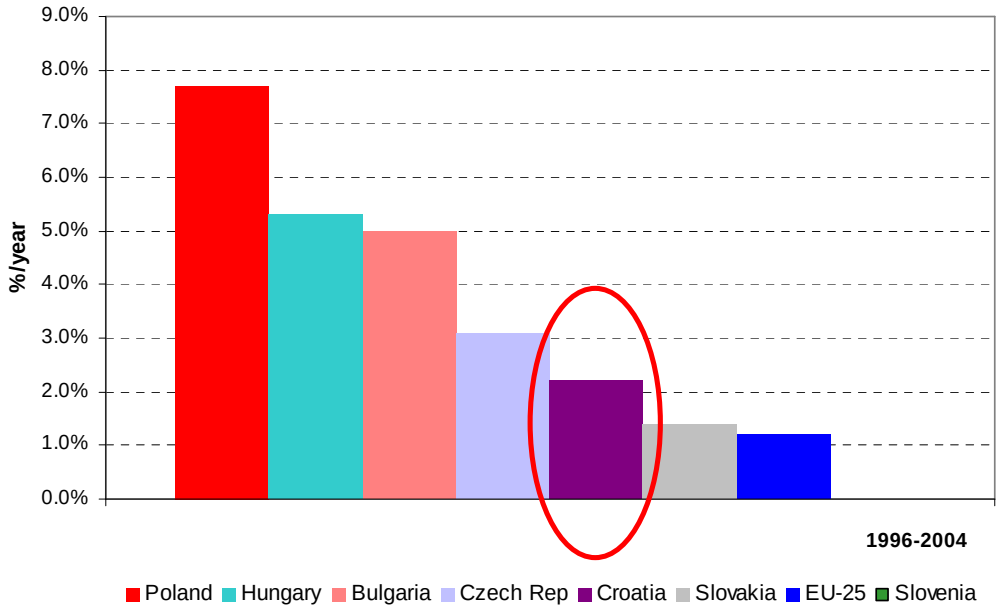


Figure 51: Energy consumption trends in road transport

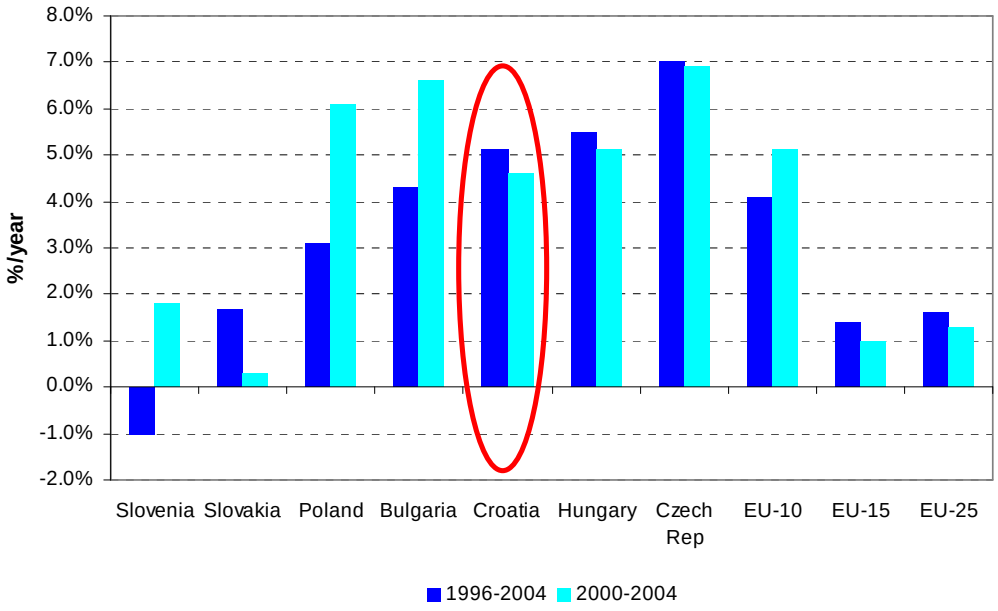


Figure 52: Unit energy consumption of cars

