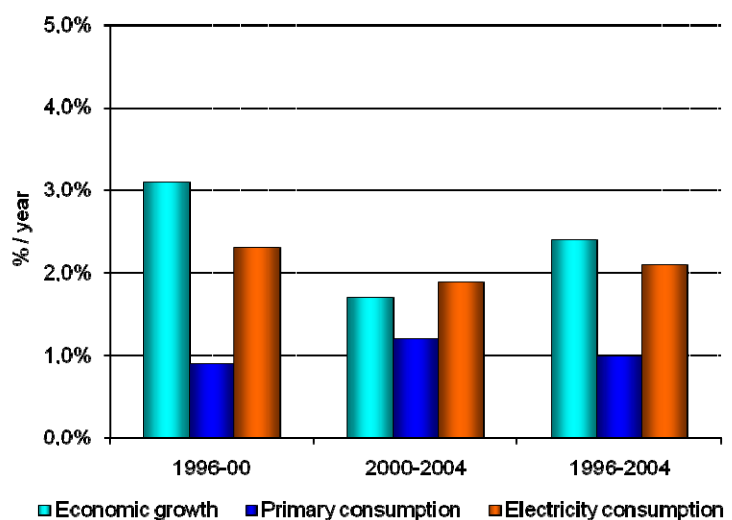
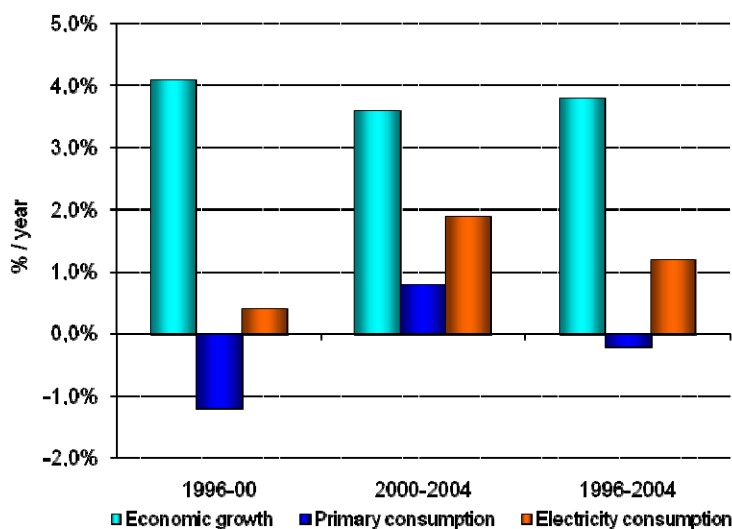


1. Overall Energy Efficiency Trends

1.1. Energy consumption trends

The primary energy consumption decreased as a whole in the new EU member countries, later referred to as EU-10⁶ or New Member Countries, between 1996 and 2000 despite a sustained economic growth (-1%/ year for the consumption as compared to 4%/year for the GDP). Since 2000, the energy consumption pattern of New Member Countries is more in line with the EU-25, although the economic growth was much higher than in the EU-15⁷ (Figure 1-1).

Figure 1-1: Energy consumption⁸ and GDP in the EU-10 and in the EU-25



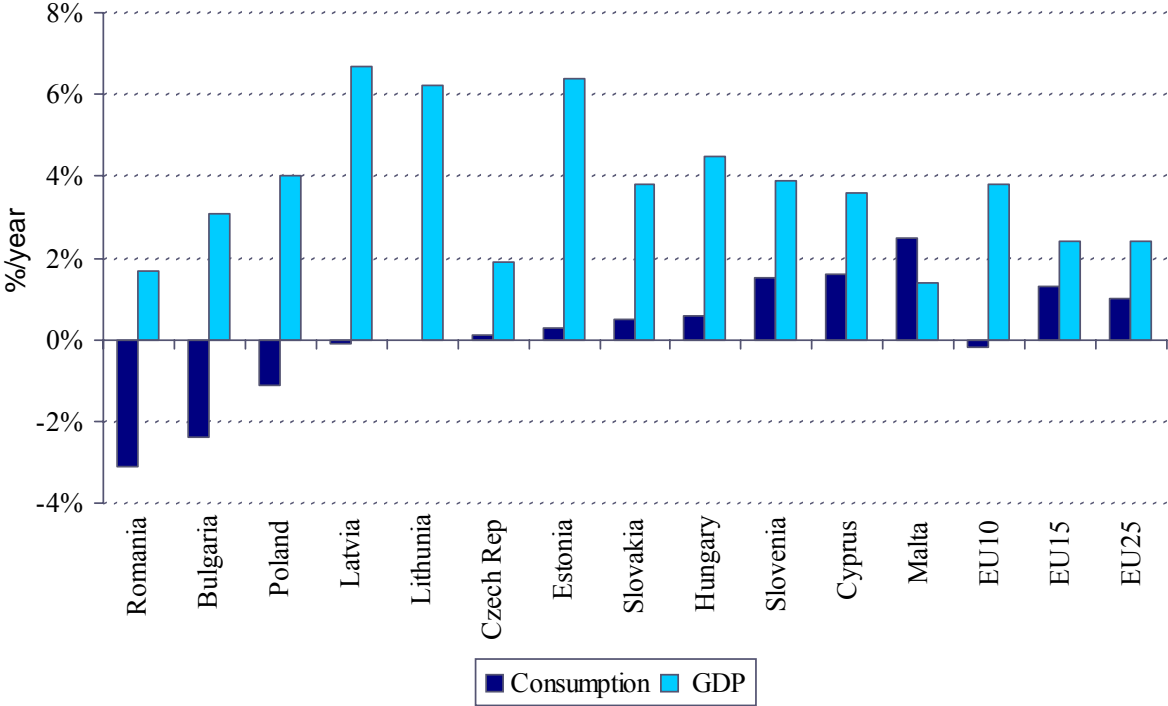
⁶ EU-10: Cyprus, Czech Rep, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia.

⁷ The average economic growth in the EU-10 was on average 1.6 times higher than in the EU-15 from 1996 to 2004 and 2.2 times higher after 2000 because of an economic slow down in the EU-15.

⁸ Source of data: Enerdata from Eurostat; energy consumption under normal climate conditions, i.e. with climatic corrections, excluding non-energy uses, which are not affected by energy efficiency issues.

The trends by country show the large decoupling between the energy consumption and the economic growth (**Figure 1-2**). In most countries, the high economic growth was possible with a low progression in energy consumption or even a reduction in some countries (Romania, Bulgaria, Poland); in Slovenia, Malta and Cyprus, there is however an energy consumption growth around 2%/year.

