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C O N S U L T A N T S

Energy Efficiency Policies and Measures in Belgium

Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE)

ECONOTEC

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Warning

For the energy consumptions, the ODYSSEE data base uses federal statistics, except for the final energy consumption of the industrial sector, where the sum of the energy consumptions of the three Regions has been used, because they appear to be more reliable (among other things because the regional energy balances better take into account the consumption of waste products, in cement ovens etc.).

The industrial energy consumption figures are missing for the years 1991-1993, because they are not available for the Flemish Region.

General remarks on the quality of the available data used in this report are given in Annex 3.

1 Executive Summary

This report is the country report for Belgium on Phase 11 of the “ODYSSEE-MURE” project, extending from September 2007 to September 2009.

It provides an overview of energy efficiency trends (for the period 1990-2007), based on indicators calculated using the ODYSSEE data base, developed and updated in the framework of the project, as well as of the main energy efficiency policy measures.

The final energy consumption of the country is analysed both as a whole and by major consumer sector: industry, residential, tertiary, transport. For each sector, it has been aimed to assess the size of energy efficiency changes, to identify main factors responsible for these changes and to assess the contributions of these factors.

Despite a sustained economic growth in the latest years, the overall energy consumption has decreased. In 2007, the total primary energy consumption by 1,0% and the final energy consumption by 4,9%. This decline in energy consumption has taken place in all major end use sectors (industry, residential, tertiary, transport). This evolution confirms the decoupling between energy consumption and economic growth started around 1997.

Both the primary and the final energy intensities have been regularly decreasing since 1996. From 1990 to 2007, the primary energy intensity has decreased by 12% and the final energy intensity by 23%.

While energy intensities show an energy efficiency in economic terms (measuring the quantity of energy used to produce one euro of GDP or value added), the ODEX indicator, developed in the course of the project, aims to best reflect the evolution of the technical efficiency of energy use of a sector, at any aggregation level. It is a kind of weighted average of unit energy consumptions of elementary components of the sector, based as far as possible on activity variables expressed in physical units.

Between 2000 and 2007, the overall ODEX indicator has decreased by 12%. The indicators for industry, the residential and transport sectors have fallen by 15%, 8% and 10% respectively.

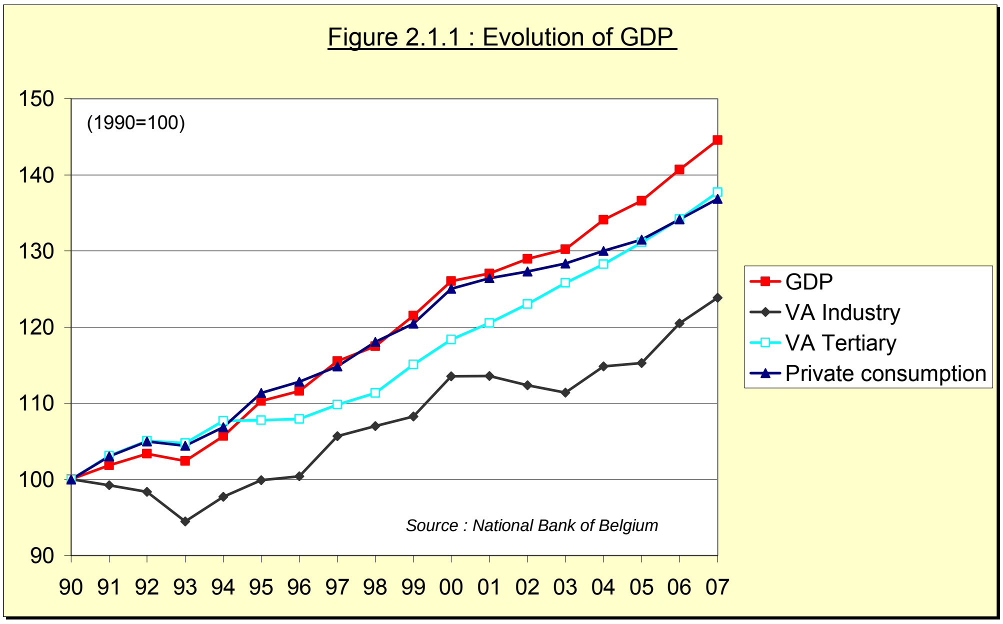
As far as policy measures are concerned, a peculiarity of the Belgian context is that energy efficiency is mainly a responsibility of the three Regions. A particular emphasis is being put on the transposition of two important European directives: directive 2002/91 on the energy performance of buildings (EPBD) and directive 2006/32 on energy efficiency and energy services (ESD).

The report describes the recent energy efficiency policy measures and discusses their evaluation, with a particular focus on the case of voluntary agreements in industry.

2 The Background to Energy Efficiency

2.1 Overall economic context

The figure below shows, in real terms, the evolution of the main macro-economic indicators since 1990: GDP, value added of industry, value added of the tertiary sector and private consumption of households. One can notice the strong growth of the economy during the latest years, including in the industrial sector, after its slowdown over the period 2001-2003.



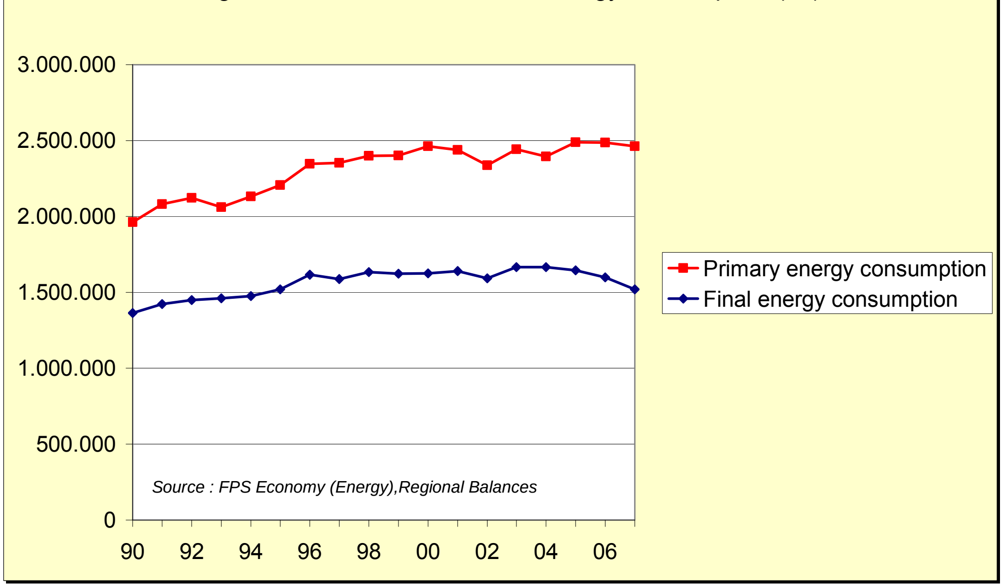
Overall over the period, there has been a slower growth for industry, in the early nineties and at the beginning of the years 2000.

2.2 Energy consumption trends

The total primary energy consumption (before climate correction), shown on the following figure, has practically stabilised since about the year 2000, with a low in 2002 (the warmest year, as can be seen from the evolution of the number of degree-days in Figure 3.1.3). In 2007, it fell by 1,0%.

As to the final energy consumption, which had started decreasing it 2003, it fell by a significant 4,9% in 2007.

Figure 2.2.1 : Evolution of total energy consumption (TJ)



Together, both evolutions show a decrease in the ratio final/primary energy consumption, which could partly be explained by an increase in the share of electricity in final energy consumption (compare figures 2.2.2 and 2.2.3).

Figure 2.2.2 : Total final energy consumption by energy carrier - 1990

Source : FPS Economy (Energy)

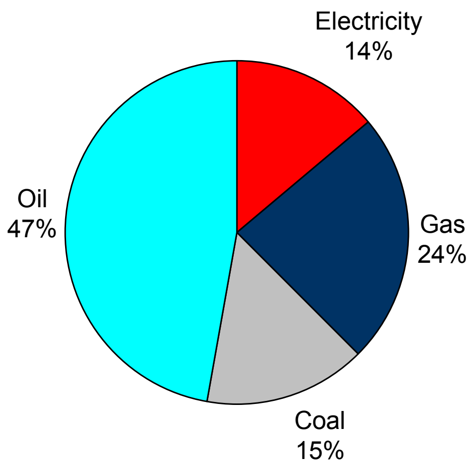
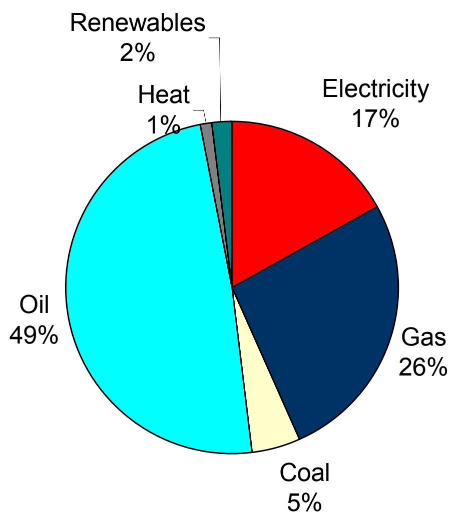


Figure 2.2.3 : Total final energy consumption by energy carrier - 2007

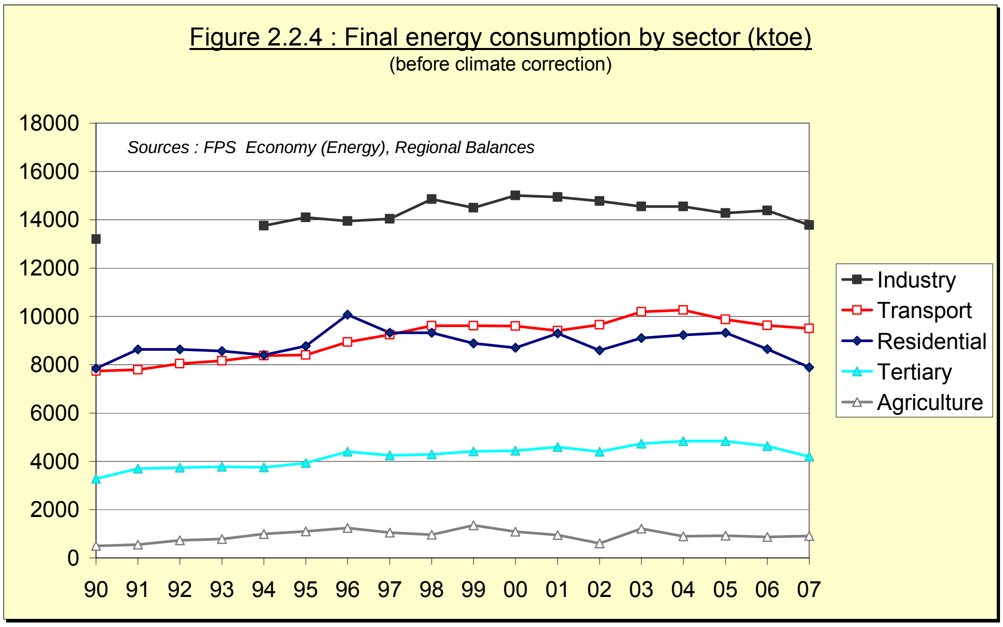
Source : FPS Economy (Energy)

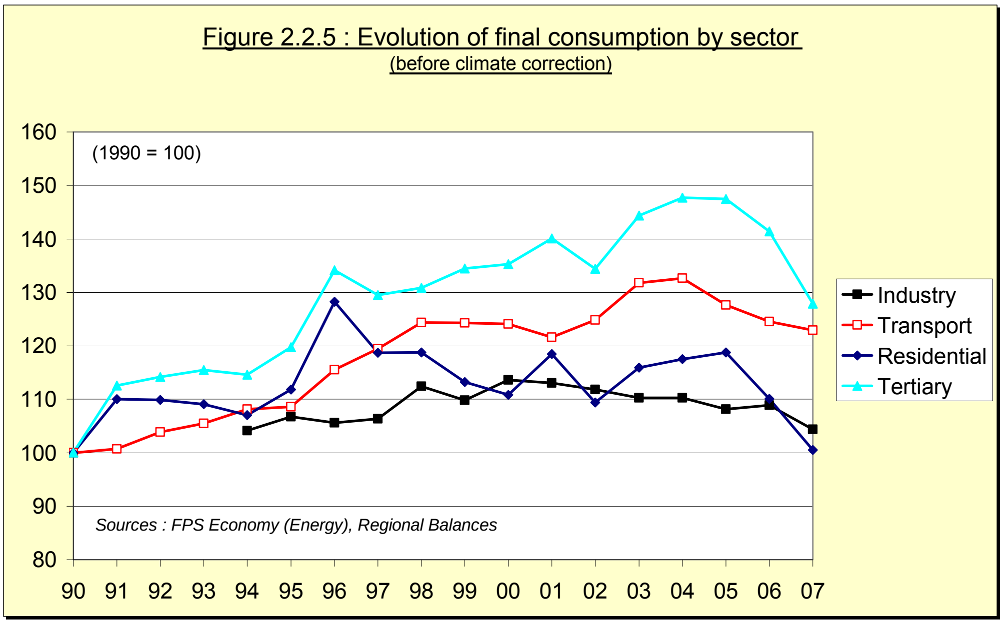


The next figure shows the development of the final energy consumption by major sector from 1990 to 2007 (without climate correction).

The main energy consumer is industry, followed by the transport sector and the residential sector. The tertiary sector has only about half the consumption of the residential one.

In the last two years, there has been a decrease in the consumption of all major sectors.





The largest growth over the period is that of the tertiary sector, followed by the transport sector.

2.3 The policy background to energy efficiency

2.3.1 Policy making process

In the Belgian federal system, policies and measures to improve energy efficiency and to reduce greenhouse gas emissions are established at different levels of government, according to the division of power between the federal state and the regions. Each of these levels of power establishes its own priorities for and climate policy. A coordination of the federal and regional policies is taking place in the framework of the CONCERE/ENOVER committee as far as energy efficiency is concerned and of the National Climate Commission as far as greenhouse gas emissions are concerned. The general context for the preparation of policies and measures regarding climate change is established by a number of guiding plans drawn up by the federal and regional authorities, which determine policy objectives and strategies.

2.3.2 National climate policy

Climate change is one of the main driving forces for the energy efficiency policy. In January 2009, the National Climate Commission has issued the “National Climate Plan

2009-2012". This document provides a detailed inventory of the existing federal and regional policies and measures taken up to 31 December 2008, which are either classified by sector or as cross-cutting ones.

The 'Cooperation Agreement [between the federal government and the three Regions] for the implementation of a National Climate Plan and reporting in the context of the UNFCCC and the Kyoto protocol', adopted on 14 November 2002, concerns the implementation and the follow-up of the National Climate Plan and the establishment of reports in the context of the UNFCCC, the Kyoto Protocol and the decision for a Monitoring Mechanism (Decision 280/2004/EC), with the ultimate goal being to reduce emissions of CO2 and other greenhouse gases.

To implement this Cooperation Agreement, the 'National Climate Commission' (NCC, the executive body of the Cooperation Agreement) was formally put into place on 5 December 2003. This Commission is an essential instrument for the implementation of the Kyoto Protocol in Belgium. It has a key role in assessing and monitoring the national climate policy and the institutional setting-up of the flexible mechanisms. The NCC is composed of representatives of the federal and regional governments.

Within the framework of the Cooperation Agreement, an internal burden sharing arrangement was agreed on 8 March 2004 between the federal government and the three regions. This agreement defines differentiated targets for the three regions, and determines the extent to which the federal government will contribute to the national effort, through both the implementation of domestic measures and the acquisition of emission allowances on the international market.

Each of the three Regions has developed its own climate plan. The Flemish Climate Plan 2006-2012 (FCP) was approved by the Flemish government on 20 July 2006. The Walloon Air-Climate plan was adopted by the Walloon government in March 2007. The Brussels-Capital Region adopted on 13 November 2002 (Decision G-31.55.0) an eight-year Air and Climate Plan, the Plan for Structural Improvement in Air Quality and the Fight against Climate Change, 2002-2010. This plan is currently being reviewed.

2.3.3 Energy efficiency policies

In 2007, Belgium submitted its first National Energy Efficiency Action Plan (NEEAP) in the framework of EU directive 2006/32 on energy end-use efficiency and energy services. This plan compiles the individual plans of the federal government and each of the three Regions (Flanders, Wallonia and Brussels-Capital). This plan describes the energy efficiency policy measures taken by the relevant federal or regional authorities.

Energy efficiency is mainly a responsibility of the Regions. The federal government is responsible for specific aspects such as the fiscal policy, the pricing policy and product policies. The NEEAP specifies energy saving objectives to be reached by the Regions, however with the help of the federal policy measures.

3 Overall Assessment of Energy Efficiency Trends

Energy efficiency trends are analysed first in terms of energy intensities and then in terms of the ODEX indicator. Both approaches are complementary; they differ as to their meaning and the quality of the data.