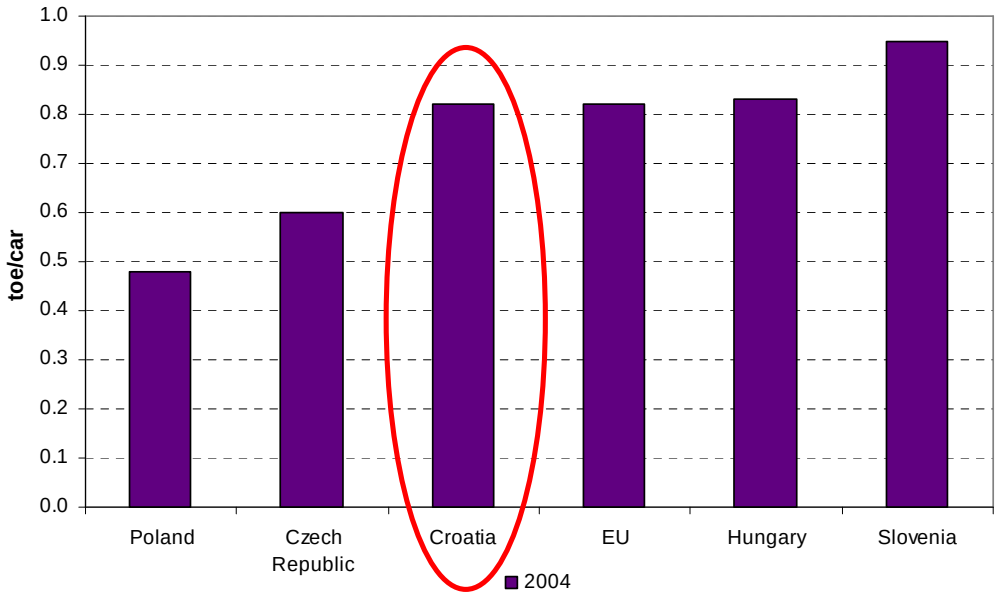


Figure 53: Average consumption per m^2 for space heating in households

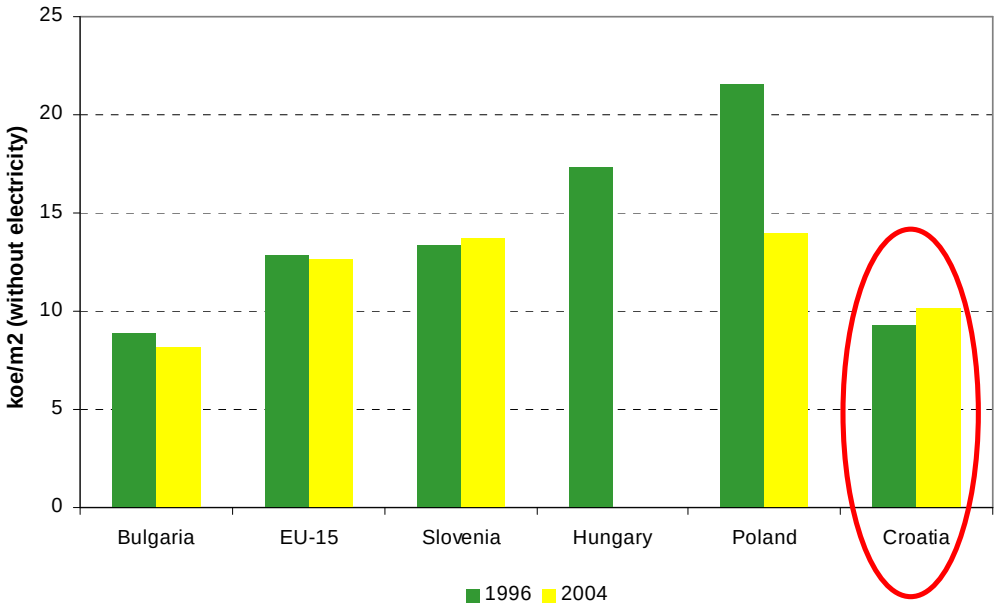


Figure 54: Electricity consumption per dwelling