Figure 1-2: Energy consumption and GDP in New Member Countries

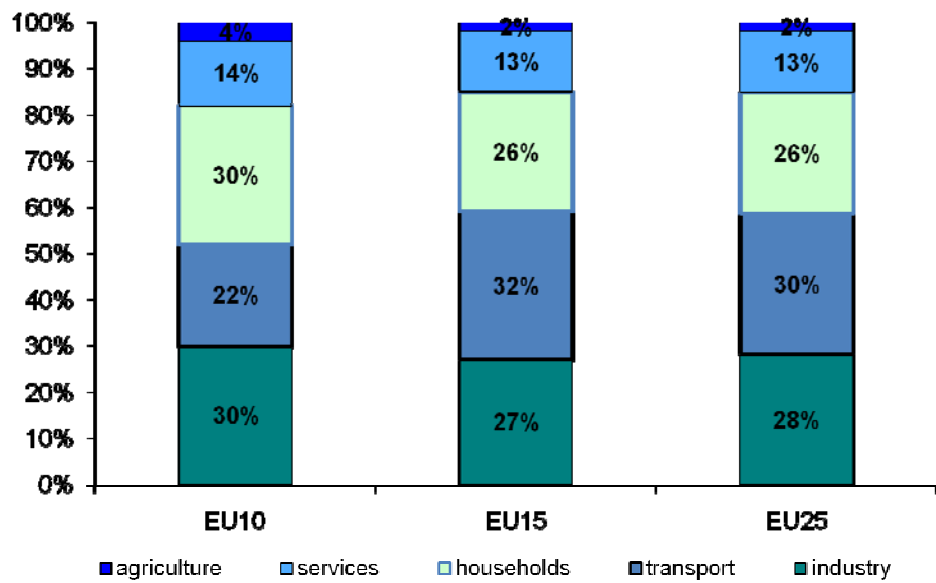
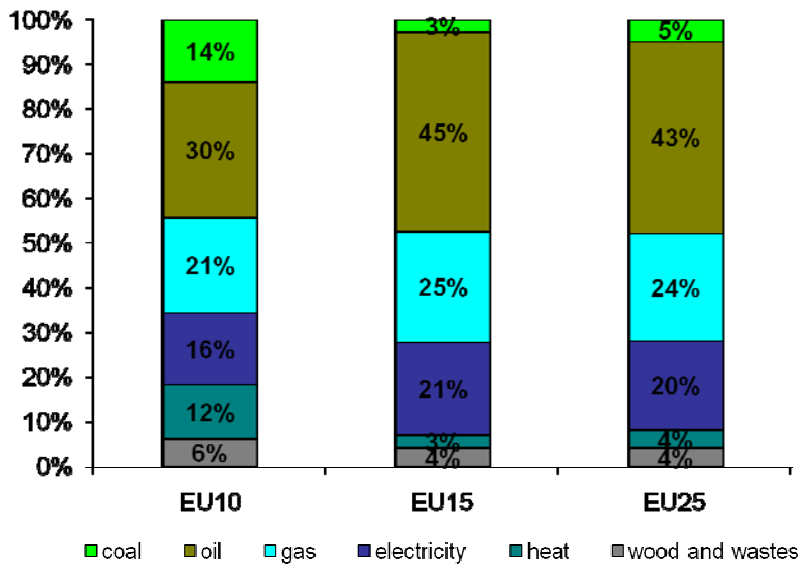


Since 2000, the energy consumption trends are changing in most countries: higher energy consumption growth in the Baltic countries (between 3 and 6%/year), in the Czech Republic, in Slovenia and in the EU-10 as a whole and reverse trend from a reduction to a progression in Bulgaria and Romania.

As opposed to the EU-15, oil is not the dominant energy source in EU-10 countries; district heat and solid fuels (coal and lignite) have a higher market share (12% for heat and 14% for solid fuels in the EU-10 as opposed to 3% each in the EU-15) (**Figure 1-3**). The share of gas increased from 21 % in 1990 to almost 25 % in 1994. The share of electricity is also significantly lower in New Member Countries (16% compared to 21% in the EU-15).

Industry and households have a higher market share in New Member Countries than in the EU -25; on the other hand, the energy consumption of transport is significantly lower (22% against 32% for the EU-15 and 30% for the EU-25 average (**Figure 1-3**). Buildings (households and service sector) absorb a larger share of the final energy consumption in New Member Countries than in the average of the EU-25 (44 % against 39%).

Figure 1-3: Final consumption by energy and sector (EU-10, EU-15, EU-25)⁹



Energy use in services and transport is increasing more than twice rapidly in New Member Countries than in the EU-25 (respectively 4.4 %/year between 1990 and 2004 for services against 1.5% for the EU-15 and 1.9%/year for the EU-25, 3.2%/year for transport against 1.6% for the EU-15 and 1.7%/year for the EU-25). The energy consumption of industry decreased significantly in New Member Countries (-2.7%/year on average over 1990-2004), compared to a low progression in the EU-15. Household energy is also slightly declining.

⁹ Energy consumption measured under normal climate conditions, excluding non-energy uses.

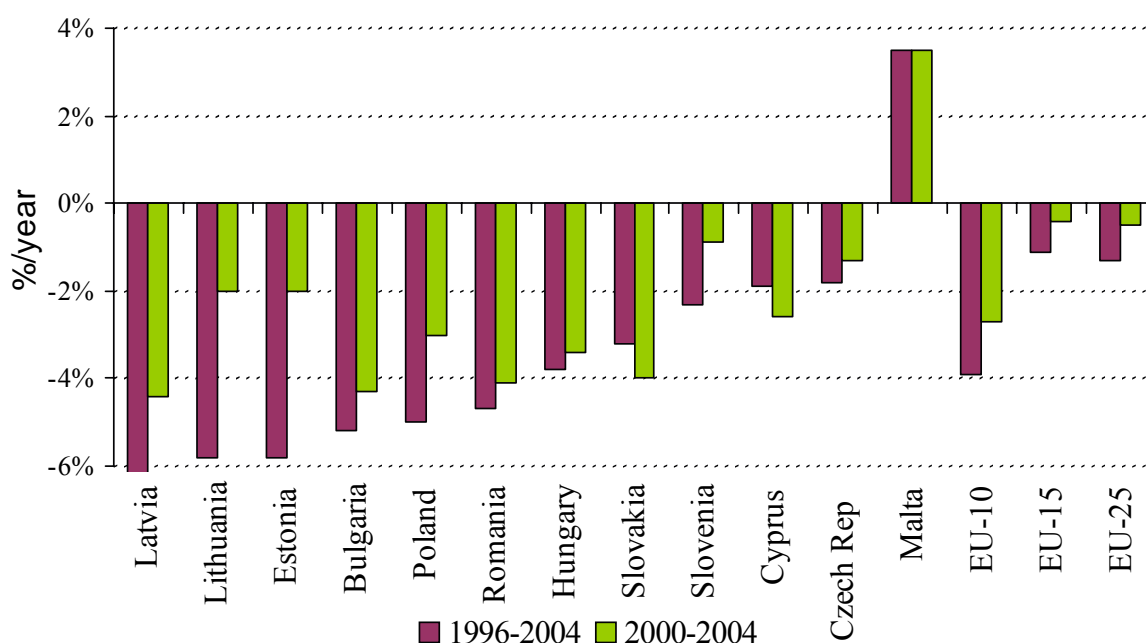
1.2. Trends in primary and final energy intensities

The primary and final energy intensities relate the primary and final energy consumption¹⁰ of a country to its GDP: they measure how much energy is required to generate one unit of GDP. Their variation over time reflects the influence of various factors, which include energy efficiency improvements but also changes in the nature of the economic activity (the “economic structure”) or in the structure of the energy mix, changes in lifestyle (more appliances, more cars) etc.