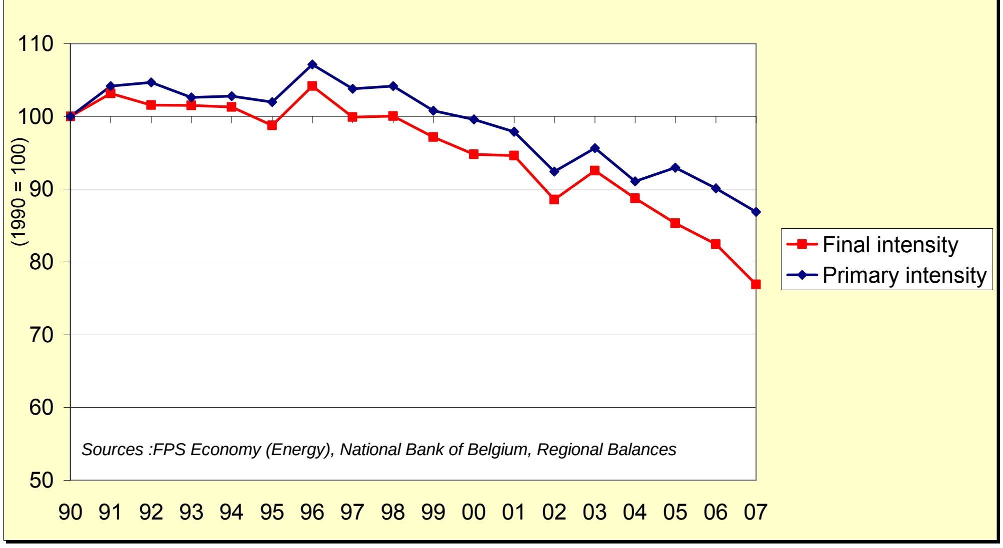
3.1 Overall trends in energy intensity

3.1.1 Energy intensity of GDP

An energy intensity is obtained by dividing the energy consumption of a sector by the value added or the GDP. It is an indicator of "economic" energy efficiency, in that it show how much energy is being used to produce one euro of economic output.

The figure below shows the evolution of the energy intensity of both primary and final energy consumptions[1].

Figure 3.1.1 : Evolution of energy intensity (without climate correction)



The latest developments confirm the decoupling of energy consumption from the economic activity started around 1997. In particular the last two years show a significant reduction of the energy intensities.

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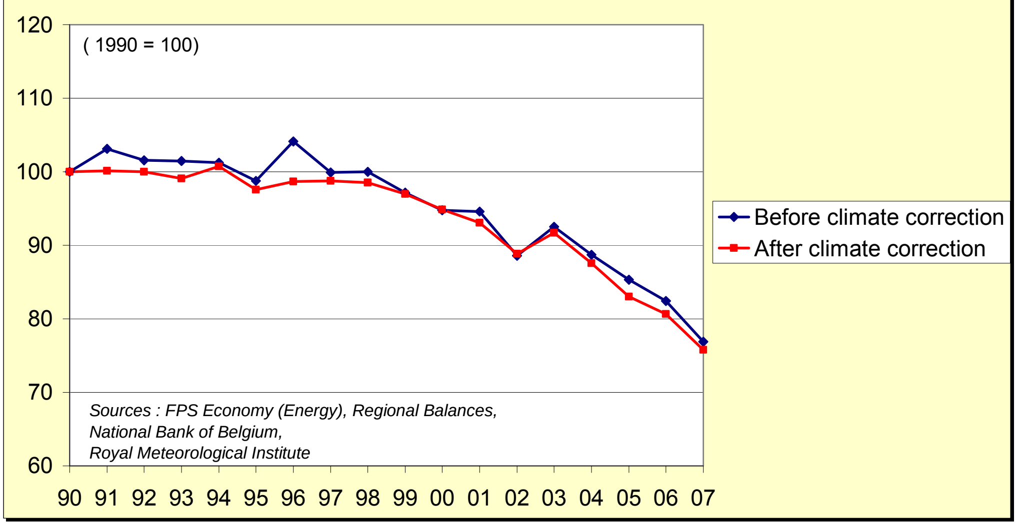
1 Before climatic correction and without the energy consumption for non energy uses.

The widening gap between both curves from 1999 to 2001 is in particular due to the significant increase in net imports of electricity during these two years (+3 473 GWh in 2000, +4 781 GWh in 2001). These electricity imports are indeed converted to primary energy with a factor of one. In 2002, the net electricity imports have declined by 1 518 GWh.

The evolution in time should rather be appreciated after climate correction (i.e. at constant climate), which is shown below for the total final energy consumption.

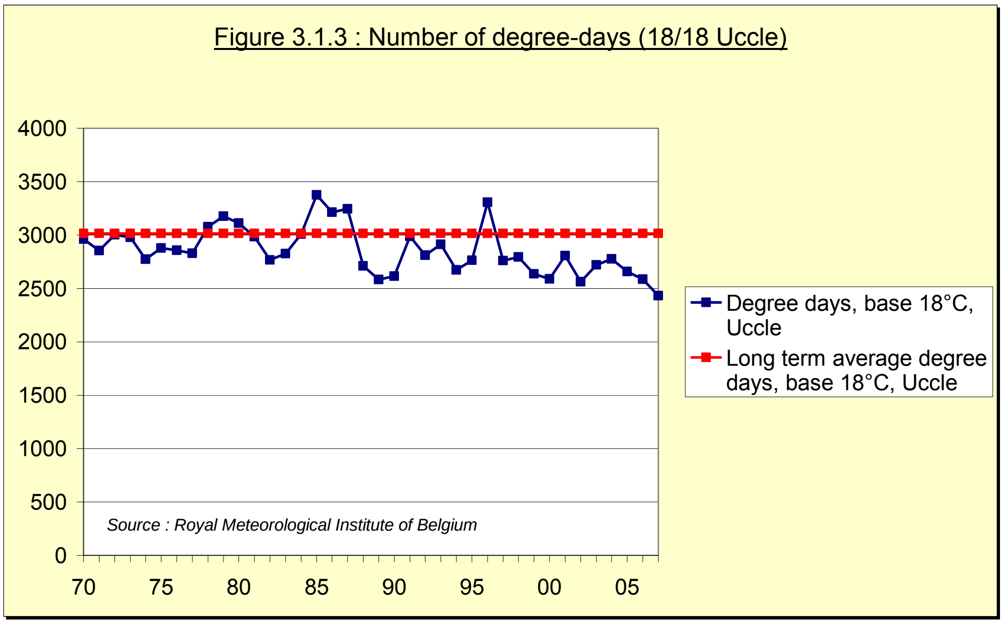
After climate correction (see later the evolution of the number of degree-days), the curve becomes smoother, and the energy intensity of total final energy is regularly decreasing since 1997, except for the year 2003.

Figure 3.1.2 : Evolution of energy intensity of total final energy



The kind of anomaly observed for 2002-2003 relates to the residential sector. It is a little removed by the climate correction, but even after climatic correction the energy consumption remains inexplicably low for that year. It should be noted that 2002 – based on the number of degree-days taken into consideration – the hottest year over the whole period, except for 2007.

The following figure shows the evolution of the number of degree-days in Uccle (Brussels), which has been used for calculating the climate correction.



2007 has been the hottest year of the period since 1970. It should be noted that since 1990, 1996 has been only year with a colder than "normal" (long term average) climate, as defined by the Royal Meteorological Institute, which shows that the average climate is clearly becoming hotter.

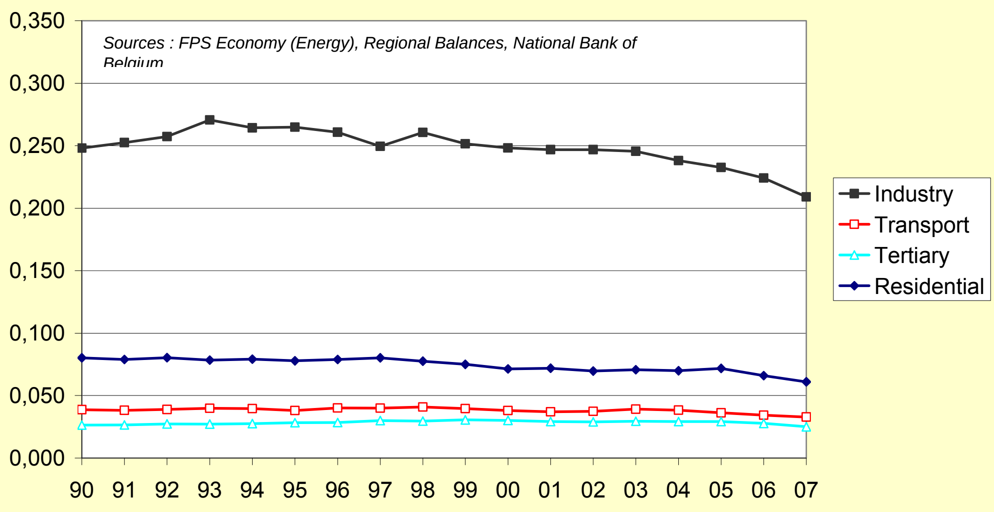
3.1.2 Energy intensity by sector

The energy intensity (after climate correction) by major end-use sector is presented on the next figure. The energy intensities have been calculated by dividing the energy consumption by the following, closely related, activity variables:

- value added, in the case of the industrial and tertiary sectors;
- private consumption of households, in the case of the residential sector;
- GDP, in the case of the transport sector.

Figure 3.1.4 shows that the energy intensity of industry is about 6 to 7 times higher than the intensities of the tertiary and the transport sectors.

Figure 3.1.4 : Final energy intensity by sector (ktoe/M€)
(after climate correction)



It should be reminded that these energy intensities remain imperfect measures, especially because the activity variables used are only imperfect indicators of the real activity changes.

Besides, this indicator is influenced not only by energy efficiency, but also by the structural effects happening within each sector (typically, a switch towards activities with a lower energy consumption per unit of value added).

Noteworthy is that over the last two years, the final energy intensity has decreased for all sectors, and, with the exception of the residential sector, it has steadily decreased for all sectors over the last four years. On the other hand, up to 2003, the residential sector was the only one having an energy intensity significantly below that of 1990.

There appear to be significant differences between sectors. The tertiary sector has seen its energy intensity increase up to 15% above its value in 1990. A steadily decreasing trend starting between 1997 (residential) and 1999 (tertiary) can be observed for all sectors, except for the transport sector, where a rise has taken place in 2002 and 2003.

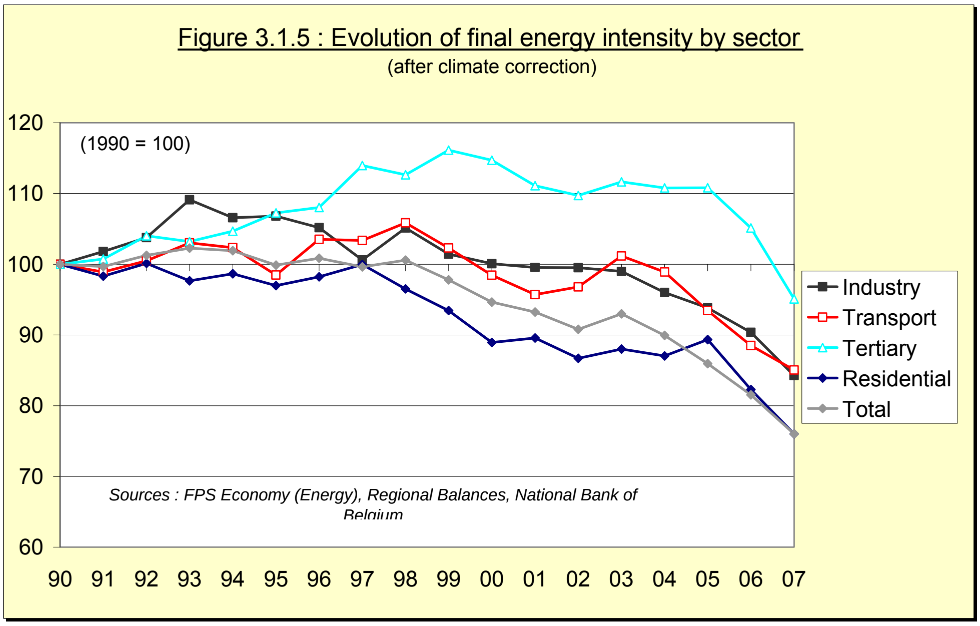


Figure 3.1.5 : Evolution of final energy intensity by sector
(after climate correction)

It is interesting to notice that between 1990 and 2007, the overall energy intensity has decreased more than the intensities of each sector individually. This reveals a structural effect corresponding to a shift from industry towards the other sectors.

This can be seen by examining together:

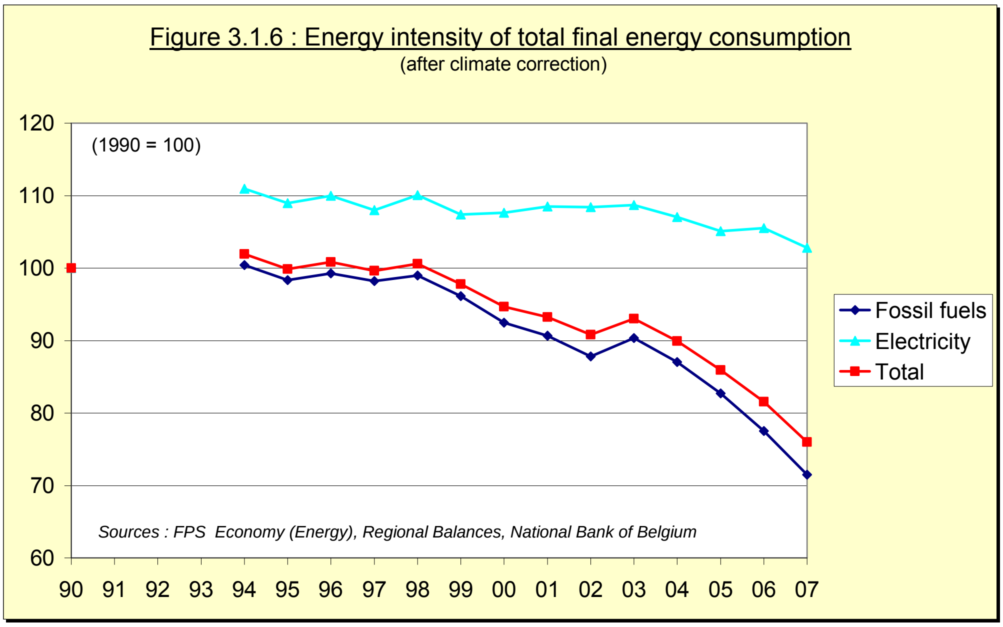
- the evolution of the activity variables on Fig. 2.1.1;
- the relative levels of the energy intensities of the various sectors on the figure below.

3.1.3 Energy intensity of GDP for fuels and electricity

Below, the energy intensity is calculated separately for two categories of energy carriers: fuels — which are often largely substitutable amongst each other and may hence be considered jointly — and electricity, which is mostly tied to specific uses.

From 1990 to 1994, the energy intensity for electricity has grown by 10% (which is likely to be due to an increased penetration of new applications of electricity, amongst which in particular electric steel making). Afterwards, it has slowly decreased.

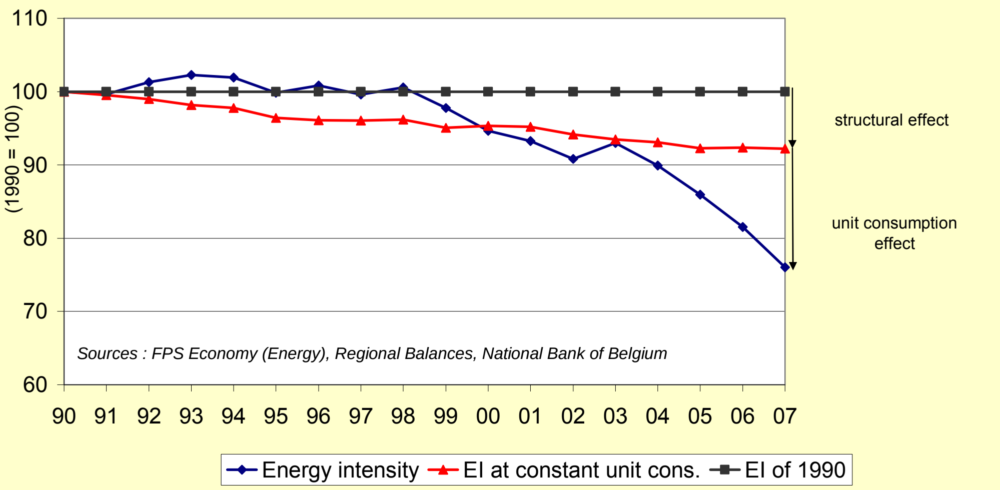
For fuels, after remaining almost stable up to 1998, the energy intensity starts a quite significant downward trend, except for a higher value in 2003, which was discussed above.



3.1.4 Impact of structural change

As explained before, the reduction of the energy intensity of GDP can be considered as the result of two different contributions: a structural effect and a unit consumption effect. One way of decomposing these two contributions is shown below (after climate correction).

Figure 3.1.7 : Energy intensity and macro-economic structural effect



On this figure, the unit consumption effect (a proxy for the energy efficiency effect) is the difference between the actual energy intensity and the energy intensity obtained by assuming that the four main sectors (industry, residential, tertiary, transport) keep their unit consumptions constant and equal to those of 1990.

The structural effect corresponds to the difference between the energy intensity at constant unit consumptions of 1990 and the energy intensity in 1990. It represents the effect of the relative change in importance between the sectors.

The way this structural effect is calculated is described in Annex 4.

Compared with 1990, the reduction of energy intensity reached in 2007, which amounts to 23%, consists for the major part of a unit consumption effect (of about 15%) and to a lesser extent to a structural effect (8%). One can see that the unit consumption effect actually only started in 1998, the structural effect having increased regularly since 1990.

Actually, the unit consumption effect is partly influenced the structural effects happening within each of the four sectors, in particular by structural changes in industry.

The above overall analysis has limitations, because of its very aggregate level and the fact that the activity variables are imperfect, in particular for transport, where in absence of any better activity variable, the GDP has been chosen (which is standard practice). The results (which have changed as a consequence of the changes in the value added statistics) should therefore be interpreted with care.

