ECONOTEC CONSULTANTS

ODYSSEE-MURE

Energy Efficiency trends and policies in BELGIUM

19 November 2015

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Acknowledgements:

The authors would like to thank Aurore Brunson (Brussels Environment), Nadine Dufait (LNE), Aline Guilmot (Energy Obervatory, FPS Economy), Virginie Leclercq (Brussels Environment), Valérie Pevenage (SPW-DGO4) and Tineke Schrijvers (FPS Economy) for their useful comments on an a draft of this report. Remaining errors or shortcomings are the responsibility of the authors.

Co-funded by the Intelligent Energy Europe
Programme of the European Union

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<u>Note</u>

For the final energy consumptions, the ODYSSEE data base currently uses the federal statistics, except for electricity and natural gas, for which the sum of the energy consumptions of the three Regions has been used, because they provide more consistent time series over the period 2000-2013, in particular for the various branches of industry.

EXECUTIVE SUMMARY

This report is the country report for Belgium on the latest phase of the European ODYSSEE-MURE project (www.odyssee-mure.eu), extending from April 2013 to September 2015. It provides an overview of energy efficiency trends (for the period 2000-2013) and of the main energy efficiency policy measures in Belgium, based on the ODYSSEE and the MURE databases, developed in the framework of the project.

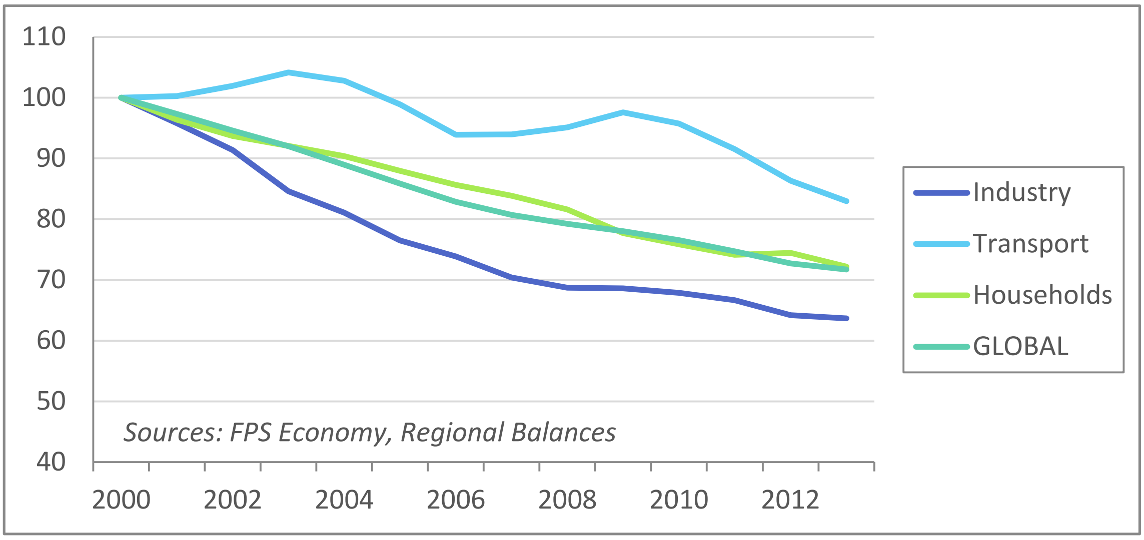
The project gathers representatives from the 28 EU Member States plus Norway. It aims at monitoring energy efficiency trends and measures in Europe, using the two databases: ODYSSEE comprising detailed data on energy consumptions, activities and related CO2-emissions (around 1000 data series by country) and MURE describing energy efficiency policy measures, including their impact (around 2000 measures).

In this report, the final energy consumption is analysed both as a whole and by major final 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.

The primary and the final energy intensities have decreased by 20% between 2000 and 2013. They represent the evolution of energy efficiency in economic terms, i.e. the quantity of energy used to produce one unit of GDP or value added. A slowdown of the decrease is observed since the economic crisis in 2008.