Rapid decrease in the energy intensities in the EU-10 as a whole: the rapid economic growth was possible with almost no growth in energy consumption, which shows a total decoupling between energy use and GDP

In the EU-10 as a whole, the primary energy intensity has been decreasing by almost 4 %/year between 1996 and 2004¹¹ (Figure 1-4).

Figure 1-4: Trends in primary energy intensities in the EU-10 and EU-25¹²



This progression in the energy productivity is almost of the same magnitude as the economic growth: as a result the energy consumption was in 2004 almost at the same level as in 1996. In 2004, the primary intensity was 26% below its 1996 level. Compared to the EU average the rate of energy productivity improvement is three

¹⁰The primary energy intensity relates the primary energy consumption of a country (or “total primary energy supply”) to the GDP (toe/€ at 2000 prices).

¹¹ These trends can be compared to the objective of the European Directive on Energy Services that aims at 1%/year energy efficiency improvements over nine years starting in 2008, although the definition of energy efficiency is somehow different from just a reduction in energy intensities.

¹² Under normal climate conditions.

times more rapid in New Member Countries. Between 1996 and 2000, the reduction in energy intensities was a little more rapid (5 %/year). In most countries increase in energy productivity was rapid (around 6%/year in the Baltic countries), around 4-5% in most of the Eastern European countries.

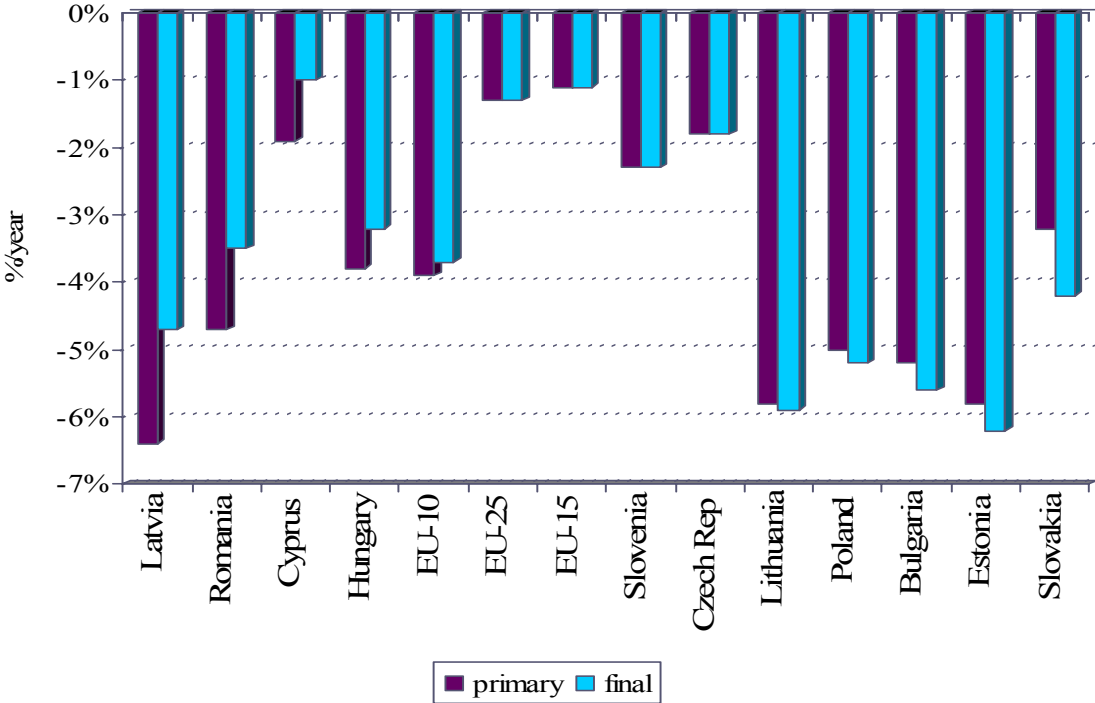
Slow down in the energy intensity reduction in most countries since 2000

Since 2000, there is a net slow down in most countries, especially in the Baltic countries, in Poland, in Slovenia, in the EU-10 and the EU as a whole; however, since 2004 there is a more rapid reduction in the EU-25 (0.9%/yr over 2000-2006 compared to 0.5%/year over 2000-2004¹³).

In new EU member countries as a whole and in 6 countries in particular, the primary energy intensity has decreased faster than the final intensity because of energy efficiency gains in electricity generation

Over the period 1996-2004, the primary energy intensity decreased faster on average than the final energy intensity in four countries (Cyprus, Latvia, Hungary and Romania) as well as in the EU-10 as a whole (Figure 1-5)¹⁴. This tendency results from an overall improvement in the efficiency of power plants¹⁵. For two countries, the variation is about the same (Slovenia and the Czech Republic).

Figure 1-5: Variation of energy intensities in new EU countries¹⁶



¹³ Source: Enerdata world energy data base

¹⁴ The final energy intensity relates the energy consumption of final consumers to the GDP (i.e. excluding the energy used for energy transformations, and in particular for electricity production).

¹⁵ In Hungary, it is linked to the rapid penetration of gas-combined cycles.

¹⁶ Under normal climate conditions (1996-2004)

In the other countries, part of the reduction in the final energy intensity is offset by increasing losses in energy transformation

For five countries (Poland, Estonia, Lithuania, Slovakia and Bulgaria), the final energy intensity decreases faster than the primary energy intensity: this means that increasing losses in energy transformation offset part of the reduction in the final energy intensity. These higher losses may come from more rapid growth in electricity consumption for final end-users (compared to fossil fuels), which results in increased losses in the electricity sector¹⁷ (case of Poland, Estonia, and Lithuania), and/or changes in the electricity generation mix (towards less efficient technologies, such as nuclear) (case of Slovakia and Bulgaria).

Final energy intensities are decreasing very rapidly in most EU-10 countries

Since 1996, final energy intensity has decreased rather rapidly in most countries: by 5 to 6 %/year in Estonia, Lithuania, Bulgaria, Poland and Latvia and by 3 to 4% in Slovakia, Romania and Hungary and in the EU-10 as a whole. In comparison, the rate of decrease was only around 1%/year in the EU -25.

Structural changes in the GDP have had a marginal impact on the energy intensity variation in the EU New Member Countries

Final energy intensities are influenced by structural changes in the economy i.e. shifts in the GDP structure among economic or industrial branches. For instance, an increasing share of services in the GDP, all other things being equal, results in a decrease of the final energy intensity because it requires much less energy to create one unit of GDP in the services sector than in the manufacturing industry (by a factor of 6 as an average for New Member Countries¹⁸). For the same reason, a falling contribution of energy-intensive branches to the industry value added also results in a decrease of the final energy intensity.