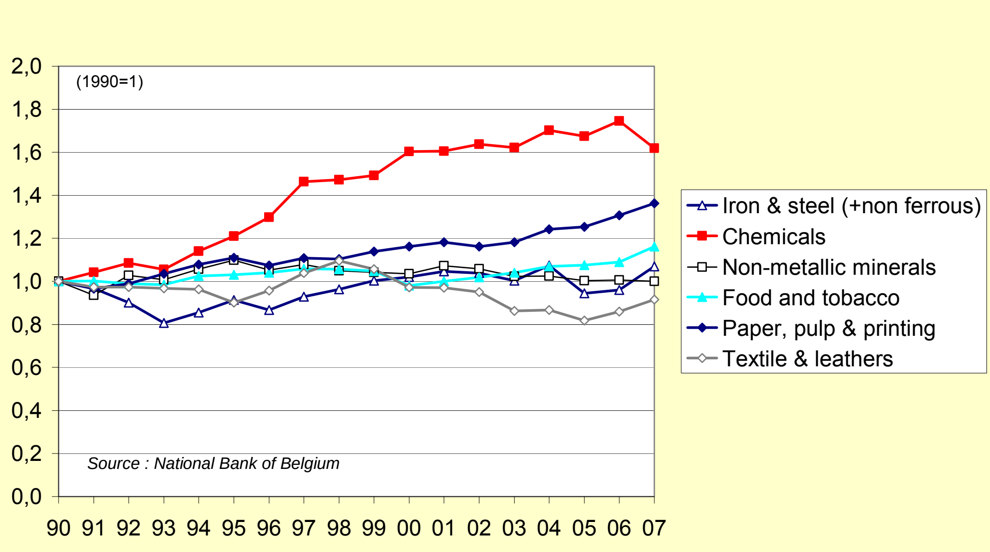
A better indicator of the actual energy efficiency would need to take structural effects into account at a more detailed level, and preferably use activity variables expressed in physical units. Such analyses are presented in the next section.

3.2 Industry

3.2.1 Overall context

The figure below shows the growth in value added by industrial branch since 1990. Considering the whole period, striking is the substantial growth in the chemical sector, which lies clearly above all other most energy intensive sectors. During the last three years a significant growth has taken place in the paper, pulp & printing sector.

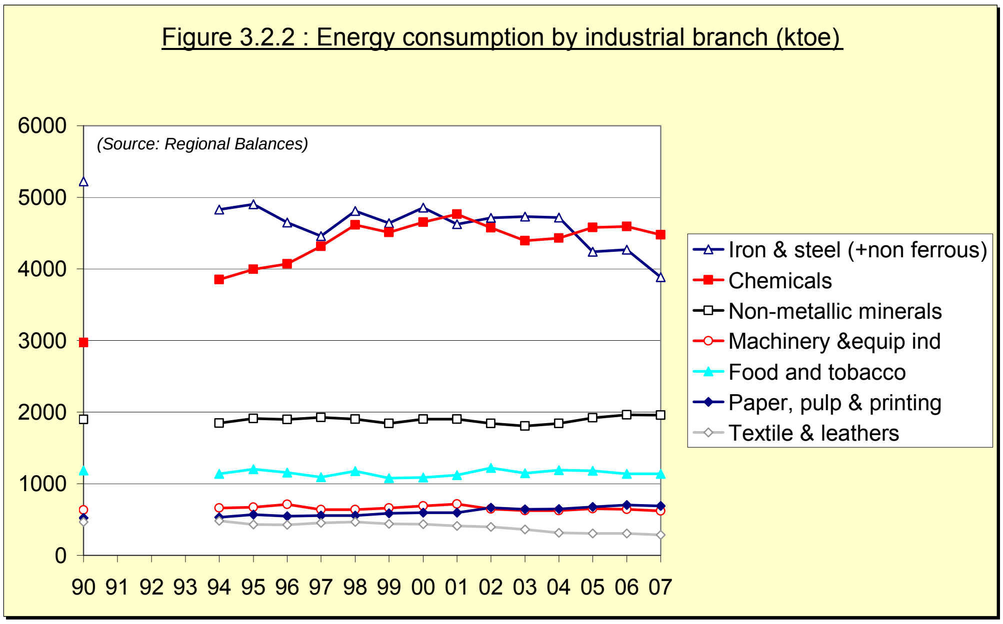
Figure 3.2.1 : Evolution of value added by industrial branch



Iron & steel and non ferrous industries are kept together because the data on value added are not available anymore for each sector individually. This sector has seen its value added fluctuate over the years, but without significant growth between 1990 and 2007.

3.2.2 Energy consumption trends

By far the two main consumers are the iron & steel industry (here aggregated with the non ferrous metals sector), which has seen its consumption decline, and the chemical industry, of which the consumption has very strongly increased between 1990 and 1998.



The non-metallic minerals sector (essentially cement, lime and glass production) and the food & tobacco sectors, the next ones in terms of energy consumption, have had a pretty stable consumption over the entire period.

Among the remaining sectors, the consumption of paper, pulp & printing has been increasing, while that of textile & leathers has lost importance.

3.2.3 Energy intensity trends/Unit consumption trends

3.2.3.1 Energy intensities by branch

The two figures below show the evolution of the (final) energy intensity (total energy consumption/value added in ‘constant prices’[2]) for the main branches of industry.

Figure 3.2.3 : Evolution of energy intensity by industrial branch

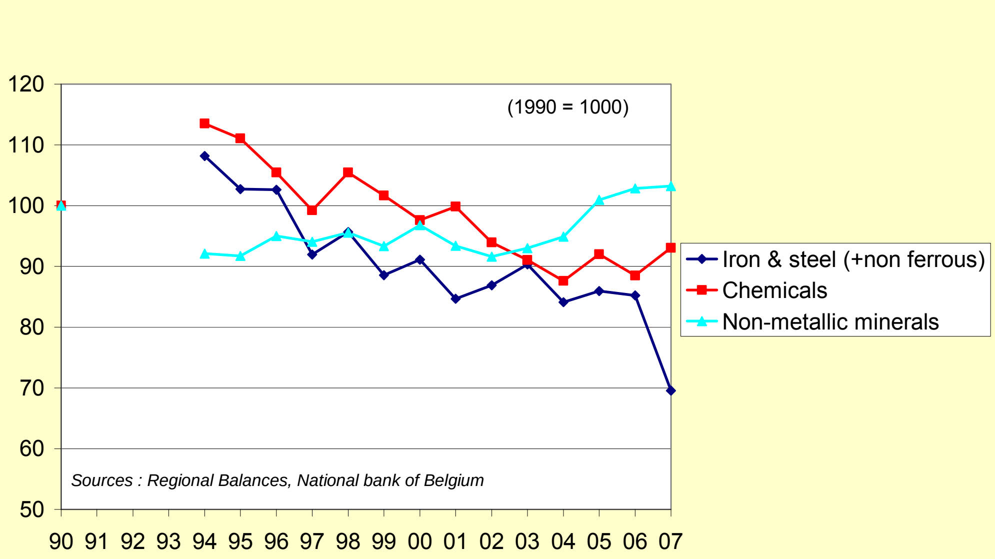
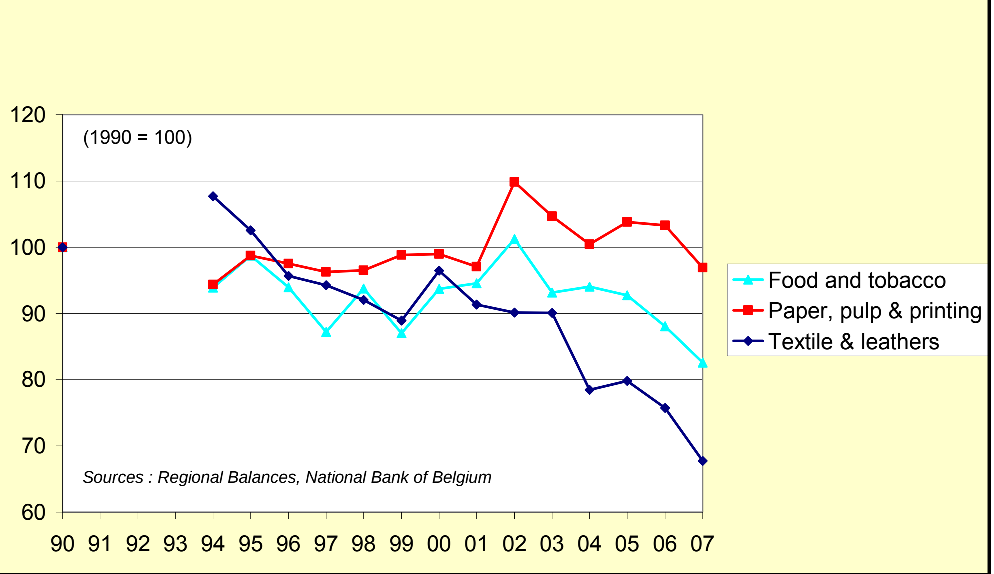


Figure 3.2.3 shows a clearly decreasing trend since 1994 for both the iron & steel industry and the chemicals sector (at least up to 2004 for the latter). For iron & steel, the decrease has even reached 35% between 1994 and 2007. Whereas for the non metallic minerals, there has been an increase over the same period.

2 Actually, the value added is expressed in chained euros.

Figure 3.2.4 : Evolution of energy intensity by industrial branch



As far as Food & tobacco, Paper, pulp & printing and Textile & leathers are concerned, as shown on Figure 3.2.4, the latest figures confirm a declining trend for all three since 2002.

3.2.3.2 Inter-branch structural effects

This section examines to what extent the evolution of the energy intensity of industry as a whole is the result of a structural effect within industry, i.e. a shift in weight between branches with different energy intensities.

The analysis of the intra-industry structural effects has been carried out taking into account the following 7 sectors:

- Iron & steel (+non ferrous),
- Chemicals,
- Non-metallic minerals,
- Machinery &equip ind,
- Food and tobacco,
- Paper, pulp & printing,
- Textile & leathers.

The “other industrial sectors” are not included, as they are heterogeneous. These 7 sectors actually represented 84% of the total energy consumption of industry in 2000.

On the next figure, the variation in energy consumption since 1990 has been separated into three effects: an activity effect, a structural effect and a unit consumption effect.

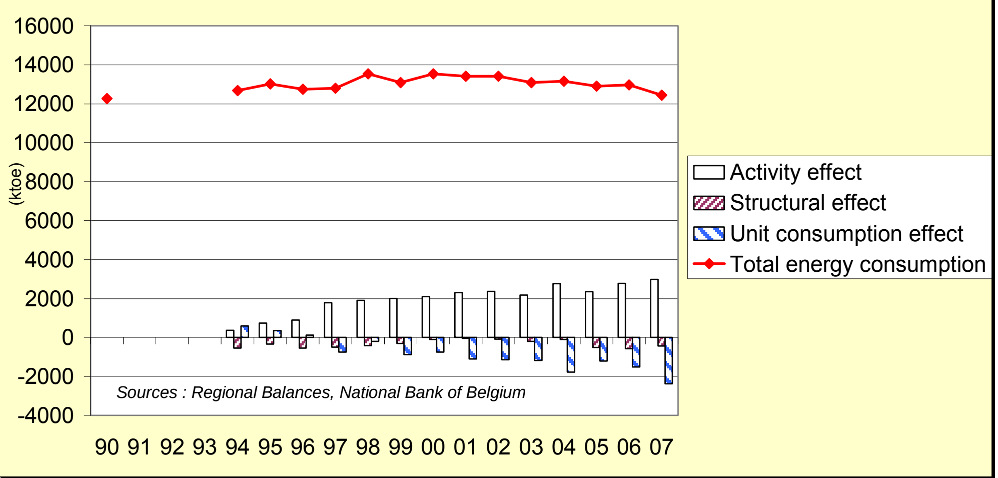
For the calculation of the activity effect, the activity variable taken into account for each sector is the value added at constant prices (i.e. in chained euros). The unit consumption effect for each sector is calculated as the difference between the actual fuel consumption and the fuel consumption that would have been obtained if the fuel intensity had remained equal to that of 1990.

The largest contribution to the variation in fuel consumption comes from the activity effect, which has been stronger since the second half of the nineties.

The second effect by size is the unit consumption effect, which was the largest in 2007.

There also appears to be a small negative structural effect (which means a positive contribution to the reduction of energy consumption). This reflects the fact that, on average, there has been a shift towards sectors with a lower intensity than in 1990.

Figure 3.2.5 : Total energy consumption in industry and variation since 1990



One can see that the energy consumption decrease in 2007 can be explained by the unit consumption effect, i.e. by a decrease, on average, in energy consumption per euro of value added for the various sectors.

Remember that the structural effect is calculated using the energy intensities of the reference year, in this case 1990. The results are sensitive to the choice of that reference year.

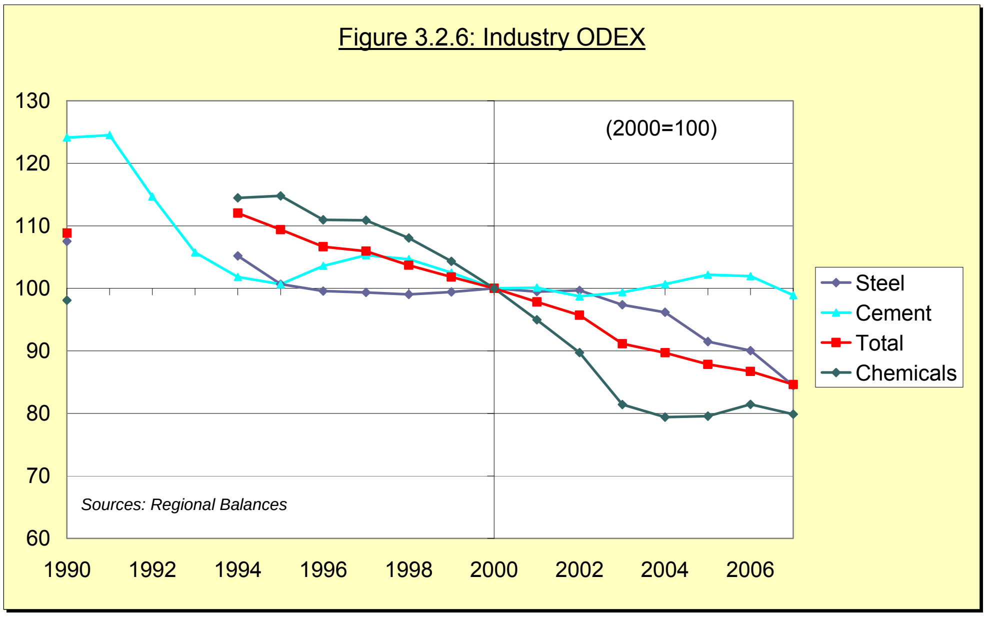
It should also be remembered that this analysis remains approximate, because the activity variable used (value added) is only an imperfect indicator of the activity level of each sector. This is also why unit effects are influenced by intra-branch structural effects, and therefore only imperfectly represent the evolution of energy efficiency.

Note also that the results obtained are sensitive to the choice of activity variable. The picture would have been different if the industrial production index had been used instead of the value added (e.g. in the chemical industry the industrial production index has historically increased much more slowly than the value added).

3.2.4 The ODEX indicator for industry

The ODEX indicator aims at better estimating the technical energy efficiency. It is presented and discussed in section 3.6. However, for reasons of completeness, we also include the indicator in the analysis of each sector.

The figure below shows the ODEX indicator for industry.



As explained in section 3.6.3, this indicator has been calculated using a disaggregation in 9 branches.

One can notice a significant and regular overall improvement of energy efficiency, reaching 17% over the period 1990-2004. In general all sectors show significant energy savings.

As mentioned in section 2.2.3, the substantial increase in the ODEX of the chemical industry between 1990 and 1994 reveals a major structural effect in this sector (investment in naphtha cracking), without which the efficiency improvement would actually have been higher.

3.3 Households

The energy consumption statistics for the residential sector are only disaggregated by fuel. There are no statistics on the share of this consumption by type of use (space heating, water heating or other uses). This limits the possibilities to calculate indicators.

In this sector fuels and electricity are substitutes, and the penetration of electric heating is significant. Therefore the total energy consumption is being considered instead of the sole fuel consumption.

Per inhabitant, the fuel consumption has reached a peak in 1997, has remained more or less stable from 1997 to 2005, and decreased significantly in 2006 and 2007. The electricity consumption per inhabitant has increased until 2001, after which it has more or less remained stable.