As measured by the ODEX indicator, developed in the framework of the project, energy efficiency improved on average by 2,5%/year between 2000 and 2013 (see Figure 1). Industry achieved the largest improvement, on average 3,4%/year – partly due to structural effects in the chemical and the iron & steel industries –, with a slowdown since the economic crisis.

Figure 1: ODEX by sector and Overall ODEX



While in the household sector the progress was steady, of on average of 2,5%/year, the transport sector experienced fluctuations, with periods of rising energy efficiency index, leading to an average improvement of 1,4%/year.

In the Belgian federal state, energy efficiency policy is a responsibility of the three regions, with supporting measures from the federal government.

The regions have, each for its own territory, implemented the EPB directive [1]; promoted further energy efficiency by households and tertiary buildings through grants, compulsory audit schemes, awareness raising programmes, etc.; fostered energy savings in industry by signing voluntary agreements with industry (Flanders, Wallonia); implemented mobility measures; and promoted renewable energies and cogeneration by setting up green and CHP certificates systems.

The main measures taken by the federal government are tax reductions (for energy efficiency investments by households and for low CO2 emission cars), the transposition of the EU directives on labels and on Ecodesign, and the promotion of public transport by railway.

The main policies and measures have been introduced in the MURE database, with their major characteristics. Among the latter, quantitative impact evaluations (taken from the NEEAP3 [2]) are available for the most important measures. The savings by region are synthesised by sector in Table 1 (in terms of final energy savings).

Table 1: Summary of final energy savings in three regions

(GWh)	2012	2016	2020
Flanders	21.047	35.602	47.869
Wallonia	10.389	14.621	15.141
Brussels	851	2.465	4.617
Total	32.287	52.688	67.627

Source: NEEAP3 (ESD[1] + ETS[2] savings)

[1] ESD : Energy Savings Directive [4].

[2] ETS: Emission Trading System (European directive 2003/87/EC).

INTRODUCTION

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In this report, the final energy consumption is analysed both as a whole and by major final 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.

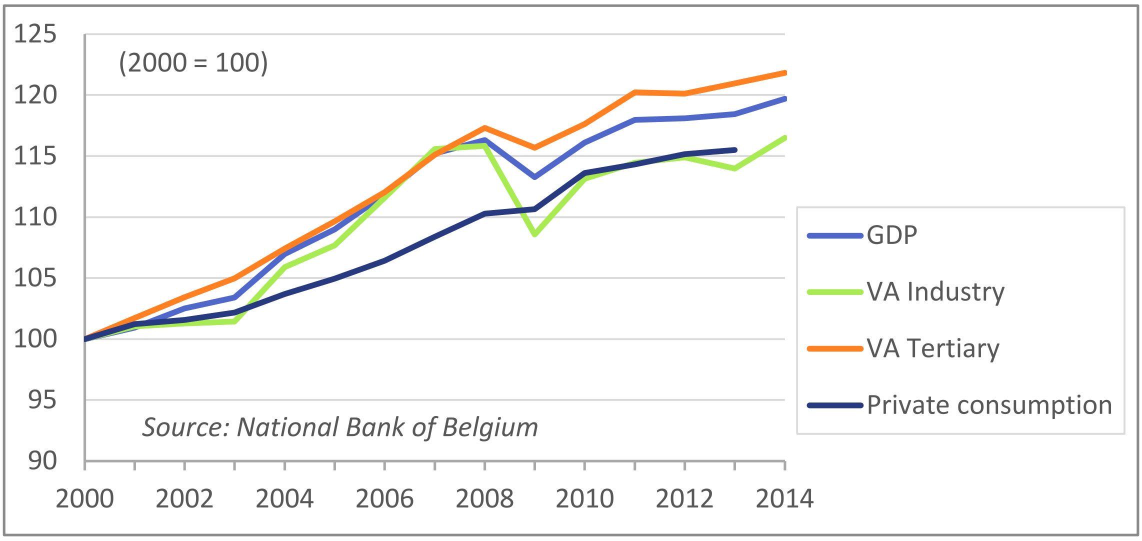
The energy efficiency is first analysed in economic terms, through energy intensities; in a second step it is assessed using the ODEX indicator, which aims to be closer to the technical energy efficiency.