The impacts that modifications in the economic structure have on the energy intensities will of course depend on the magnitude of these structural changes¹⁹. In the EU-10, structural changes among the main economic sectors have been very small: the contribution of services to the GDP has remained stable around 56 % between 1996 and 2004. In three countries, Latvia, Cyprus and Malta, services have significantly increased their share of the GDP (between 4 and 8 points, mainly linked to tourism in the two Mediterranean countries). In 2 countries, industry grew faster than services: Hungary and Slovakia (-4 and 3 points reduction in the services' share in the GDP).

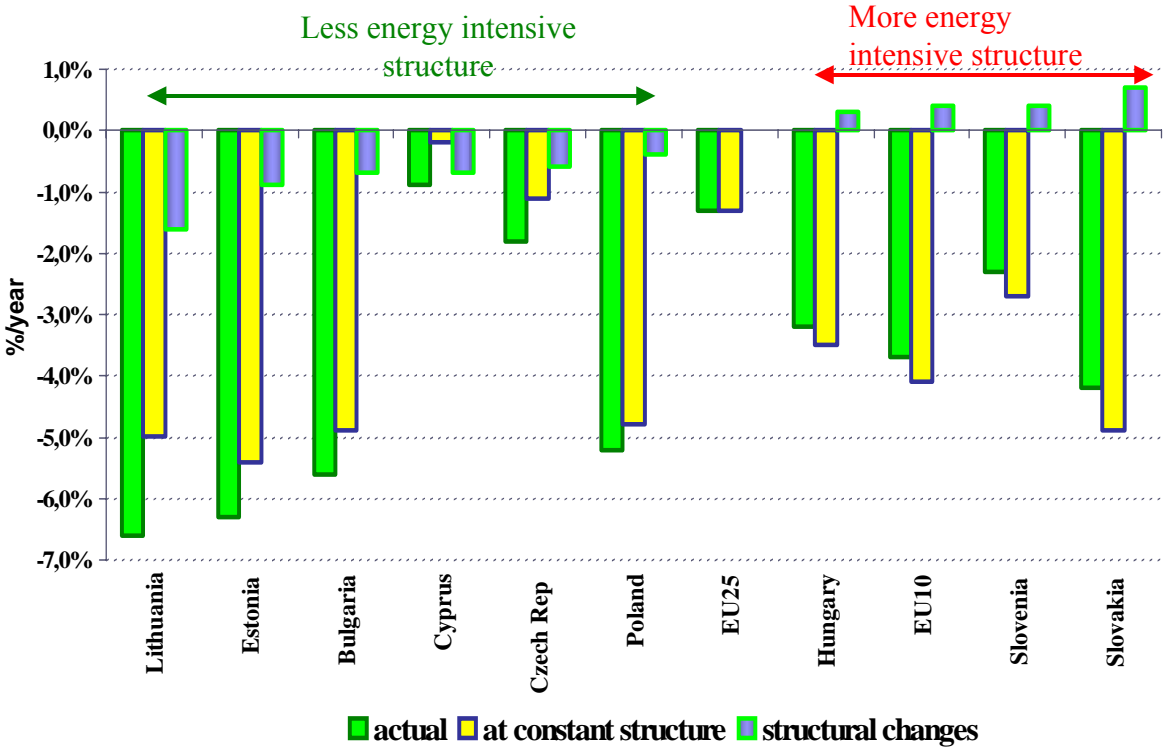
¹⁷ If electricity is produced by nuclear or thermal power plants, there are significant losses in electricity generation that are accounted for in the transformation sector (losses of 66 % for nuclear and between 65 and 50 % on average for conventional thermal power plants)

¹⁸ Manufacturing is 9 to 12 times more intensive than services in Poland, Slovakia, Cyprus, Czech Republic and Bulgaria; this ratio is around 5 in the Baltic countries and 2.5 in Malta and Hungary. For the EU as whole the ration is 10.

¹⁹ Changes in the industry structure are discussed in the industry chapter

In the EU-10 as a whole, structural changes among the different economic sectors (services, agriculture, construction, mining and manufacturing), as well as within manufacturing branches had a small but negative effect on the final intensity reduction during the period 1996-2004 (**Figure 1-6**). The same trend can be observed for Hungary, Slovenia and Slovakia. In the other countries, structural changes contributed to decrease the intensity: by about 33% in the Czech Republic, 25% in Lithuania, 15% in Estonia and Bulgaria and less than 10% in Poland. In Cyprus, most of the gains in energy productivity are linked to structural changes in the economy (almost 80%).

Figure 1-6: Structural changes in the economy and final intensity (EU-10)



Energy intensities need first of all to be expressed with purchasing power parities adjusted before any comparison

The conversion of national currencies in € with exchange rates does not reflect the fact that in New Member Countries consumer prices are on average much lower than in the EU-15 countries

- by a factor **2 on average**
- **in a range of 1.5** for Slovenia to around **3** for Romania and Bulgaria

In order to reflect the relative purchasing power of the different currencies, a conversion based on purchasing power parity is preferable: a given amount when converted from national currency to Euro at purchasing power parities buys the same basket of goods and services (**Box 1-1**).

Box 1-1: Why converting energy intensities at purchasing power parities

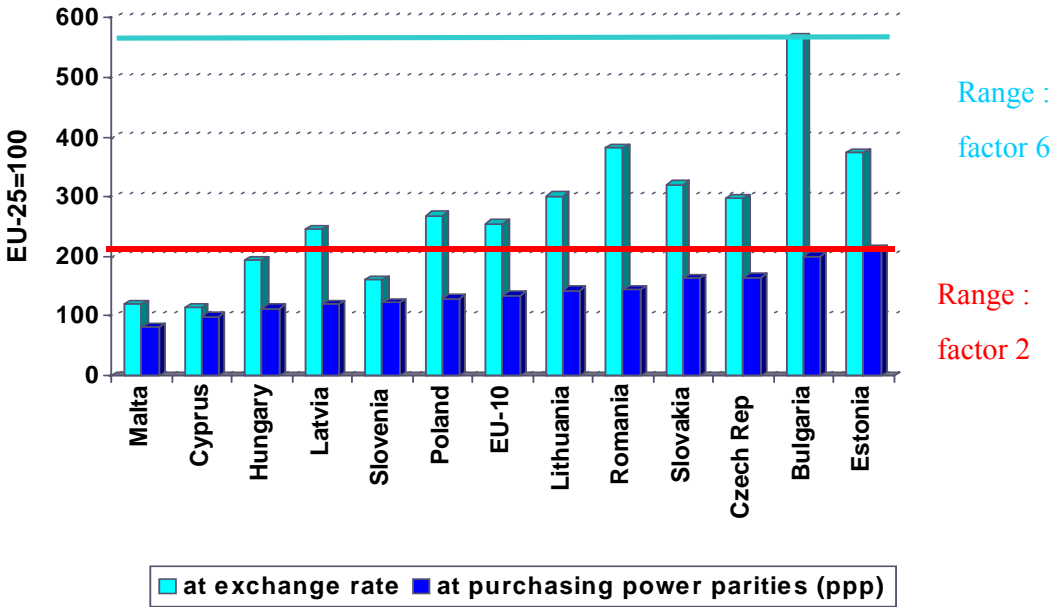
Let us take 3 factories producing the same car: one in the EU, one in Slovenia and one in Romania, with the same technical performance, i.e. the same energy input per car produced (in toe or GJ per car).