Figure 3.3.1: Residential energy consumption per inhabitant

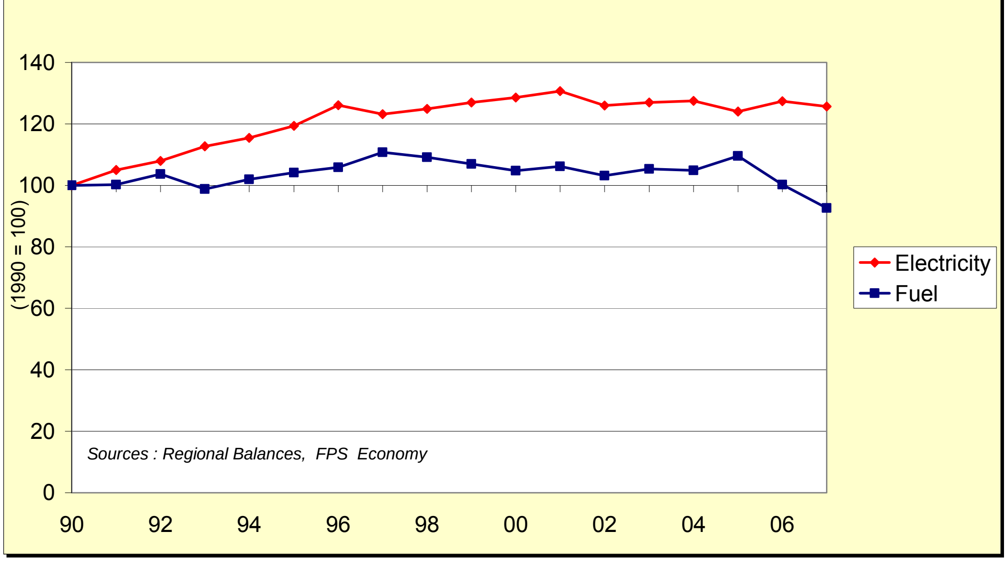
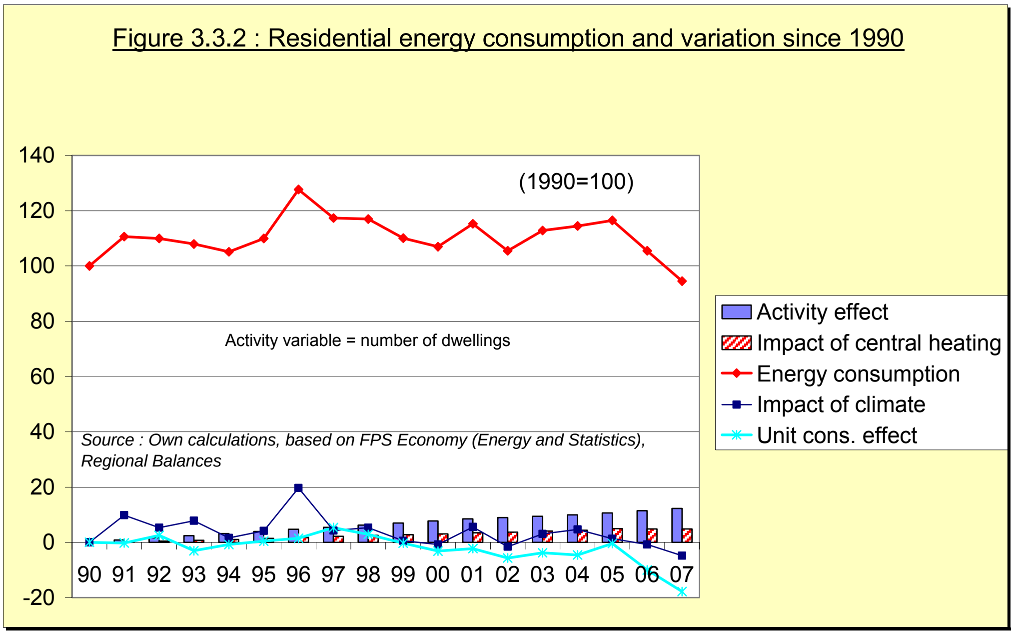


Figure 3.3.2 decomposes the evolution of the fuel consumption since 1990 in the following components:

- the impact of an activity variable, chosen here as the number of dwellings;
- the impact of the climate (estimated from the number of degree-days);
- the impact of the increased penetration of central heating;
- the unit consumption effect, corresponding to energy savings.



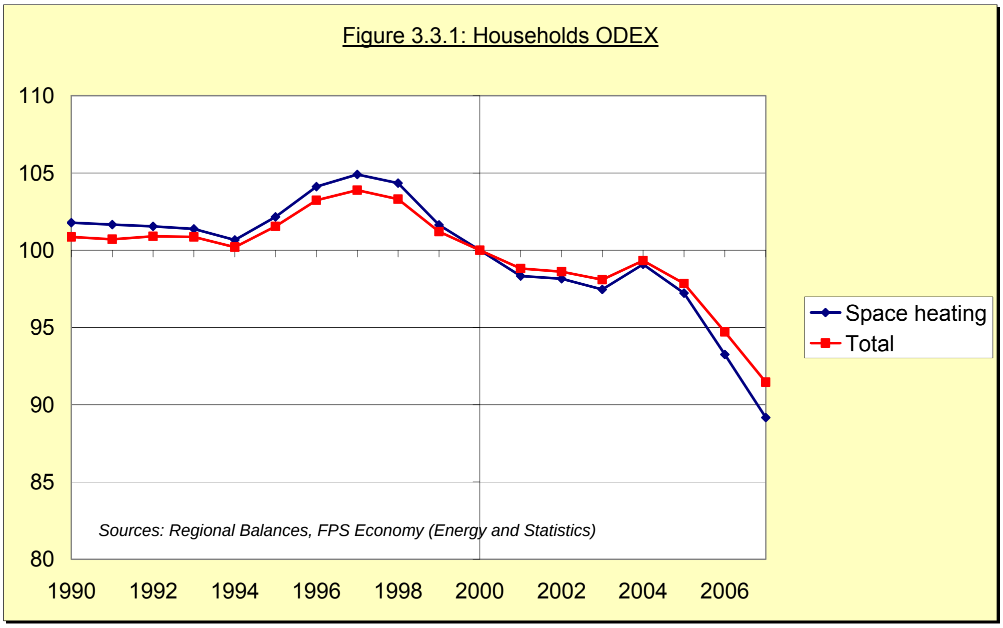
One can see that the climate is the main factor explaining the higher fuel consumption in the nineties as well as the fluctuations of that consumption.

The number of dwellings and the penetration of central heating have a smooth impact, regularly increasing with time. The first is quite significant, reaching 12% in 2007, while the second remains more limited, with a value of 4,8% in 2007.

The unit consumption effect, which is calculated as a residue, can be interpreted combining as energy savings, including behavioural effects such as reducing the indoor temperatures, for example as a reaction of higher energy prices. It is largest in 2006 and 2007, where it corresponds to an energy saving of 18% compared to 1990.

3.3.1 The ODEX indicator for the residential sector

The figure below shows the evolution of the ODEX indicator for the household sector.



This indicator is calculated as the average fuel consumption per dwelling, after correction for the number of degree-days and the increased penetration of central heating (ee section 3.6.1).

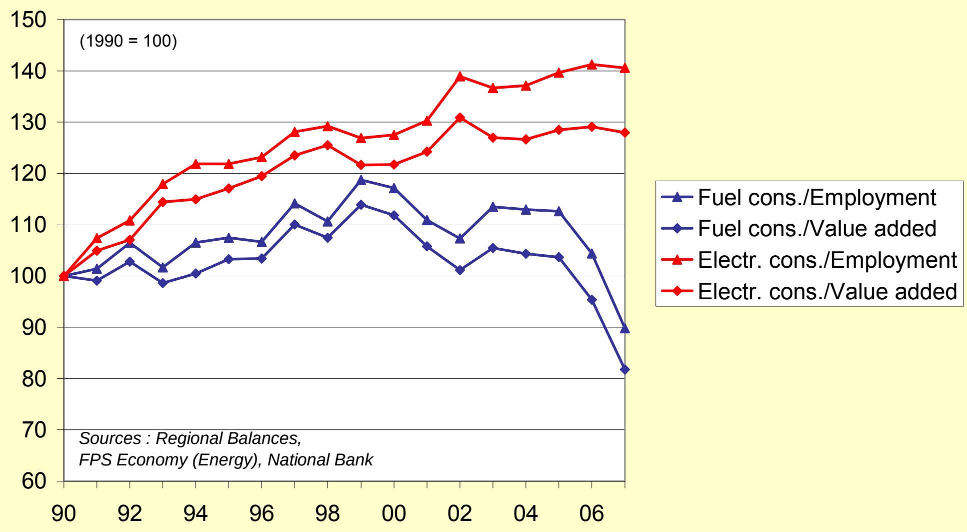
3.4 Services

For the tertiary sector various activity variables can be considered. Figure 3.4.1 shows the evolution of the energy consumption per employee and per unit of value added.

The results are different, as the value added has increased significantly more than the number of employees. But one can notice that for the fuel consumption, both curves peak in 1999, after which the unit consumption decreases, especially during the last two years, becoming lower than in 1990.

For electricity, the unit consumptions have been increasing regularly up to 2006, at a decreasing rate however, and flattening out in 2007.

Figure 3.4.1: Tertiary sector - Ratio energy consumption/Activity

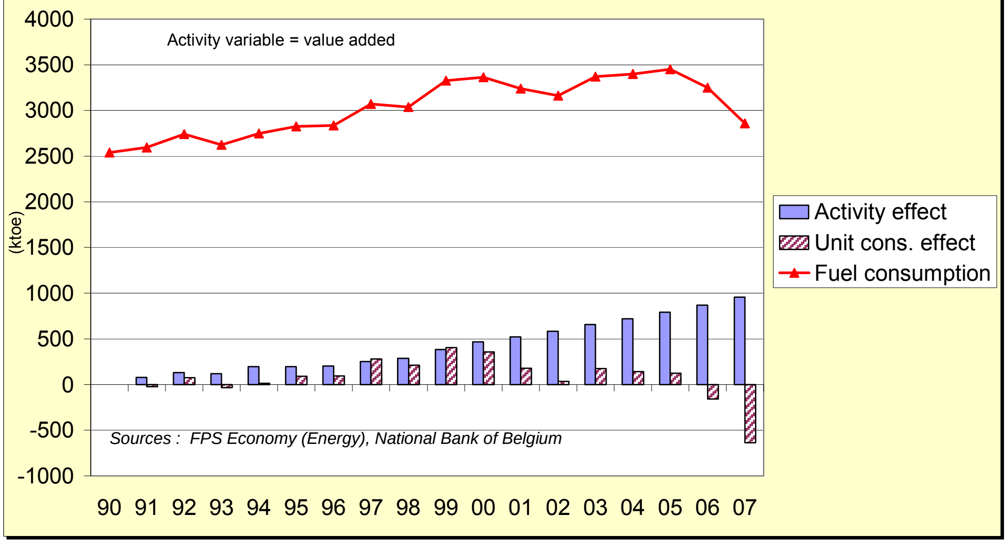


The decomposition analysis on Figure 3.4.2 is similar to that of the residential sector, except that the consumption of fuels has been considered in isolation. Indeed, as there is hardly any electricity consumption for space heating in the tertiary sector, fuels and electricity have been considered separately.

The total fuel consumption has increased up to 2005, but has significantly declined in 2006 and 2007, and this for the first time.

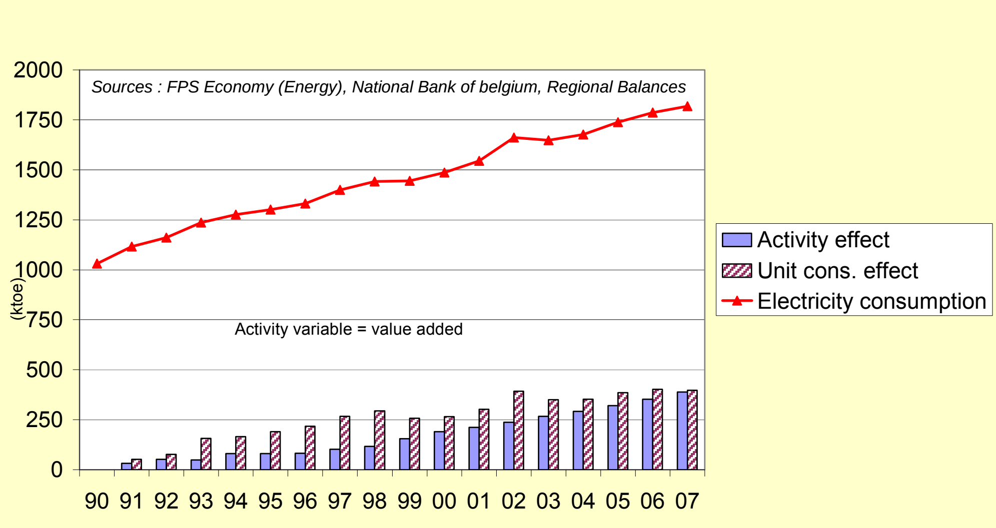
The activity variable chosen is the value added of the tertiary sector. As for the residential sector, the main driving force has been the activity variable. However, one can clearly notice that the reduction in fuel consumption of the last two years is due to the unit consumption effect, i.e. a reduction in the fuel consumption per unit of value added.

Figure 3.4.2 : Fuel consumption in tertiary sector and variation since 1990



For the electricity consumption, displayed below, one can notice, besides the steady increase of the activity effect that the unit consumption effect (the dominant effect in the nineties, likely to result from the increasing use of new applications of electricity, amongst which computer and other office equipment) has been stabilized at its level of 2002.

Figure 3.4.3 : Electricity consumption in tertiary sector and variation since 1990



3.5 Transport

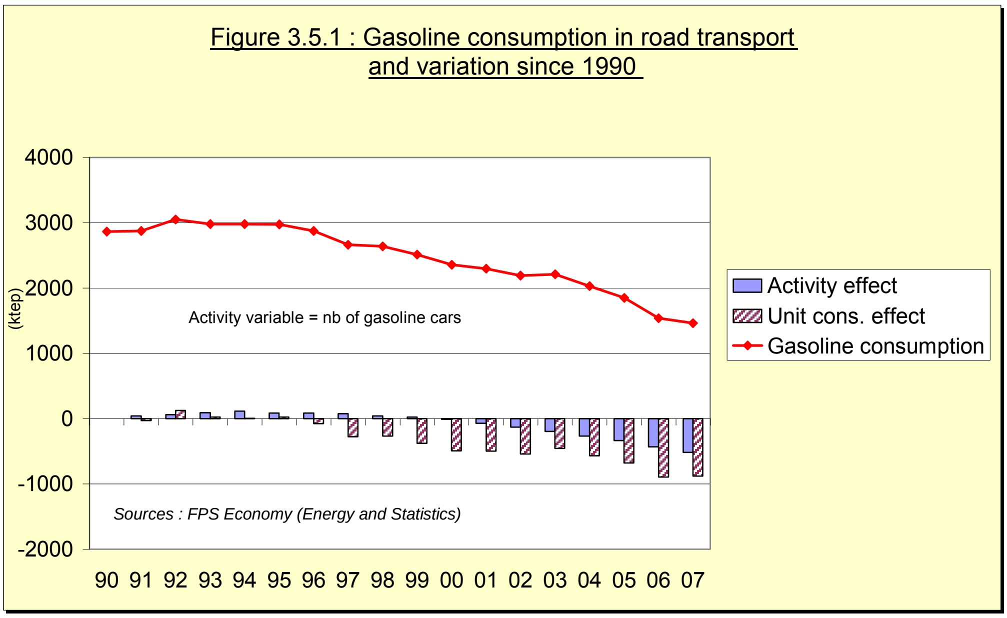
3.5.1 Passenger transport

3.5.1.1 Analysis based on the number of cars

The available statistics don't disaggregate the fuel consumption for road transport by type of vehicle (cars, trucks…). However, as gasoline cars account for over 90% of total gasoline consumption, it makes sense to compare the evolution of the number of gasoline cars with the total gasoline consumption.

The gasoline consumption, which remained flat until 1995, has since followed a steadily decreasing trend.

This evolution can be decomposed between an activity effect and a unit consumption effect. Figure 3.5.1, where the activity variable chosen is the number of gasoline cars, shows that since 1996, the decrease in fuel consumption is mainly due to the unit consumption effect (average gasoline consumption by car), but also to a rising contribution of the activity effect (decrease in the number of gasoline cars).



For road transport by diesel vehicles such an analysis is not possible, however, because diesel cars now account for a large share of the diesel oil consumption and the energy consumption statistics don't disaggregate the fuel consumption between passenger cars and trucks.

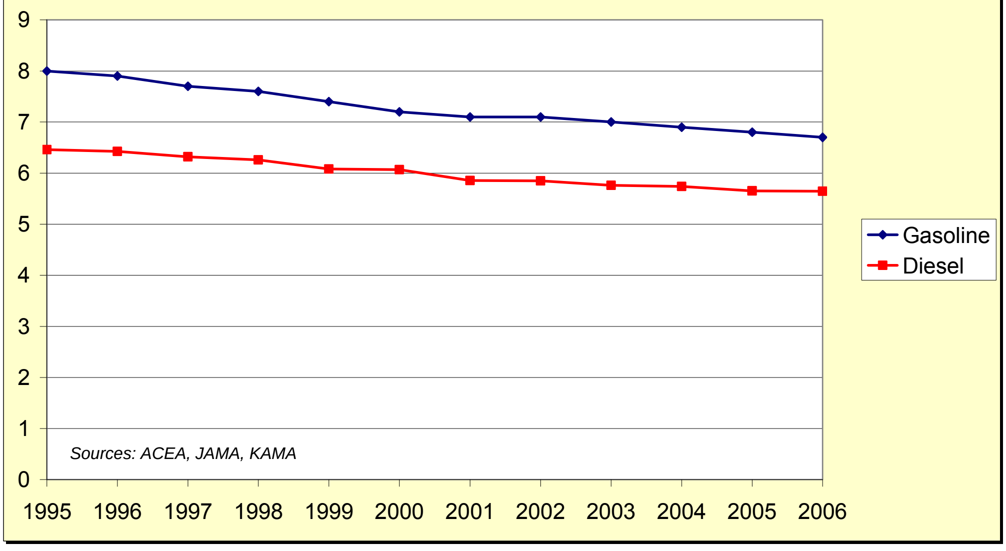
Given the nature of the activity variable, the unit consumption effect includes both a specific consumption (l/100 km) effect and an average mileage effect. The decrease in average mileage, which is quite substantial, can probably be explained by the shift of from gasoline to diesel, which is likely to have occurred mostly for the highest mileages, thereby reducing the average mileage of gasoline cars.

The data does not allow to distinguish between the contribution of behaviour (in particular the average mileage) and that of improvement in efficiency.

3.5.1.2 Specific fuel consumption of new cars

Figure 3.5.2 shows the evolution of the average normalised specific consumption of new cars, based on the test cycle of Directive 93/116/EC. The data, from ACEA (obtained through the Odyssee website), represents the average for the Belgian market of cars manufactured by members of the European, Japanese and Korean automobile construction associations (ACEA, JAMA and KAMA).

Figure 3.5.2: Average specific fuel consumption of new cars (l/100 km)



It can be noticed that since 1995, there has been a significantly decreasing trend in average fuel consumption of both gasoline and diesel new cars sold. For diesel cars, the decrease is less important, which could be explained by the shift from gasoline to diesel cars, which rather took place for the largest of the gasoline cars. In 2006, the specific consumption of diesel cars has remained stable.

3.5.2 Freight transport

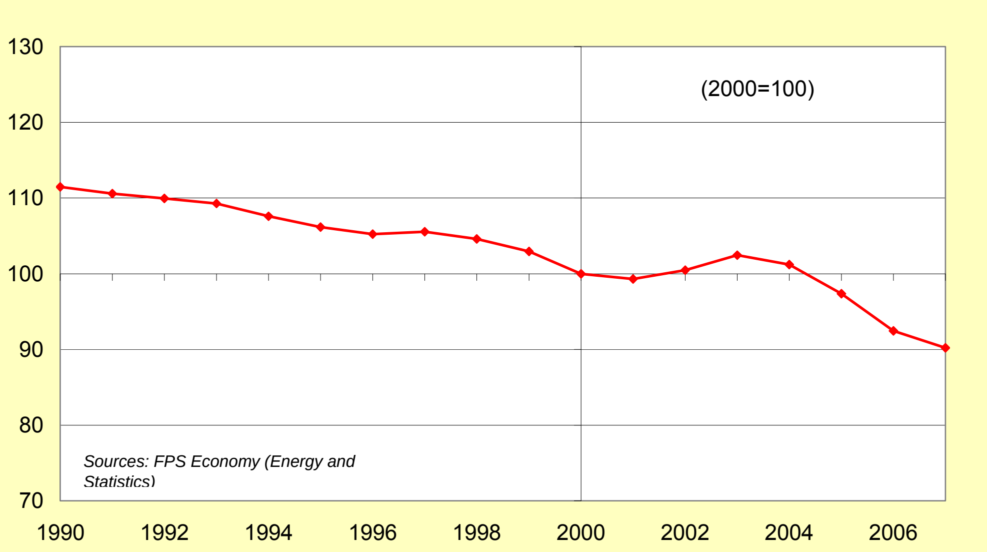
While the total consumption of diesel fuel is known, it cannot be used here, because a large fraction of it (about one third) is used in diesel cars, and this fraction varies from year to year according to factors that are not quantified (amongst which in particular the average mileage of diesel cars).

Hence it is not possible to split into its different components the fuel consumption for freight transport by road.

3.5.3 The ODEX indicator for transport

The figure below shows the ODEX indicator for the transport sector.

Figure 3.5.3 : Transport ODEX



This indicator takes into account the road and rail transport modes, for both passenger and goods transport. For road transport, it represents the evolution of energy consumption per vehicle. See further comments in section 3.6.2.

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

The ODEX indicator has been developed in the framework of the ODYSSEE project. Its aim is to best reflect the evolution of the technical efficiency of energy use of a sector, at whatever aggregation level of the latter.

The traditional way of measuring the energy efficiency improvement of a sector is to use the energy intensity. However the energy intensity is influenced not only by technical efficiencies, but also by structural changes within the sector, such as a shift from energy intensive towards less energy intensive products.

The ODEX indicator is a kind of weighted average of unit energy consumptions of elementary components of the sector, based as far as possible on activity variables expressed in physical units instead of in monetary terms[3]. It takes into account the impact of all energy saving measures (whether or not policy driven), including technical progress and behavioural changes.

The ODEX indicators used in this report is a 3-year moving average, which has as effect to smooth the curves.

It should be noted that for the residential sector a "technical ODEX" has also been defined within the ODYSSEE project, which differs from the ordinary ODEX indicator in that it aims to remove behavioural factors[4]. Such a technical ODEX has not been used in this report, because it has the drawback of taking into account behavioural effects with a negative sign (reducing the consumption, e.g. in a context of higher energy prices) in the same way as technical improvements, while neglecting behavioural effects with a positive sign (e.g. an increase in energy consumption as a result of decreasing energy prices).

As for the other countries in the project, no ODEX indicator could be calculated for the tertiary sector, because of a lack of required data.

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3 A description of ODEX can be found in:

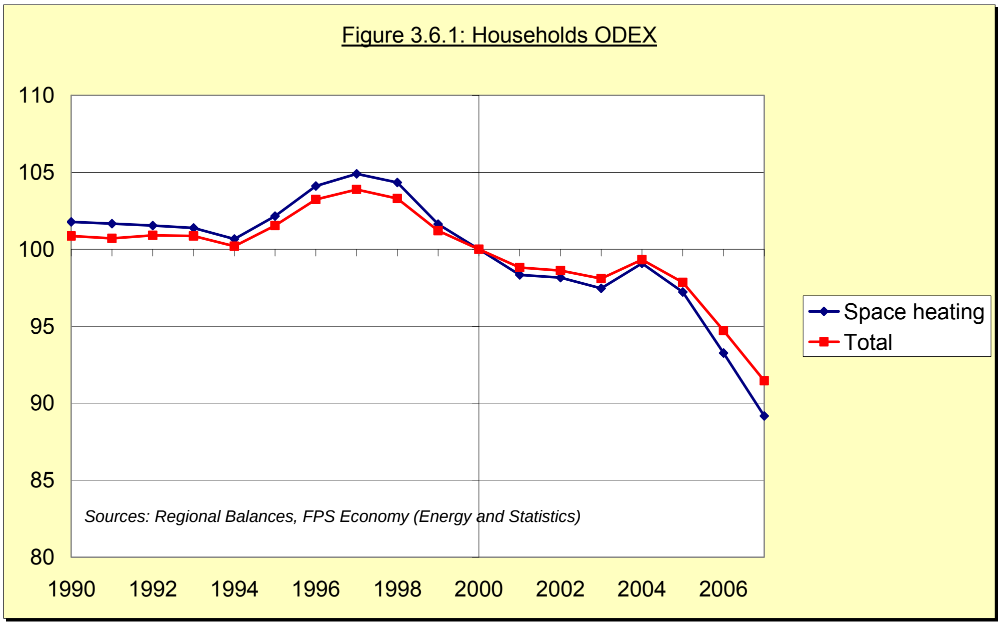
"Definition of the energy efficiency index ODEX" (www.odyssee-indicators.org).

Bosseboeuf D.: "Measuring energy efficiency progress in the EU: the energy efficiency index ODEX", presentation at ECEEE Summer Study 2005.

4 See "Definition of the energy efficiency index ODEX" (www.odyssee-indicators.org).

3.6.1 Residential

For the residential sector, the ODEX indicator is calculated as the average fuel consumption per dwelling, after correction for the number of degree-days and the increased penetration of central heating.



Between 1994 and 1997, the index has increased, which can probably be attributed to changes in "lifestyle", an increase in comfort (higher indoor temperatures, less caution with the use of energy, more appliances…)[5]. On the other hand, between 1997 and 2007 there has been significant decline in the energy efficiency index, of over 10%, probably partly caused by policy driven savings but also by increasing energy prices.

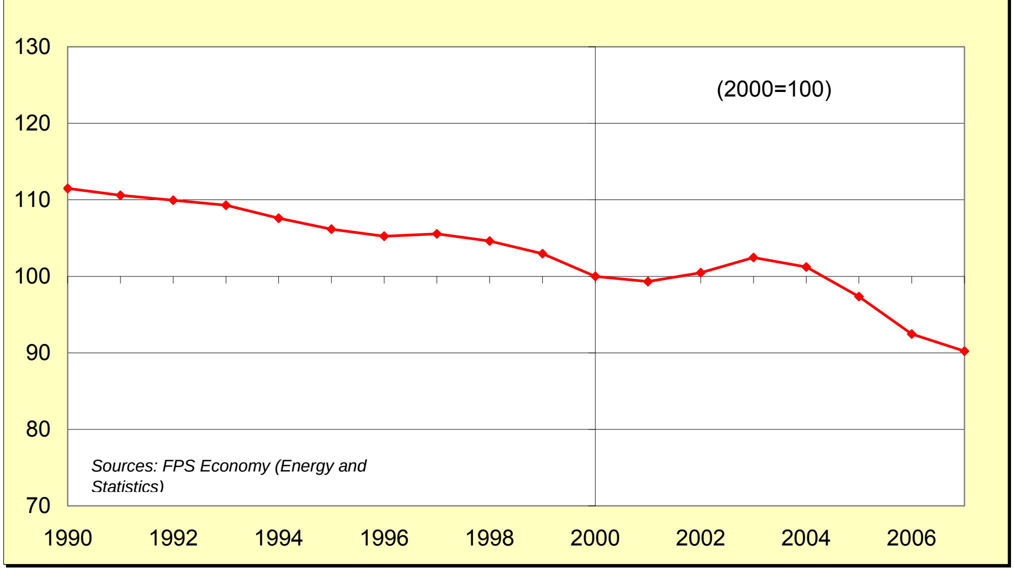
3.6.2 Transport

The ODEX indicator for transport, shown below, takes into account only road and rail transport. For road transport, given the lack of data on the vehicle fleets' average specific consumptions, this index represents the evolution of the average fuel consumption

5 It should be noted that during the period 1995-2000, the average fuel consumption per dwelling has increased in most EU countries, as well as for the EU-15 as a whole.

per vehicle, and is thus influenced as well by the average vehicle mileage as by the specific consumption (in l/100 km) of the vehicles.

Figure 3.6.2 : Transport ODEX



Because of a lack of data, the various types of road vehicles are taken into account in a simplified way, on the basis of car-equivalents.

For river transport, the energy consumption statistics are not reliable, as there is even a negative value for one year.

Except for the years 2002-2003, there has been a steady decline in the index, of about 20% between 1990 and 2007.

3.6.3 Industry

The ODEX indicator for industry has been calculated using the following 9 sector dis-aggregation:

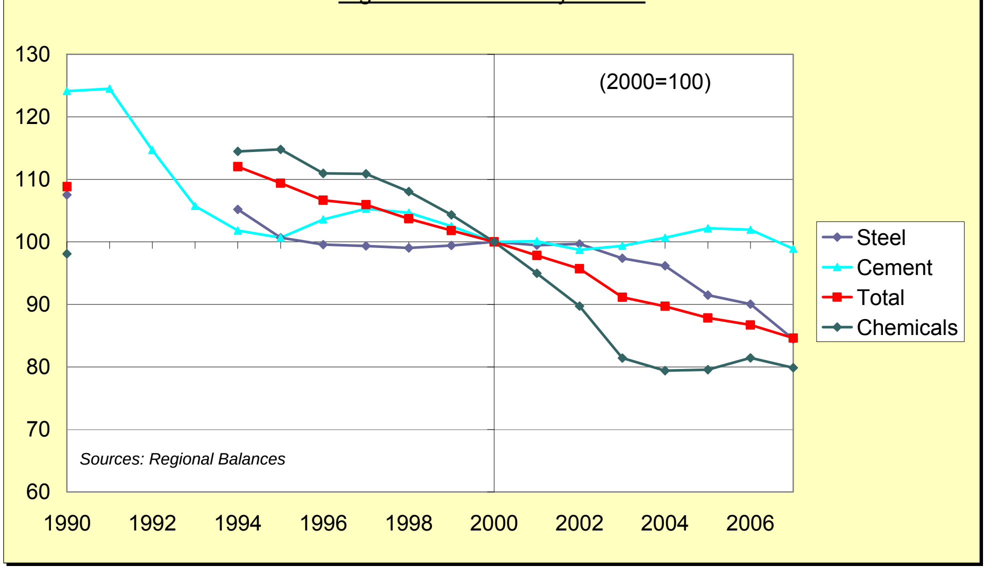
- Iron & steel,
- Non ferrous metals,
- Chemicals, rubber & plastics
- Cement
- Other non-metallic minerals,
- Paper, pulp & printing,
- Food and tobacco,
- Equipment manufacturing
- Textile & leathers,

using as activity variable the physical production of steel, cement and paper, and the industrial production index for the other sectors.

As is explained in Annex 3, the quality of federal energy consumption statistics by individual industrial branch appears to be poor. Therefore, instead of using these figures, we have aggregated the energy consumption statistics of the three Regions[6].

The index is shown for the sector as a whole as welle as for three energy intensive industrial branches. The gap for the years 1991-1993 stems from the fact that no statistics are available for Flanders for these years.

Figure 3.6.3: Industry ODEX



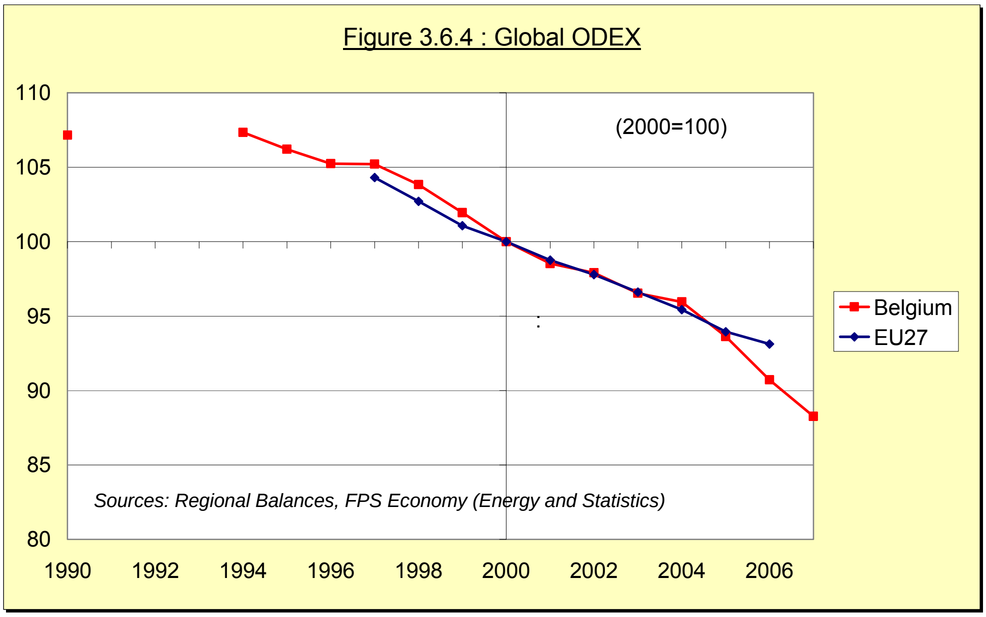
6 Even though these regional statistics may not be completely harmonised.

Striking on this figure is the evolution of the chemical industry. Between 1990 and 1994, it has increased by 15%, which pushes the overall ODEX upwards over the same period. This increase may be explained by a structural effect within that branch, corresponding to the startup of large new capacities of energy intensive naphtha cracking during this period. Without this structural effect, the energy efficiency improvement in industry over the period 1990-2004 would still be larger.

On the other hand, from 2000 to 2003, the indicator for the chemical industry has diminished by 21%. This is probably to be explained more by structural effects within the branch than by energy efficiency improvements; indeed, the more detailed data available in the framework of the voluntary agreements in both Flanders and Wallonia (see section 4.4.2) tend to show that the reduction of specific energy consumption has not exceeded a few percent. This shows the limits of the indicator when it is calculated at the aggregation level of the chemical industry as a whole.

3.6.4 The overall ODEX indicator

The figure below shows the overall ODEX indicator. This indicator takes into account the industry, residential and transport sectors, and is based on the ODEX indicator of each of these sectors, which have been presented above.

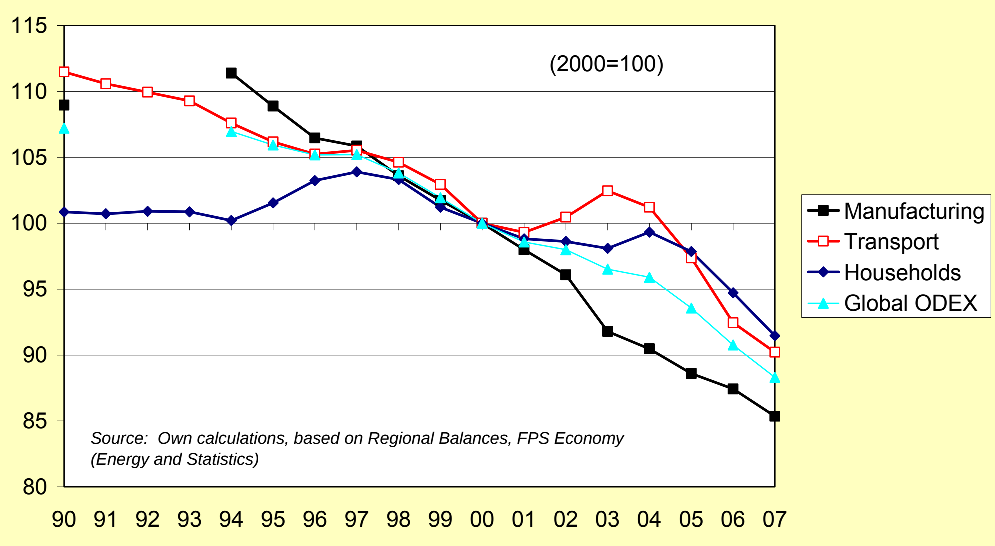


Note that this indicator should be improved in the future, as far as the disaggregation level and the choice of unit consumption indicators is concerned. The tertiary sector is not taken into account for any country because of a lack of data.

Compared with the year 2000, this indicator shows a 12% improvement in energy efficiency, which is an average of 1,8% per year.

The ODEX indicators of the different sectors are shown together below.