The value added of each car is mainly made from salaries, whose relative level across countries are influenced by the average difference in the cost of living (1.5 and 3 times lower for Slovenia and Romania respectively)

The energy intensity of the car industry will be 1.5 and 3 times higher than in the EU in Slovenia and Romania respectively with exchange rates **but the same at purchasing power parities (ppp)**. Therefore, the conversion with ppp provides an indicator closer to technical efficiency.

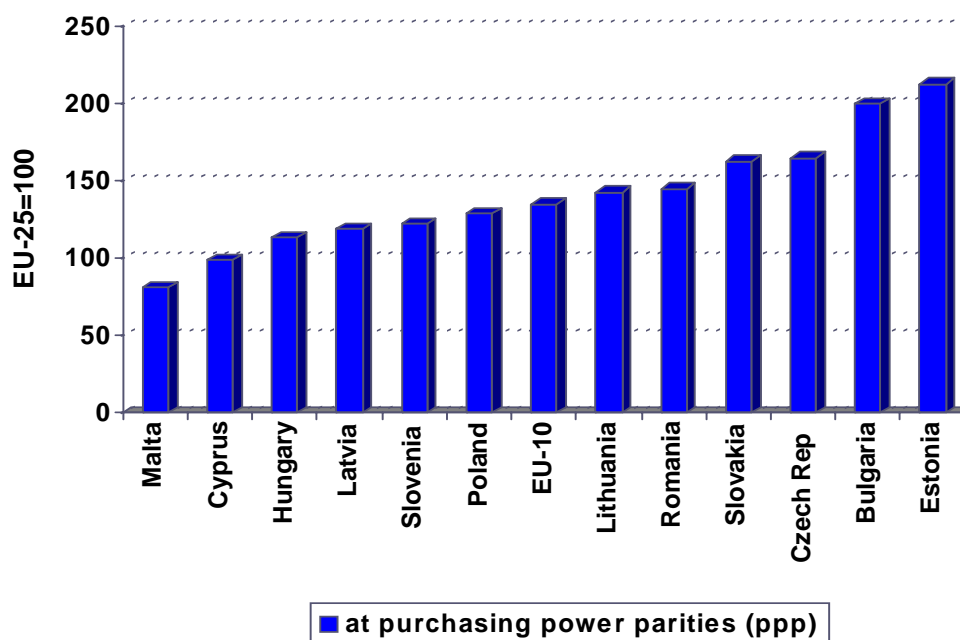
Using purchasing power parities instead of exchange rates to convert national currencies in € increases the value of the GDP in New Member Countries - by a factor 1.5 for Slovenia or a factor 3 for Romania or Bulgaria -, and thus decreases their energy intensities by the same factor compared to EU-15 countries. In other words, using purchasing power parities narrows the difference between EU-15 countries and New Member Countries: the maximum range in the primary energy intensities is a factor 6 with exchange rates, but only 2 with purchasing power parities (**Figure 1-7**).

Figure 1-7: Primary energy intensities at exchange rate and purchasing parities (2004)



After adjustment for purchasing power parities, primary intensities are about twice higher than EU-25 in Bulgaria and Estonia, 50% higher for Czech Republic, Slovakia, Romania, Lithuania and EU-10 average, 30% higher for Poland (**Figure 1-8**).

Figure 1-8: Primary energy intensities at purchasing power parities (2004)



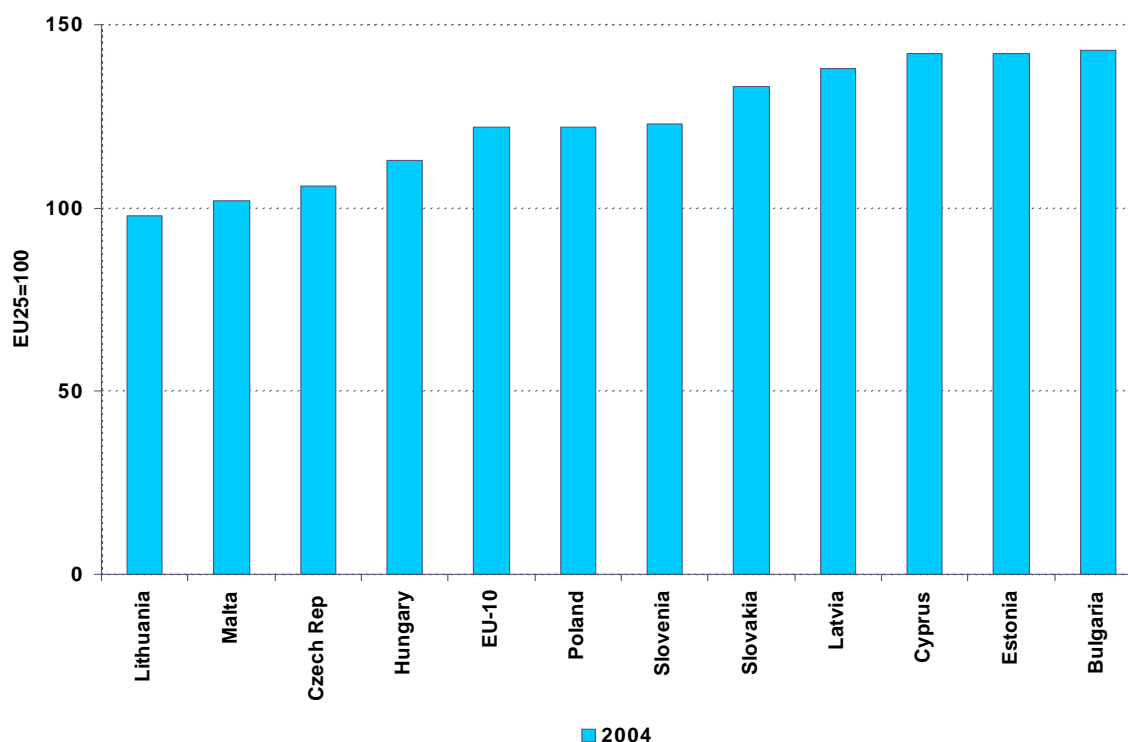
To improve the comparison of energy intensities, other adjustments are needed

Some of the differences observed in the energy intensity levels can be explained by specific national characteristics (e.g. climate, industrial specialisation, transport infrastructures, urban patterns, primary fuel mix). In order to make a more realistic comparison, the energy intensity needs to be corrected to account for these national characteristics. Three types of adjustments will be considered (**Figure 1-9** and **Figure 1-10**):

- Adjustment of the final energy intensity in heating requirements to account for climatic differences
- Adjustment of the final energy intensity in the “economic structure” to account for differences in the nature of the economic and industrial activities of the countries concerned.
- And finally, adjustment of the primary energy intensity in the primary fuel mix to account for differences in transformation losses, which is mainly linked to the way electricity is produced

These adjustments narrow the gaps among countries. Even if care has to be taken with such adjustments, they can give a more accurate picture of the relative position of countries than the usual intensity indicator calculated from the statistics. **Figure 1-9** summarises the results of all the adjustments for the final energy intensity and ranks the countries according to the value of their adjusted intensities.