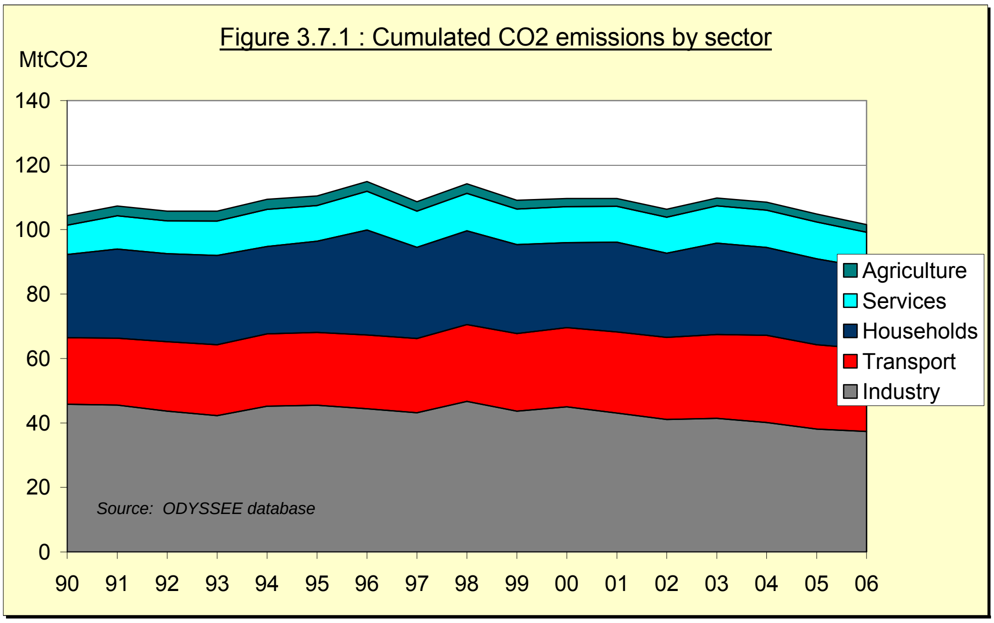
Figure 3.6.5: ODEX indicator by sector



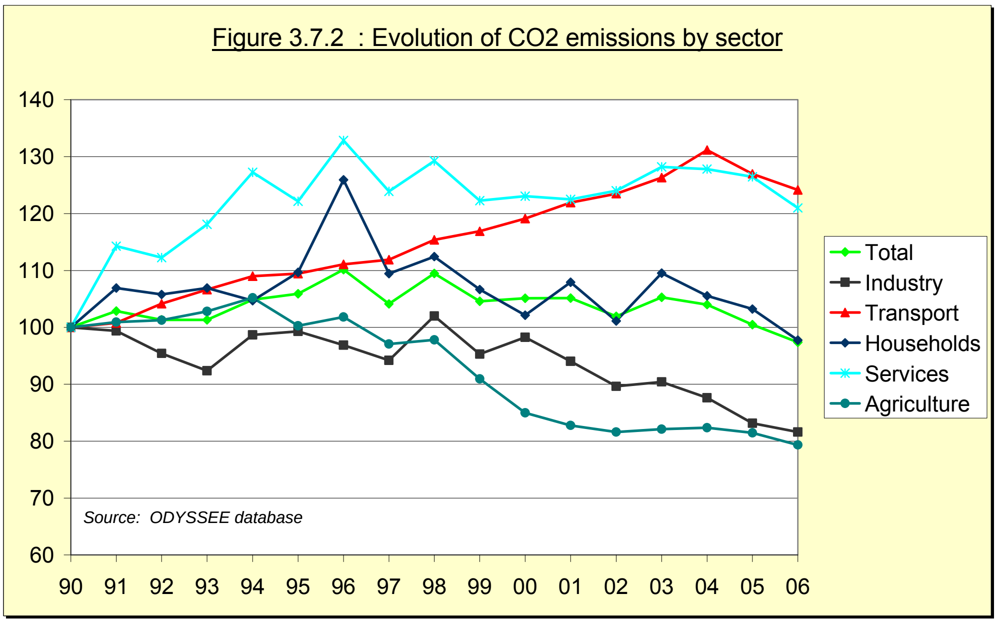
Since 2000, the largest improvement has taken place in industry, the lowest in the household sector. Caveats made above about these indicators should be kept in mind when considering this comparison.

3.7 CO2 emission trends

Overall, emissions have increased until a peak in 1996, after which they have decreased, especially during the last two years.

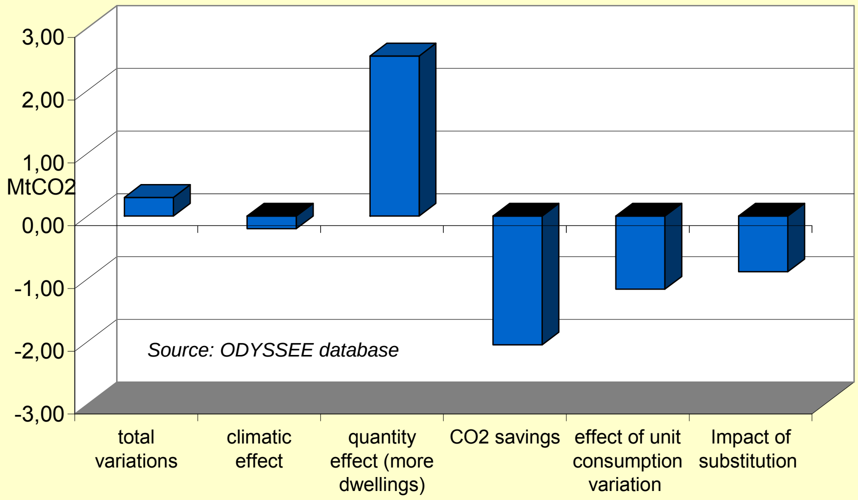


The evolution differs according to the sector, as shown on Figure 3.7.2. In absolute terms, from 1990 to 2006, industry has reduced its emissions by 8,4 Mt CO2 and households by 0,6 Mt CO2, while the transport sector has increased its emissions by 5,0 M t CO2 and the tertiary sector by 1,9 M t CO2.



The next figure shows a decomposition of the total variation of CO2 emissions between 1990 and 2006 for the households sector.

Figure 3.7.3 : Interpretation of CO2 emissions variations (households - 1990-2006)



This total variation can be decomposed in:

- the climatic effect (small, because both 1990 and 2006 were warm years);
- the quantity effect (2,6 Mt CO2, due to the increased number of dwellings);
- the CO2 savings.

The CO2 savings (2,0 Mt CO2) in turn comprises two components:

- the impact of substitution (essentially from gasoil to natural gas) is quite significant (0,9 Mt CO2);
- the unit consumption effect (1,2 Mt CO2); this represents the savings arising from the fact that new dwellings built since 1990 consume less energy than the average existing ones in 1990.

4 Energy efficiency measures

The individual policy measures with their main characteristics have been updated in the MURE database on energy efficiency measures, which is available at www.mure2.com. An overview of these energy efficiency measures is given in Annex 1.

The following remarks can be made about these measures:

- the database does not contain all existing measures, it focuses on the most important ones;
- in principle, only national measures are to be taken into consideration; in the case of Belgium, where most measures stem from the Regions, whenever a same, or a similar, measure is taken in the three regions it is represented in the database as a single measure describing the situation in the three Regions;
- in principle, measures taken in only in one region are not considered; however an exception has been made for some important measures.

4.1 Recent Energy Efficiency Measures

In 2007, Belgium submitted its first National Energy Efficiency Action Plan (NEEAP) in the framework of EU directive 2006/32 on energy end-use efficiency and energy services. This plan compiles the individual plans of the federal government and the three Regions (Flanders, Wallonia and Brussels-Capital). It describes the energy efficiency policy measures taken by the relevant federal or regional authorities. Except for Flanders, it does not yet contain an estimate of the impact of the measures.

In the framework of a cooperation agreement on the national climate policy signed in 2002 between the federal government and the regions, the National Climate Plan 2009-2012 has been issued in January 2009. This document gives a detailed inventory of the existing federal and regional policies and measures taken up to 31 December 2008, which are classified either by sector or as cross-cutting measures.

In October 2009, Flanders has issued its paper on energy policy (Beleidsnota energie 2009-2014), which, as far as energy efficiency is concerned, mainly focuses on the implementation of EU directives 2006/32 (on energy efficiency and energy services) and 2002/91 (energy performance of buildings).

In April, Wallonia has prepared a draft update of the sustainable energy plan (Actualisation du Plan de Maîtrise Durable de l’Energie), proposing over 200 new measures on energy efficiency or renewable energy.

4.1.1 Residential Sector

Before European directive 2002/91 on the energy performance of buildings (EPBD), all three regions enforced the 'K55' thermal insulation standard for new dwellings.

The transposition of directive 2002/91 is an important new piece of legislation in the three regions. The Flemish Region has adopted a law on 7 May 2004[7] on the energy performance standards for buildings. The compulsory performance standards are specified in a Flemish Government ordinance of 11 March 2006[8], which applies to all new and existing buildings and takes into account not only the building shell but also the heating system and the sanitary hot water production as well as ventilation requirements. The regulation is applicable since 1st January 2006.

In Wallonia and Brussels-Capital, the EPBD directive has been transposed in a similar way: in Wallonia, by a framework act of 19 April 2007 and a Walloon Government ordinance of 17 April 2008, where the actual requirements and calculation methods are defined; in Brussels, by the ordinance of 7 June 2007 and a governmental decree of 21 December 2007.

The three Regions (Flanders, Brussels-Capital and Wallonia) provide subsidies for energy saving investments and for the use of renewable energy sources (e.g. thermal insulation, condensation boilers, solar heating, refrigerators or energy audits) as well as for energy audits or energy accounting schemes. These subsidies, which vary with the types of energy saving investments, have generally been enhanced and increased during the last years.

At the Federal level, investments in rational use of energy give right to a tax deduction: this concerns the expenses incurred for the replacement of old boilers and the installation of solar collectors or photovoltaic systems, double glazing, roof insulation, regulation systems and energy audits. The total tax deduction allowed per fiscal year could reach up to 2600 € per dwelling for 2007.

In Flanders, as a public service obligation the electricity grid operators are required to achieve each year a given percentage of energy savings on their clients' consumptions (1% per year for the high voltage consumers, 2,2% in 2006 and 2007 for the low volt-

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7 Decreet houdende eisen en handhavingsmaatregelen op het vlak van de energieprestaties en het binnenklimaat voor gebouwen en tot invoering van een energieprestatiecertificaat, 7 May 2004.

8 Besluit van de Vlaamse Regering tot vaststelling van de eisen op het vlak van de energieprestaties en het binnenklimaat van gebouwen, 11 March 2006.

age consumers). This is achieved in particular through premiums, which are financed through an increase in electricity prices.

4.1.2 Transport Sector

In the transport sector, the increase in energy efficiency of cars used to mainly be promoted by the voluntary agreements signed at European level with the automobile manufacturers' associations on the specific CO2 emissions. After lengthy political discussions, this policy has been replaced by Regulation 443/2009 of the European Parliament and of the Council of 23 April 2009.

At national level, efforts have been made to limit the mobility of road vehicles, in particular by promoting the development of mobility planning tools, such as company transport plans, urban mobility plans, school transport plans.

Emphasis is also put on the promotion of public transport, by improving its availability, its quality and its price attractiveness. The federal government has imposed a 25% increase in passenger transport to the national railway company, through its management contracts. In this framework it has decided to provide to all civil servants free access to railway transportation for their home-to-work trips. For private sector workers, the federal government subsidises 20% of the home-to-wok trips, provided that the employer pays the remaining 80%. As a result of these measures the use of public transportation has considerably increased.

4.1.3 Industrial Sector

For industry, the energy efficiency policy is focussed on voluntary agreements between industry and the (regional) governments.

In Flanders, the voluntary agreements are "benchmark" agreements, with a commitment to bring the energy efficiency to the world top ten by 2012. They are signed by individual companies with an energy consumption larger than 0,5 PJ per year. By August 2009, 182 companies had signed such an agreement, next to 12 sector organisations.

In Wallonia, the voluntary agreements have been signed by 10 sector associations representing 136 companies, which commit themselves to a quantified energy efficiency improvement for the sector over the period 2000-2012.

On 2nd April 2004, Flanders has promulgated a law on rational use of energy ('REG-decreet') for reducing the emissions of greenhouse gases. It sets a framework for policies including subsidies, voluntary agreements, obligations for energy suppliers, flexibility mechanisms…

Besides, cogeneration is actively promoted in all three Regions, through a range of instruments (subsidies, fiscal deductions, green certificates, information campaigns…).

4.1.4 Tertiary Sector

European directive 2002/91 on the energy performance of buildings, which has now for a great deal been transposed in the three regions, also applies to the tertiary sector. For the status of the transposition of this directive, see Residential sector. Special performance requirements are foreseen for specific categories of buildings like schools and offices.

As for the residential sector, each of the three Regions grants subsidies for a range of energy saving or renewable energy measures as well as for energy audits.

4.1.5 Cross-cutting measures

The production of renewable energy as well as cogeneration are strongly encouraged through the introduction of mandatory minimum quotas of “green energy” (renewable energy and a fraction of cogeneration) imposed on energy suppliers through a system of green certificates. Energy suppliers failing to provide a number of certificates corresponding to the quota must pay a penalty of 100 €/MWh. This system has been introduced in each of the 3 regions and has been partly harmonised. Besides, the federal government strongly supports wind energy projects in the North Sea, for which in October 2009 five concessions, totalling 1500 MW capacity, had been awarded.

4.2 Patterns of Energy Efficiency Measures

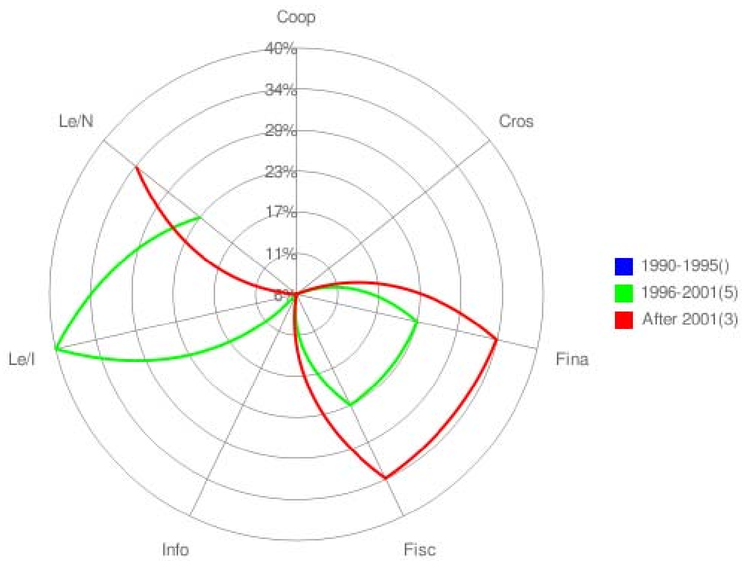
This section shows graphically the weight given to the various types of policy measure-categories in each sector, in terms of number of measures in the MURE database. It should be remembered that this database concentrates on the most important measures (see the beginning of section 3). The spider web graphs represent the percentage number of policy measures falling in the different policy categories (financial, fiscal-tariffs, information-education, legislative-informative, legislative-normative, cooperative measures, cross-cutting measures with sector-specifics).

The graphs show the types of measures which are most often used in the country, but does not take into account the impacts of the measures or their costs. Therefore they should be interpreted with caution.

The legend of the spider graphs is the following:

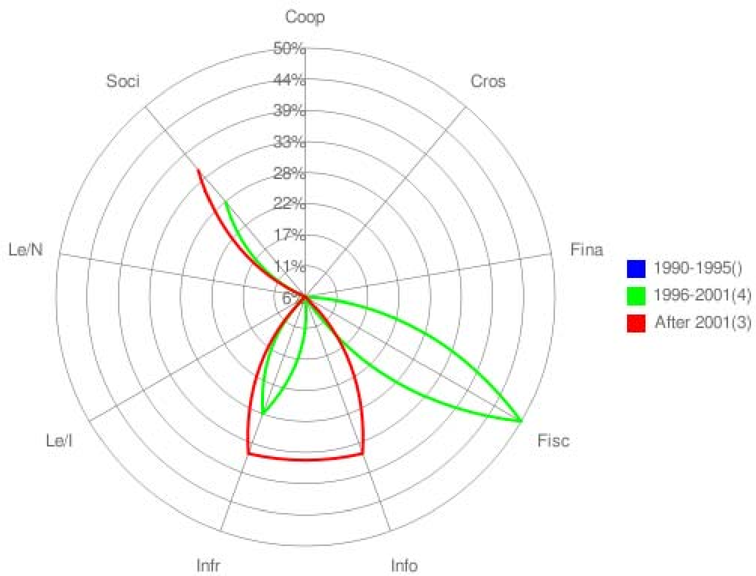
Coop:Co-operative Measures
Cros: Cross-cutting with sector-specific characteristics
Fina: Financial
Fisc: Fiscal/Tariffs
Info: Information/Education
Le/I: Legislative/Informative
Le/N: Legislative/Normative
Soci: Social/Planning/Organisational
Infr: Infrastructure
Mark: Market-based Instruments
Gene: General Energy Efficiency/Climate Change/Renewable Programmes
Nonc: Non-classified Measure Type

Figure 4.2.1: Pattern of policy measures in the household sector



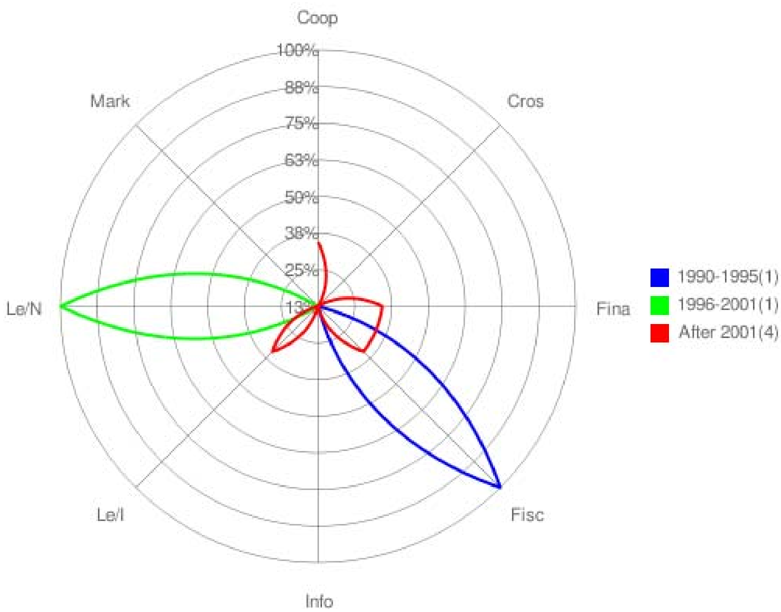
In the residential sector, the measures are predominantly legislative-informative, financial and fiscal.