Figure 1-9: Final energy intensities (adjusted²⁰)



For countries with colder climates (e. g. Baltic countries), with energy-intensive industrial activities (e. g. Czech Republic), the adjusted value is below the observed intensity. For Cyprus and Malta, the adjustments have the reverse effect and increase the intensity, mainly because of the much warmer climate.

The last adjustment consists in taking the same ratio between primary energy consumption and final energy consumption for all countries. Indeed, as shown in **Figure 1.10**, this ratio varies quite a lot from one country to the other depending on the importance of the energy transformations, which are mainly linked to the power generation mix. In countries, with nuclear electricity production, this ratio is low as nuclear production has a low energy efficiency (33%): this is the case of Lithuania, Bulgaria, the Czech Republic and Slovakia. Estonia has also high transformation losses because of the processing of oil shales.

After all adjustments, primary intensities are for most countries about 30% higher than the EU -25 and the maximum range 50% (**Figure 1-11**). The best practice shown on the graph corresponds to a fictive countries which is the combination of the EU country with the lowest final energy intensity and the country with the lowest transformations losses.

²⁰ Adjustment to EU-25 average climate, economic and industry structures.

Figure 1-10: Ratio primary to final energy intensities

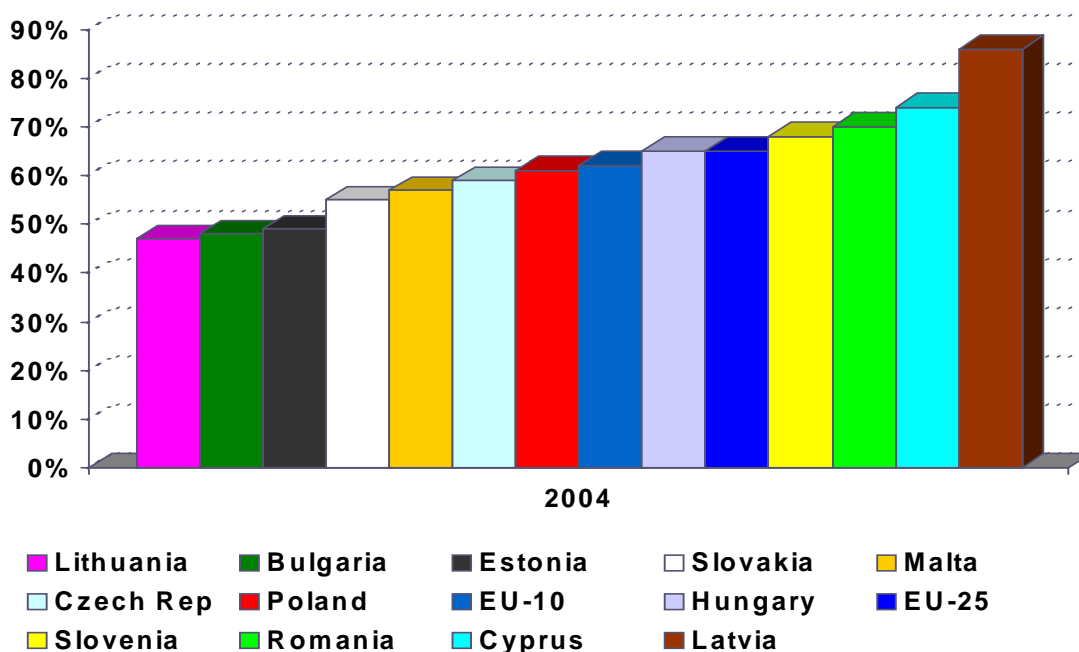
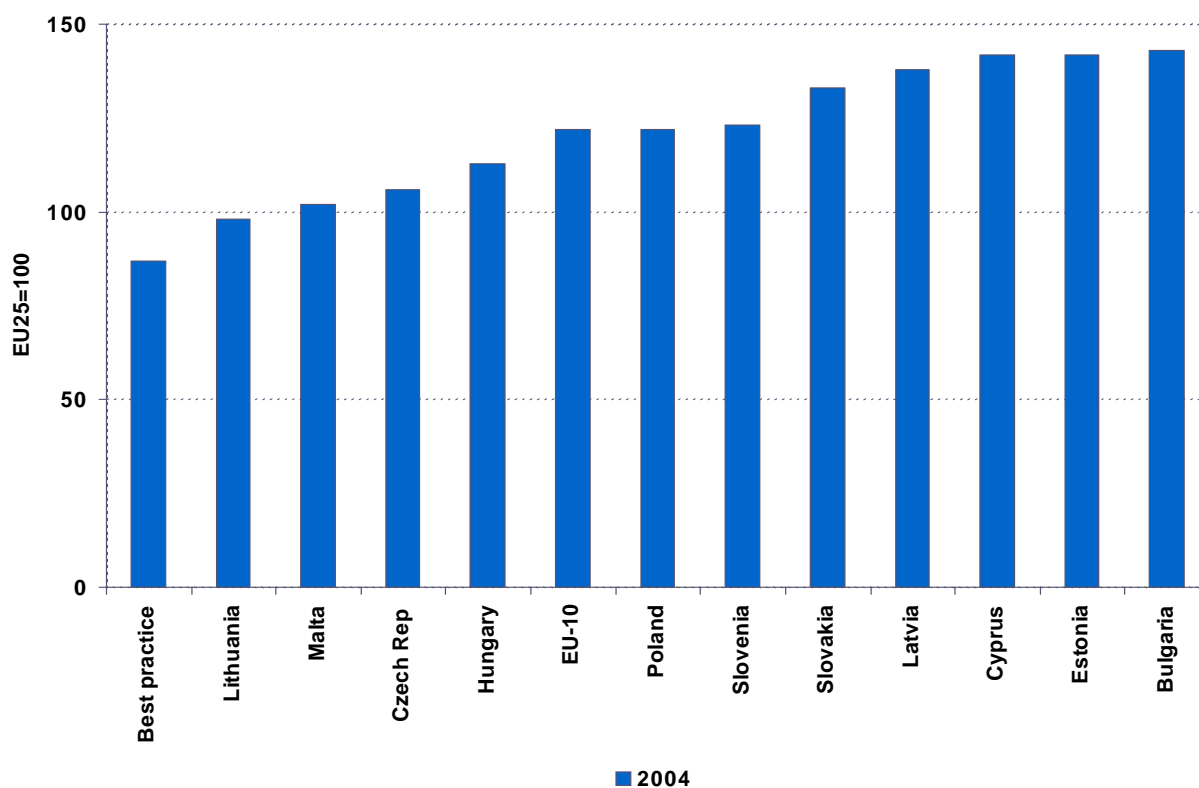


Figure 1-11: Primary energy intensities: all adjustments²¹



²¹ Adjustment to EU-25 average primary fuel mix, climate, economic and industry structures

Energy intensities assess global energy productivity and not energy efficiency performance from a technical viewpoint

Energy intensities, although adjusted for the influence of changes in the structure of economic and industrial activities, are not sufficient to assess the results of policy measures dedicated to energy efficiency. Indeed, three types of other factors influence these intensities:

- Spread of energy-efficient technologies and equipment, behaviour and practices.
- Energy substitutions in favour of energies with high end-use efficiency (e.g. district heating, natural gas or electricity);
- Economic and social changes not captured in the GDP structure:
 - in the mix between transport modes: substitution between cars and public urban transport modes in passenger traffic, or between road and rail goods transportation;
 - in living standards: increasing appliance or car ownership; changes in the size of cars, household appliances and dwellings; increased heating comfort; diffusion of new appliances (air conditioning, PC's...).

The first two factors contribute to curbing final energy intensities, whereas changes in lifestyle and transport modes tend to increase these intensities, all other things being equal. The contribution of the last factor is all the more significant in New Member Countries. In order to clarify the role of energy-related factors (i.e. energy efficiency and energy substitutions) and better assess the actual results of energy efficiency policy measures, a specific energy efficiency indicator will be used, the so-called “**ODEX**”²².

1.3. Energy efficiency progress in the EU- 25

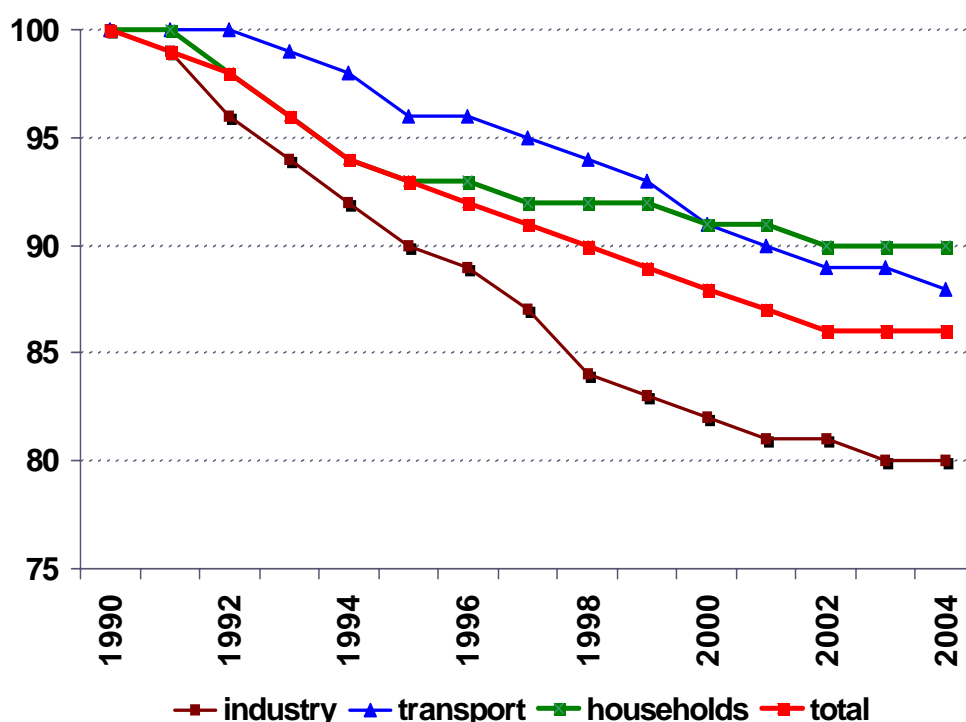
Energy efficiency in the EU-25 improved by about 14 % between 1990 and 2004, corresponding to 150 Mtoe energy savings in 2004

Energy efficiency policies and measures implemented since 1990 as well as autonomous technological progress have contributed to improving the energy efficiency of the EU-25 by 1.1 %/year on average between 1990 and 2004 (**Figure 1-12**). Without these energy efficiency gains, the final energy consumption of the EU-15 would have been 14 % higher in 2004. This represents energy savings of around 150 Mtoe for the EU-25.

Industry is the sector which achieved the largest energy efficiency improvement, with a regular energy efficiency gain of 1.5 %/year on average between 1990 and 2004. Industry is 20 % more energy-efficient than it was in 1990. For households, slow progress is observed since 1995 (10 % of improvement since 1990). In transport, the progression is modest but regular: 12 % efficiency improvement.

²² See glossary and definition

Figure 1-12: Energy efficiency progress in the EU-25



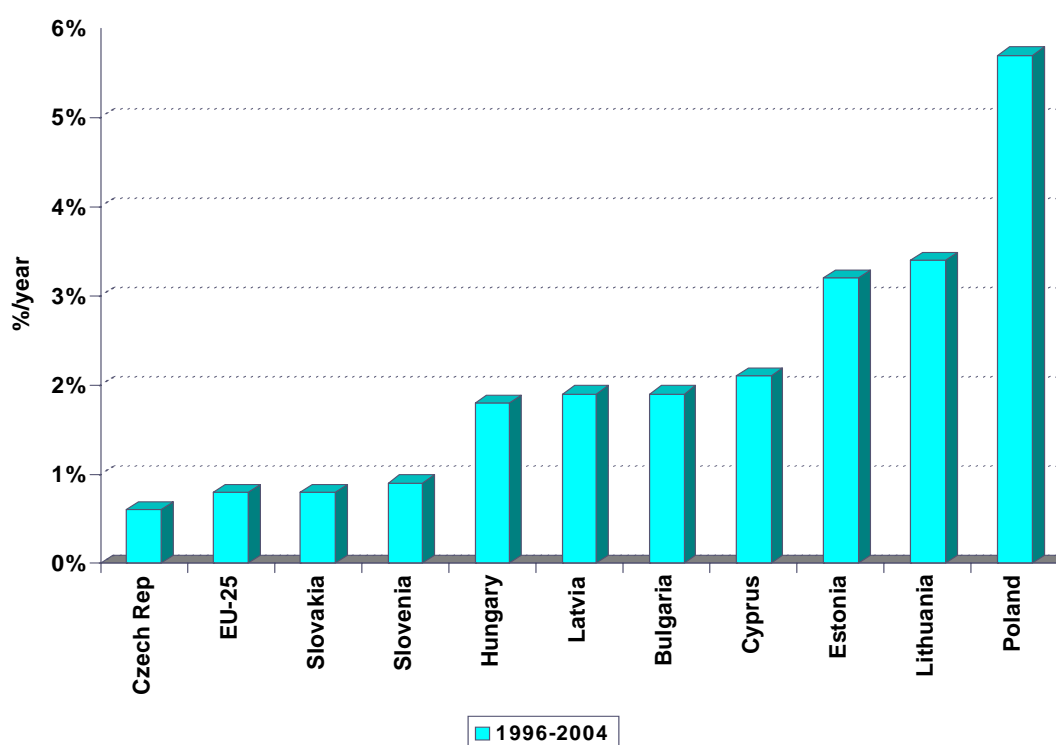
Compared to pure bottom-up evaluations, energy efficiency gains measured in ODYSSEE have a broader scope as they include all sources of energy efficiency improvements, whatever their driving factor: policy measures, price changes, autonomous technical progress or other market forces; in other words, ODEX measures total energy savings.