Figure 4.2.2: Pattern of policy measures in the transport sector



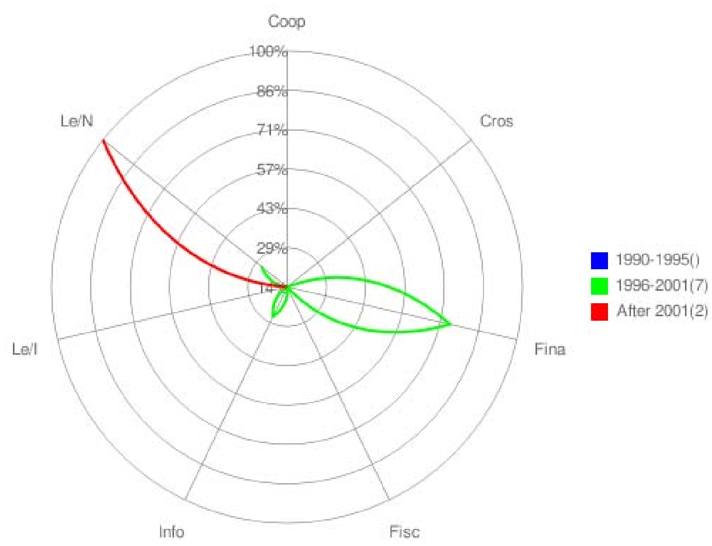
In the transport sector, the category "Fiscal measures" is the mostly used, besides organisational, infrastructure development and information measures.

Figure 4.2.3: Pattern of policy measures in the industrial sector



In industry, the most common types of measures used to be fiscal or legislative/normative ones. Later, the the Voluntary agreement measure, in the category Cooperative, which has been accompanied by subsidies, has become the most important one in terms of impact.

Figure 4.2.1: Pattern of policy measures in the tertiary sector



In the tertiary sector, in a first step the financial and education-information-training categories were the most important ones in terms of number of measures, later to be joined by the legislative/normative category (for the energy performance of buildings).

4.3 Innovative Energy Efficiency Measures

Most of the policy measures taken are well-known types of measures that can also be found in other countries (fiscal deductions, subsidies, building thermal regulations…).

One less common measure is the public service obligation in Flanders requiring the electricity grid operators to achieve each year a given percentage of energy savings on their clients' consumptions.

Another rather innovative measure is the extension of green energy certificates to cogeneration (taking into account the relative specific CO_2 emission reductions).

In the transport sector, public transport has been significantly encouraged by making public transport free of charge for certain categories of citizens (people above 65 years of age and civil servants for their home-to-work trips, in the case of railways) or generally (case of various towns).

In the future, the possibility of introducing white certificates is now being considered.

4.4 Energy efficiency measure evaluations

4.4.1 Semi-quantitative Impact Estimates of Energy Efficiency Measures

Published impact evaluations of energy efficiency measures are still very scarce. The monitoring of energy savings linked to particular measures is currently being discussed in the framework of the implementation of directive 2006/32 and more detailed evaluations will be available in the future.

The tables on the following pages are intended to present a rough subjective assessment of the impact of each of the MURE measures (see Annex 1 for more information on these MURE measures).

Definition of the qualitative impact level

The impact is defined in terms of final energy. Electricity savings are linked only to electricity, all other savings (except for those involving fuel substitution and CHP) to the overall final energy consumption.

For fuel substitution and CHP, the savings are linked to primary energy, calculated with a fixed factor of 2.5.

The categories (low, medium, high) are linked to the aggregate electricity or energy consumption of the respective sector (households, transport, industry or tertiary), and not to a particular end-use, because the aggregation of the impacts is easier.

The following limits (in each case in % of the overall final energy or electricity consumption of the sector; in case of fuel substitution and CHP: of primary energy consumption) are defined for the three impact levels:

- low impact: <0.1%
- medium impact: 0.1-<0.5%
- high impact: ≥0.5%)

4.4.1.1 Households

Code	Title	Semiquantitative Impact
BEL1	Reduction of income tax for RUE investments	Unknown
BEL2	Solar boilers	Low
BEL8	Energy performance of buildings	High
BEL10	Subsidies to households for improving energy efficiency	Medium
BEL13	Reduced VAT for renovation of old buildings	Unknown
BEL15	Minimum efficiency requirements for new central heating boilers	High
BEL16	Labels on electrical household appliances	High
BEL19	K insulation level buildings regulations	High

4.4.1.2 Transport

Code	Title	Semiquantitative Impact
BEL4	Improvement of the quality of collective transport services	Low
BEL5	Promotion of bicycle use	Low
BEL8	Modification of the rule concerning the fiscal deduction of the home-job trip costs	Low
BEL9	Modification of the starting circulation tax	Low
BEL12	Encouragement of enterprises' transport plans	Low
BEL16	Promotion of car sharing	Low
BEL17	Improvement of multimodal systems	Unknown
BEL18	Modulation of the road tax	Low

4.4.1.3 Industry

Code	Title	Semiquantitative Impact
BEL3	Minimum efficiency requirements for new central heating boilers (CE mark)	Unknown
BEL4	Energy efficiency criteria in environmental permits	Low
BEL5	Promotion of Cogeneration	Low
BEL6	Energy audits	Medium
BEL7	Voluntary agreements on energy efficiency or CO2	High
BEL9	Fiscal measures to support energy saving investments	Low
BEL15	Minimum efficiency requirements for new central-heating boilers on liquid fuels gas with a capacity > 400 kW	Unknown
BEL18	Financial incentives for investments in energy efficiency	Low

4.4.1.4 Tertiary

Code	Title	Semiquantitative Impact
BEL1	K insulation level buildings regulations	High
BEL4	Energy label for appliances	Low
BEL5	Minimum efficiency requirements for new central-heating boilers on oil or gas (CE mar	Low
BEL7	Energy performance of buildings	High
BEL8	RUE in public buildings	Medium
BEL9	Promotion of RUE with the local authorities	Low
BEL10	Solar heaters	Low

4.4.1.5 Cross-cutting

Code	Title	Semiquantitative Impact
BEL1	National Climate Policy	High
BEL2	Energy Policy	High
BEL3	Transport policies	Unknown
BEL4	Green certificates	Unknown
BEL5	Energy efficiency public service obligation	High

4.4.2 Lessons from Quantitative Energy Efficiency Measure Evaluations

Up to now, published evaluations of energy savings from particular policy measures have been very scarce.

Currently work is being carried out in consultation between the three Regions to set up a methodology to evaluate policies and measures in the framework of directive 2006/32, both in a bottom-up and a top-down approach.

Besides, a first attempt at evaluating the impact of federal measures on the Kyoto greenhouse gas emissions has recently been carried out, but the results have not yet been published.

Interesting experience has been gained with the case of voluntary agreements with industry, in both Flanders and Wallonia. The system differs between these two regions, but in both cases an annual evaluation of the progress is being made.

In Flanders, some 180 companies consuming at least 0,5 PJ of primary energy per year, together representing over 80% of the industrial energy consumption, have signed a voluntary agreement in 2002, by which they commit themselves to belong, at the latest in 2012, to the “World Top” from the point of view of their specific energy consumption, and to remain in that World Top thereafter. Each company has to have the World Top evaluated by an independent consultant every 4 years. The voluntary agreement specifies the way in which this World Top is to be determined. In order to reach it, each company was to implement as soon as possible and not later than 2005 all possible energy saving measures with an after tax internal rate of return (IRR) of at least 15%. In case this was not sufficient, the company was to also implement, not later than 2007, measures with an IRR between 6% and 15%. If this is still not sufficient to reach the World Top, the company can use another approach with an equivalent result, possibly through emission trading or other flexible mechanisms.

Each year, each of these companies must, per individual process plant, report, in a confidential way, the primary energy consumption, the production volume, as well as the energy saving measures it has undertaken, together with an assessment of their impact, to an independent “Verification Bureau”, which has the power to carry out physical controls on site. The Verification Bureau compiles the results and reports publicly in an aggregated way, by sector.

The results show that in 2002 the participating companies were together already 1,8% better than the World Top, and that between 2002 and 2007 they had, on average, reduced their specific consumption by 5,3%.

In Wallonia, voluntary agreements have been signed by 13 sector associations representing more than 120 companies and over 90% of the industrial energy consumption, which commit themselves to a quantified energy efficiency improvement for the sector over the period 2000-2012. The sectoral objectives have been obtained by consolidating the objectives of individual companies, which themselves correspond to all energy saving measures with a simple payback time of up to 4 (sometimes 5) years that have been identified for the company through an initial energy audit. Each year, an energy efficiency index is calculated by individual company and consolidated by sector by the relevant sector association. The consolidation is controlled by a verifier, who can have access to the data of individual companies. This index is calculated as 100 times the ratio of the actual energy consumption to the energy consumption that would have taken place if the specific energy consumptions had remained those of a reference year.

The results show for 2007 an average energy efficiency index of 90,1, which represents an energy saving of 9,9% compared with the reference year (which is generally 1999, but differs for some sectors).

A well in Flanders as in Wallonia, a significant advantage of the voluntary agreements is the availability of yearly quantitative data on the evolution of energy efficiency by sector, allowing to monitor in detail the progress made towards reaching the objectives. It should be noted that in both Regions, this monitoring also extends to CO2 emission.

The efficiency improvements made are smaller than those revealed by the ODEX indicator for industry in section 3.6.3. Two reasons can explain this: the ODEX indicator is based on a much more limited disaggregation, in particular as far as the chemical industry is concerned (see the comments on this subject in section 3.6.3) and (2) the voluntary agreements only cover large energy consumers, albeit very large share of the total energy consumption.

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

As mentioned in section 4, in 2007 Belgium submitted its first National Energy Efficiency Action Plan (NEEAP) in the framework of EU directive 2006/32 on energy end-use efficiency and energy services. This plan compiles the individual plans of the federal government and the three Regions (Flanders, Wallonia and Brussels-Capital). This plan describes the energy efficiency policy measures taken by the relevant federal or regional authorities. Except for Flanders, it does not yet contain an estimate of the impact of the measures.

Currently underway is the preparation of the ex ante and ex post monitoring of the impact of existing and future measures. This monitoring is subject to discussions between the federal administration and the three regional administrations in the framework of the cooperative agreement on the national climate policy.

This evaluation will allow to identify the remaining gap to be filled by new measures in order to reach the objectives of the European directive.

In Wallonia, as mentioned in section 4, many concrete new measures have been identified in the draft update of its sustainable energy plan. Important ones are those concerning a strengthening of regulations on the energy performance of buildings, both new and existing ones, in the residential and the tertiary sectors. These measures would be accompanied by a set of measures on information, education of professionals, financing, R&D, measures specific for low income households, public sector buildings, support for third party financing, etc.

One possible important new measure could be the introduction of white certificates, but this measure still needs to be evaluated, in particular in the light of the experience gained in other countries.

6 ANNEXES

Annex 1: Energy Efficiency Measure Summary

Households

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
BEL1	Reduction of income tax for RUE investments	Ongoing	Fiscal/Tariffs	2003		Unknown
BEL2	Solar boilers	Ongoing	Financial	2001		Low
BEL8	Energy performance of buildings	Ongoing	Legislative/Normative	2006		High
BEL10	Subsidies to households for improving energy efficiency	Ongoing	Financial	2003		Medium
BEL13	Reduced VAT for renovation of old buildings	Ongoing	Fiscal/Tariffs	2000		Unknown
BEL15	Minimum efficiency requirements for new central heating boilers	Ongoing	Legislative/Informative, Legislative/Normative	1998		High
BEL16	Labels on electrical household appliances	Ongoing	Legislative/Informative	1998		High
BEL19	K insulation level buildings regulations	Ongoing	Legislative/Normative	1985	2009	High

Transport

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
BEL4	Improvement of the quality of collective transport services	Ongoing	Infrastructure	2001		Low
BEL5	Promotion of bicycle use	Ongoing	Information/Education/Training	2004		Low
BEL8	Modification of the rule concerning the fiscal deduction of the home-job trip costs	Ongoing	Fiscal	2000		Low
BEL9	Modification of the starting circulation tax	Completed	Fiscal	2002	2005	Low
BEL12	Encouragement of enterprises' transport plans	Ongoing	SocialPlanning/Organisational	2001		Low
BEL16	Promotion of car sharing	Ongoing	SocialPlanning/Organisational	2003		Low
BEL17	Improvement of multimodal systems	Ongoing	Infrastructure	2005		Unknown
BEL18	Modulation of the road tax	Ongoing	Fiscal	2001		Low

Industry

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
BEL3	Minimum efficiency requirements for new central heating boilers (CE mark)	Ongoing	Legislative/Normative	1997		Unknown
BEL4	Energy efficiency criteria in environmental permits	Ongoing	Legislative/Informative	2004		Low
BEL5	Promotion of Cogeneration	Ongoing	Financial, Fiscal/Tariffs	2005		Low
BEL6	Energy audits	Ongoing	Financial	2002		Medium
BEL7	Voluntary agreements on energy efficiency or CO2	Ongoing	Co-operative Measures	2003		High
BEL9	Fiscal measures to support energy saving investments	Ongoing	Fiscal/Tariffs	1993		Low
BEL15	Minimum efficiency requirements for new central-heating boilers on liquid fuels gas with a capacity > 400 kW	Ongoing	Legislative/Normative	1988		Unknown
BEL18	Financial incentives for investments in energy efficiency	Ongoing	Financial	2002		Low

Tertiary

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
BEL1	K insulation level buildings regulations	Ongoing	Legislative/Normative	1986	2009	High
BEL4	Energy label for appliances	Ongoing	Information/Education/Training	1999		Low
BEL5	Minimum efficiency requirements for new central-heating boilers on oil or gas (CE mar	Ongoing	Legislative/Normative	1997		Low
BEL7	Energy performance of buildings	Ongoing	Legislative/Normative	2006		High
BEL8	RUE in public buildings	Ongoing	Financial, Information/Education/Training	2002		Medium
BEL9	Promotion of RUE with the local authorities	Ongoing	Financial	1999		Low
BEL10	Solar heaters	Ongoing	Financial	2001		Low

Cross-cutting

Code	Title	Status	Type	Starting Year	Ending Year	Semiquantitative Impact
BEL1	National Climate Policy	Ongoing	General Energy Efficiency / Climate Change / Renewable Programmes	2002		High
BEL2	Energy Policy	Ongoing	General Energy Efficiency / Climate Change / Renewable Programmes			High
BEL3	Transport policies	Ongoing	Non-classified Measure Types			Unknown
BEL4	Green certificates	Ongoing	Market-based Instruments	2002		Unknown
BEL5	Energy efficiency public services obligation	Ongoing	Market-based Instruments	2002		High

Annex 2: Country Profile

Energy Efficiency Profile : Belgium

October 2008

Energy Efficiency Trends

Overview

Over the period 2000-2006 the energy efficiency bottom-up index for the total final energy consumption (ODEX) decreased by 7 %. Mainly the industrial sector contributed to this develop-ment, whereas the energy efficiency index of the transport sec-tor only scarcely im-proved (6%) and the index of households is almost stable (-2%).

It should be noted that this index remains quite approximate, because of limitations in available statistical data, in particular a lack of disaggregation in the national energy consumptions.

Industry

In 2006, the efficiency index for the industrial sector (measured at the level of 9 branches - in terms of energy used per production index or per tonne - and aggregated to the whole sector) had improved by 12% compared to the base year 2000 (19% in relation to 1990). In general all sectors show significant energy savings. Consumption data (which have been compiled from regional statistics) are missing for 1991-1993. Noteworthy is the substantial increase in the ODEX of the chemical industry between 1990 and 1994, which reveals a major structural effect in this sector (investment in naphtha cracking), without which the efficiency improvement would have been higher.