Energy efficiency in most New Member Countries improved by about 2 %/year

The ODEX variation can be expressed as yearly variation in order to measure the annual progress in energy efficiency. In seven countries, the rate of energy efficiency improvement (or rate of energy savings) is around or above 2 %/year over the period 1996-2004. In 3 countries and as in the EU-25, it is below 1%/year, which corresponds to the annual target of energy saving set in the ESD²³ (**Figure 1-13**). In all new members, most of the energy efficiency improvements evaluated with ODEX come from the industry sector: in transport and households, the assessment is still limited by the lack of detailed energy consumption data by end-use and mode of transport.

²³ This is a very approximate estimate of the ESD savings. In addition, the savings, as measured by ODEX have a different definition, as they include savings in energy intensive industries (ETS) and exclude savings in services.

Figure 1-13: Energy efficiency progress in EU-10 countries and Bulgaria (%/year)²⁴



1.4. CO₂ intensities²⁵

Total CO₂ emissions from energy use in the EU-25 as a whole were 5 % above their 1990 level in 2004. After dropping until 1994, they have increased steadily since then (0.7 %/year on average). Over the period 1990-2004, CO₂ emissions from energy use have risen much slower than the rise in economic activity: almost six times less (5 times less for the emissions of final consumers).

Total CO₂ emissions per capita decreased from 8.5t in 1990 to 8.2t in 1993 and 1994; they increased afterwards and were back to their 1990 level in 2004.

Almost half the reduction in CO₂ intensity is due to increased use of energy carriers with lower emission factors

Total CO₂ emissions per unit of GDP, the “CO₂ intensity”, decreased more rapidly in the EU-25 as a whole than energy intensity: by 2 % /year and 1.2 % /year, respectively, on average between 1990 and 2004 (**Figure 1-14**). This gap is due to switching to

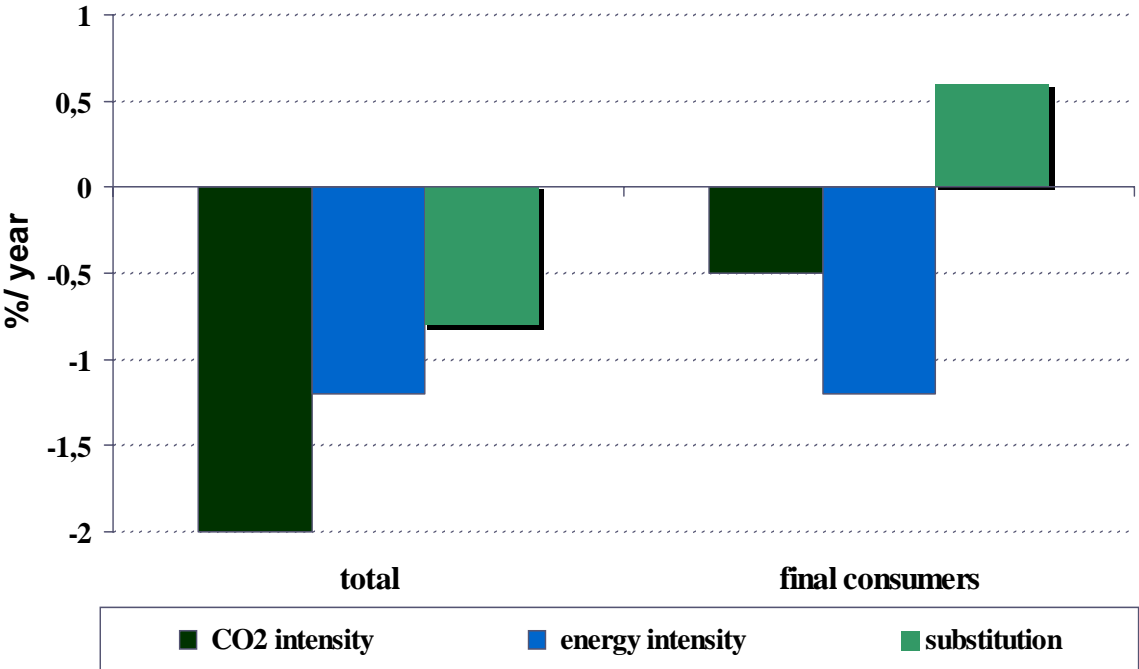
²⁴ For Malta, the results are not shown since the values obtained are not relevant as the data series are too short.

²⁵ This section deals with CO₂ emissions from energy combustion. The indicators are not expressed under normal climate conditions (i. e. with climate corrections) to comply with the official definition of CO₂ inventories. CO₂ emissions of final consumers include the emissions of auto producers.

energy with lower CO₂ emissions factors: the average emission factor of one toe decreased by 11 % over the period from 2.48 to 2.2 tCO₂/toe. In other words, the energy used tended to contain less and less carbon; this phenomenon is usually referred to as the “decarbonisation” of the economy. These switches explain almost 42% of the reduction in the total CO₂ intensity, the rest (58%) is linked to the reduction in energy intensity.

If we exclude the energy transformations and only consider CO₂ emissions from final consumers, fuel substitutions have this time a different effect: they tend to increase the emissions: the energy used by final consumers contain more and more carbon (the average emission factor of one toe increased by 9 % over the period from 2.3 to 2.5 tCO₂/toe: this a different trend compared to what was observed in the EU-15²⁶.

Figure 1-14: Variation of CO₂ intensity in the EU-25 between 1990 and 2004



1.5. Conclusions

- The energy efficiency of final consumers improved by 14 % on average in the EU-25 between 1990 and 2004. This resulted in energy savings of about 150 Mtoe in 2004.
- Over the period 1998-2004, the rate of energy efficiency improvement (or rate of energy savings) is around or above 2 %/year in six new EU countries. In 3 other countries and as in the EU-25, it is below 1%/year, which corresponds to

²⁶ See the similar publication on the EU-15 "Energy efficiency trends and policies in the EU-15 " (2007)

the annual target of ESD target for many countries; however, the definitions of energy savings are not directly comparable.

- In most countries the greatest achievements come from the industry sector.
- The rapid economic growth in EU new members was possible with almost no growth in energy consumption, which shows a total decoupling between energy use and GDP.
- Primary intensities measured at purchasing power parities are on average 50% higher in EU-10 countries than in the EU -25.
- After correction for national characteristics (in terms of climate, industrial and economic specialisation and primary fuel mix) and adjustment to the EU -25 situation, the difference in intensities drops to 25%.
- CO₂ emissions in the EU-25 are in 2004 5 % below their 1990 level: they have increased almost six times less rapidly than the GDP. Slightly less than half of this reduction (42%) is due to fuel substitutes with lower emission factors.