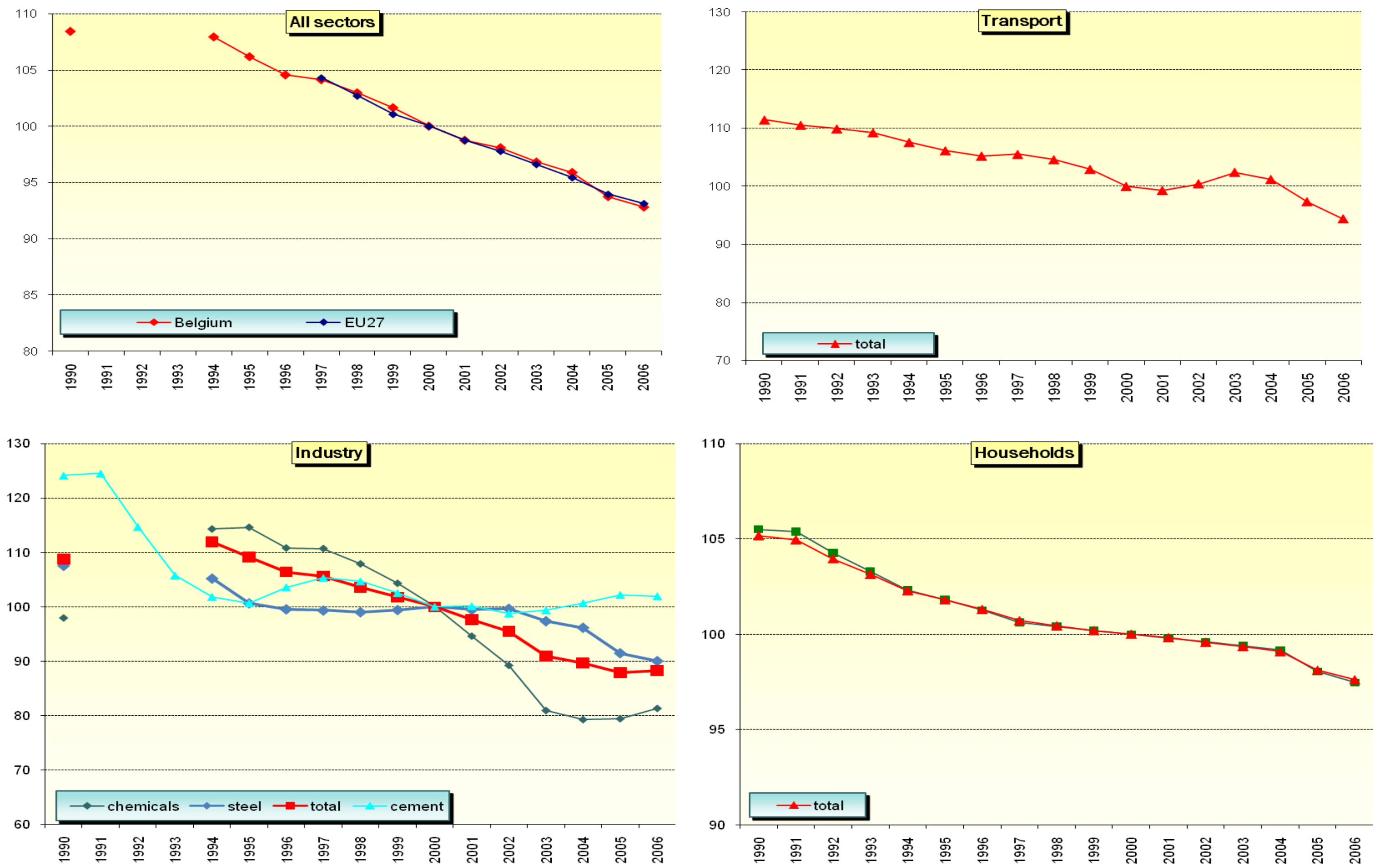
Households

For the households sector, the energy efficiency index takes into account space heating, water heating and cooking. It's measured by the average fuel consumption per use and dwell-ing. For space heating, it includes climatic correction and cor-rection for the penetration of central heating. Between 2000 and 2006, the index has declined by only 2%. Since 1990, the decrease is 7%.

Transport

For the transport sector, the index takes into account road, rail and air transport. For road transport, given the lack of data on the vehicle fleet's average specific consumptions, this index represents the evolution of the energy consumption per vehi-cle, and is thus influenced as well by the average vehicle mile-age as by the efficiency of the vehicles. Between 1990 and 2000, the index has declined by 11%. Since 2000 and despite a light increase in 2002/2003, it decreased by 6% more (mostly because of the index of road transport improved).

Energy efficiency index , base 100 = 2000



Source: ODYSSEE data base

Energy Efficiency Policy Measures

Institutions and programmes

Belgium is a federal country and energy efficiency as well as the development of renewable energy sources are essentially a responsibility of the 3 regions (Flanders, Wallonia, Brussels). The *National Climate Plan 2002-2012*, which has been signed in 2002 by both the federal and the regional ministers responsible for environment, energy and transport, foresees a number of measures to be taken at either the federal or the regional levels. A new National Climate Plan is currently under preparation. Each region has also developed its own, multi-annual, climate plan.
The Flemish Region has issued its second climate plan (Vlaams Klimaatsbeleidsplan 2006-2012) in 2006; in Wallonia climate plan (Plan Air-Climat) was modified and adopted in March 2007.

Industry

For industry, the energy efficiency policy is focussed on voluntary agreements between industry and the (regional) government. In Flanders, these agreements are "benchmark" agreements, with a commitment to bring the energy efficiency to the world top ten by 2012. They are signed by individual companies with an energy consumption larger than 0.5 PJ per year. By December 2006, 185 companies had signed such an agreement. In Wallonia, voluntary agreements have been signed by 13 sector associations representing more than 120 companies, which commit themselves to a quantified energy efficiency improvement for the sector over the period 2000-2012. Besides, cogeneration is actively promoted in all three Regions, through a range of instruments (subsidies, fiscal deductions, green certificates, information campaigns…).

Households, Services

All three regions enforce thermal insulation standards for new and renovated buildings in the household and the tertiary sectors. They have transposed European directive 2002/91 on the energy performance of buildings, imposing energy performance standards for all types of buildings, taking into account all energy efficiency aspects (building shell, heating, ventilation…) for new and existing buildings. In the Flemish Region, the EPB entered in force in January 2006; in Brussels, since July 2008 and it's foreseen in Wallonia from September 2009.
All three Regions award subsidies for a range of energy saving or renewable energy investments, as well as for energy audits or energy accounting schemes.
At the federal level, the purchase of energy saving equipment is being encouraged by fiscal deductions for energy saving investments, as well as by labelling of large domestic appliances. In Flanders, quantified energy savings (between 1% and 2.2% per year in 2003-2008) for their customers are being imposed to electricity grid operators as a public service obligation. The latter award premiums to their clients for the purchase of energy saving appliances, which are financed through an increase in electricity prices.

Transport

Emphasis is put on the promotion of public transport, by extending its supply and improving its availability, its quality and its price attractiveness. Free access to public transport is also provided, either to certain categories of citizens (people above 65 years of age and civil servants for their home-to-work trips, in the case of railways). A particular effort has also been put on promoting the development of mobility planning tools such as company transport plans, urban mobility plans, school transport plans.

Energy prices and taxes

In the voluntary agreements, the public authorities have promised, if it is in their power, that no CO2 tax would be applied to the participating companies. However such a tax is not under discussion. For stationary applications, there are some federal energy taxes on fuels and electricity, which have been adapted in 2003 (increase for liquid petroleum products, decrease for natural gas for households). A progressive shift from the diesel car purchase tax towards the diesel excise tax has also been implemented. The changes remain in the order of a few percent of the fuel prices.

Selected Energy Efficiency Measures

Sectors	Title of Measure	Since
Industry	Voluntary agreements on energy efficiency or CO2	2000
Industry	Promotion of cogeneration	
Households	Insulation standards for new dwellings	1985
Households	Insulation standards for renovated dwellings	2000
Households	Energy label for appliances	
Households and tertiary	Labels for high efficiency boilers (OPTIMAZ, HR, HR+)	1985
Households and tertiary	Public service obligation of electricity grid managers in Flanders	2003
Households and tertiary	Energy performance standards of buildings (in the 3 regions)	2006, 2008,2009
Tertiary	Insulation standards for new and renovated buildings	2000
Transport	Promotion of public transport	

Source: MURE data base
www.mure2.com

ECONOTEC

ADEME

Enerdata

Fraunhofer Institute Systems and Innovation Research

Annex 3: Data Situation and Data Quality

Limited availability of data

There is no centralisation of statistical data on determinants of energy consumption in Belgium. Therefore, as usual, the data necessary for completing the ODYSSEE data base is collected specifically for this project from a large number of different sources.

Most available data have been updated to the year 2007.

Despite the large amount of data that has been collected, a data shortage remains. In particular, the following data are still unavailable:

- the disaggregation of energy consumption in the residential sector between space heating, water heating and other uses; we have used here a disaggregation proposed by ENERDATA, coordinator of the project; in the future we plan to use the figures available in the regional energy balances;

- a disaggregation of energy consumptions by sub-sector in the tertiary sector (hospitals, schools, public administration,...), which would allow an analysis of structural effects in that sector;

- the consumption of electricity in the residential and tertiary sector (only the high voltage fraction of the consumption is known); we have used the data of the regional energy balances;

- the disaggregation of fuel consumption for road transport by type of transport (passenger/goods) and by type of vehicle (e.g. passenger cars versus trucks).

- aside from a few exceptions, unit consumption data by main intensive product (eg, chlorine, ammonia, olefines) and its evolution in time; note that this generally the case in the other countries too;

- evolution of energy consumptions by type of process (eg, electric steel, cement production by the wet or dry route);

Quality of the data

The indicators presented in this report are of course a function of the quality of the data used, i.e. in particular the activity and energy consumption data. It is therefore important to keep in mind the limits in the data when drawing conclusions from these indicators.

In this respect, comments are given below on the quality of national accounting statistics (value added and GDP) and energy consumption data, and a table is provided which assesses the quality of the data for the ODEX indicator.

National accounting statistics

The value added data have been updated up to the year 2007. The data source is the national accounts, which are prepared by the Institute of National Accounts, according to reference methodology ESA95.

As mentioned in previous reports, the introduction of ESA95 has triggered an in-depth revision of the way in which the Belgian national accounts are calculated, with fundamental changes to data sources, calculation methods and methodology. The sectoral disaggregation has also been modified to a certain extent.

For the moment, consistent time series are still only available for the years since 1995. Consistent time series for the period since 1970 have been announced since a few years ago, but are still not available.

For keeping long time series, we have used the values of the former accounting system for the years 1990-1995.

This situation implies a break in the statistical time series between 1994 and 1995. Besides, future revisions might still alter the values of some indicators presented in this report. For these reasons, all indicators using GDP or Value Added data should be interpreted with caution.

Energy consumption data

By industrial branch, the quality of the official statistics from the Federal Public Service Economy (which are those provided to Eurostat and the International Energy Agency) appears to be poor:

- One weakness of this energy consumption data is the relatively limited quality of the sectoral disaggregation for petroleum products, and, hence also for the total energy consumption by sector (in particular industrial branches).

This is due to the fact that these energy consumption statistics are based on information from energy suppliers. While for grid bound energy carriers such as natural gas and electricity, the sectoral allocation is generally well known, the dealers of petroleum products are not always aware of the sector where the products they supply are being used, in particular because of the presence of intermediary dealers.

- For the year 2002, there is an important anomaly in the energy consumption of the iron & steel sector, which decreased by 19% in comparison with 2001, while the steel production rose by 5%. More precisely, the consumption of solid fuels declined by 35%, while the proportions of oxygen and electric steel had practically remained stable.
- For the years 2003 and 2004, the energy consumption statistics of several industrial branches seem overestimated because of a sudden upward jump of their natural gas consumption, for which we could get no explanation. This is essentially the case for the non metallic minerals, food, textile and metal construction sectors. The total gas consumption of industry for these years does not look abnormal. The problem rather lies in the distribution of this consumption among the various branches. One possible reason might be a (partial) distribution of the consumption of the "Other sectors", without retroactive effect on the previous consumptions.
- The federal energy consumption statistics don't include important waste fuels, such as those used in the petrochemical industry, the cement industry and in the pulp & paper industry. For these three sectors the sum of the regional energy consumption statistics, which do include waste fuels, are significantly larger than the federal figures. From a point of view of energy efficiency monitoring, it is important to take all energy carriers into account.
- A further limit of the federal statistics is that they are actually supply statistics rather than consumption statistics, and may differ from the latter by the stock variation.

For these reasons, instead of using the federal statistics' figures, we have aggregated the energy consumption statistics of the three Regions. This aggregation remains a rough approach, as the regional statistics are not harmonised (there may remain differences in sector allocation, fuel definitions, treatment of autoproducers, the accounting or stocks…), but has been considered preferable to keeping the federal statistics.

One drawback to this approach is that no statistics are available for Flanders for the years 1991-1993. Therefore there is a gap for these 3 years.

ODEX data quality

The quality of the ODEX indicators is qualified by qualifying the data used for calculating the indicator. Two types of grades are used:

- one to qualify the data source A, B and C;
- one to qualify the data quality 1,2 and 3.

The grades were given using “objective” criteria for the source and semi-objective criteria for the quality.

Quality of source:

A: Official statistics

Official statistics/surveys (national statistical office, Eurostat/AIE, Ministries statistics); Model estimations used as official statistics; Data “stamped” by Ministries

B: Surveys/ modelling estimates (consulting, research centres, universities, industrial associations)

C: Estimations made by national teams (for the project)

Quality of data:

1 Good

2 Medium

3 Poor

The tables below show the qualification of the data used for the various indicators.

	Unit	Quality	Grade
INDUSTRIE			
Consumption			
chemicals, rubber & plastics	Mtoe	A	1
primary metals	Mtoe	A	1
steel	Mtoe	A	1
other (non ferrous)	Mtoe	A	1
non mineral netallic	Mtoe	A	1
cement	Mtoe	A	1
other	Mtoe	A	1
paper	Mtoe	A	1
food	Mtoe	A	1
textiles	Mtoe	A	1
equipment	Mtoe	A	1
Production index			
chemicals, rubber & plastics	index	A	1
non ferrous	index	A	1
non mineral netallic	index	A	1
food	index	A	1
textiles	index	A	1
equipment	index	A	1
Production			
production of steel	kt	A	1
production of paper	kt	A	1
production of cement	kt	A	1
TRANSPORT			
Consumption			
road	Mtoe	A	1
cars	Mtoe		
goods transport	Mtoe		
buses	Mtoe		
motocycles	Mtoe		
rail transport	Mtoe	A	1
water transport	Mtoe	A	3
air (total)	Mtoe	A	1
Data on trafic, specific consumption, stock			
specific cons of cars	l/100km		
trafic of road	Gtkm	A	1
num of bus	k	A	1
number of mototcycles	M	A	1
trafic of water	Gtkm	A	1
number of air transport passengers	Mpas	A	1
rail trafic	Gtkb	A	1
rail trafic of goods	Gtkm	A	1
rail trafic of passengers	Gpkm	A	1
Trains' technical coefficients for goods		A	1
Trains' technical coefficients for passenger		A	1
stock of cars	M	A	1
stock of truck&light veh	M	A	1

	Unit	Quality	Grade
HOUSEHOLDS			
Consumption			
consumption of households	Mtoe	A	1
electricity cons of households	Mtoe	A	1
fuel cons of households	Mtoe	A	1
fuel cons of households with cc	Mtoe	B	2
degree days	1	A	1
degree days of reference	1	A	1
share of space heating	1	C	2
percent of dwelling with central heating	1	A	2
floor area	m2		
Stock of permanently occupied dwellings	k	A	1
Annual new dwellings	k	A	1
number of new houses	k	A	1
Theorical unit consumption of new multi family dwellings	toe/dw	C	3
Theorical unit consumption of new single family dwellings	toe/dw	C	3
specific consumption of new dwellings	toe/dw	C	3

One can notice that overall the data used is of either good or medium quality. This is amongst other thanks to the use of the regional energy consumption statistics.

It should be remembered however that the main limit of the current ODEX indicator for Belgium is not so much the quality of the data used, but the lack of data, which obliges us to use a simplified indicator, based on the available data.

Annex 4: Evaluation of the structural effect

The reduction in energy intensity — whether of the GDP as a whole or of a subset of the economy — over a given time period can be decomposed into two separate contributions:

- a ***structural effect***, corresponding to a shift from energy intensive sectors to less en-ergy intensive ones, or vice-versa;

- an ***unit consumption effect*** (which, assuming there are no intra-sectoral structural effects, represents the result of the efficiency improvement).

Calculated mathematically, these two components are not additive, there remains a residue. However, it is convenient and common practice to define these two effects in such a way that they are additive and sum up to the reduction in energy intensity:

Variation in energy intensity = structural effect + unit consumption effect

In order to make them additive, one aggregates the residue with one of the two terms. This can be done by calculating one of the effects in the proper way and deriving the second term by difference.

The energy intensity at year t can be written as:

$$EI_t = \frac{\sum_i VA_{i,t} \frac{CONS_{i,t}}{VA_{i,t}}}{GDP_t}$$

where:

$CONS_{i,t}$: energy consumption of sector i at year t

$VA_{i,t}$: value added of sector i at year t

Note that in this expression, $\frac{CONS_{i,t}}{VA_{i,t}}$ represents the energy intensity of sector i.

Structural effect

The structural effect used in this report is defined as the change in energy intensity between year 0 and year t when the unit consumptions are assumed to remain constant at their value for the reference year.

$$SE_t = EI_0 - \frac{\sum_i VA_{i,t} \frac{CONS_{i,0}}{VA_{i,0}}}{GDP_t}$$

$$= \frac{\sum_i VA_{i,0} \frac{CONS_{i,0}}{VA_{i,0}}}{GDP_0} - \frac{\sum_i VA_{i,t} \frac{CONS_{i,0}}{VA_{i,0}}}{GDP_t}$$

$$= \sum_i \frac{CONS_{i,0}}{VA_{i,0}} \left(\frac{VA_{i,0}}{GDP_0} - \frac{VA_{i,t}}{GDP_t} \right)$$

Unit consumption effect

The unit consumption effect is evaluated as the difference between the total reduction in energy intensity and the structural effect:

Unit consumption effect = $EI_t - EI_0 - SE_t$

$$= \frac{\sum_i VA_{i,t} \frac{CONS_{i,0}}{VA_{i,0}}}{GDP_t} - \frac{\sum_i VA_{i,t} \frac{CONS_{i,t}}{VA_{i,t}}}{GDP_t}$$

$$= \sum_i \frac{VA_{i,t}}{GDP_t} \left(\frac{CONS_{i,0}}{VA_{i,0}} - \frac{CONS_{i,t}}{VA_{i,t}} \right)$$

The unit consumption effect appears as a weighted average of the reduction of energy intensity of the individual sectors, the weighting factors corresponding this time to the structure of the economy in the year for which the efficiency improvement is evaluated.