1 ECONOMIC AND ENERGY EFFICIENCY CONTEXT

1.1 ECONOMIC CONTEXT

Figure 2 shows the evolution in real terms of the main macro-economic indicators since 2000: GDP, value added of industry, value added of the tertiary sector and private consumption of households. After the dip in 2009 due to the economic crisis, with a fall of 2,8% in GDP, 1,4% in the tertiary sector and 8,5% in industry, the rebound that took place in 2010 and 2011 has not allowed to recover the previous growth trajectory, and since then economic growth has been slower. Interesting to be noted is that the private consumption of households has been much less impacted by the crisis.

Figure 2: Evolution of GDP



While the growths of industry and the tertiary sector were similar, equal to that of GDP, up to 2008, industry suffered more from the crisis and could not recover as well. Overall over the period, it is the sector with the slowest growth, even though it grew more than GDP in 2014.

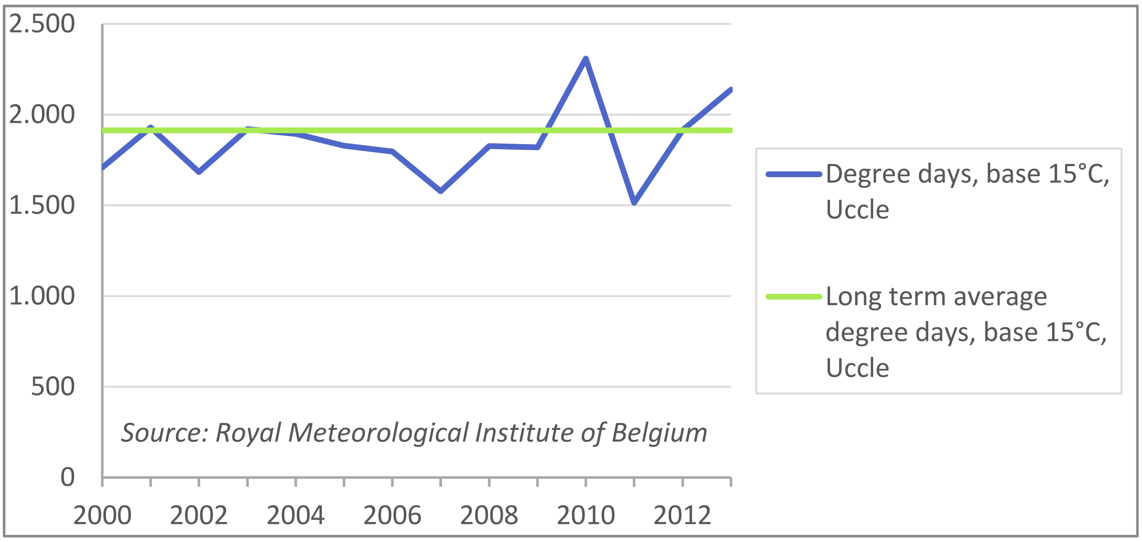
1.2 TOTAL ENERGY CONSUMPTION AND ENERGY INTENSITIES

1.2.1 CLIMATIC CORRECTION

For the analysis of energy consumption and energy efficiency trends by sector, we have used climate corrected data for the energy consumptions. This climate correction, consisting in the simple degree-day method[3], has been applied to the residential and the tertiary sectors, and this on the estimated share of the energy consumption that is used for heating.

The degree-days used are the 15/15 degree-days observed in Uccle and the long term average is the average over the period 1981-2010. Figure 3 shows the evolution of this number of degree-days since 2000, as well as the long term average.

Figure 3: Number of degree-days (15/15 Uccle)



Only two years out of fourteen are significantly above the long term average, which tends to confirm the warming-up of the atmosphere. To be noted is the size of the climate correction for 2007, 2010 and 2011.

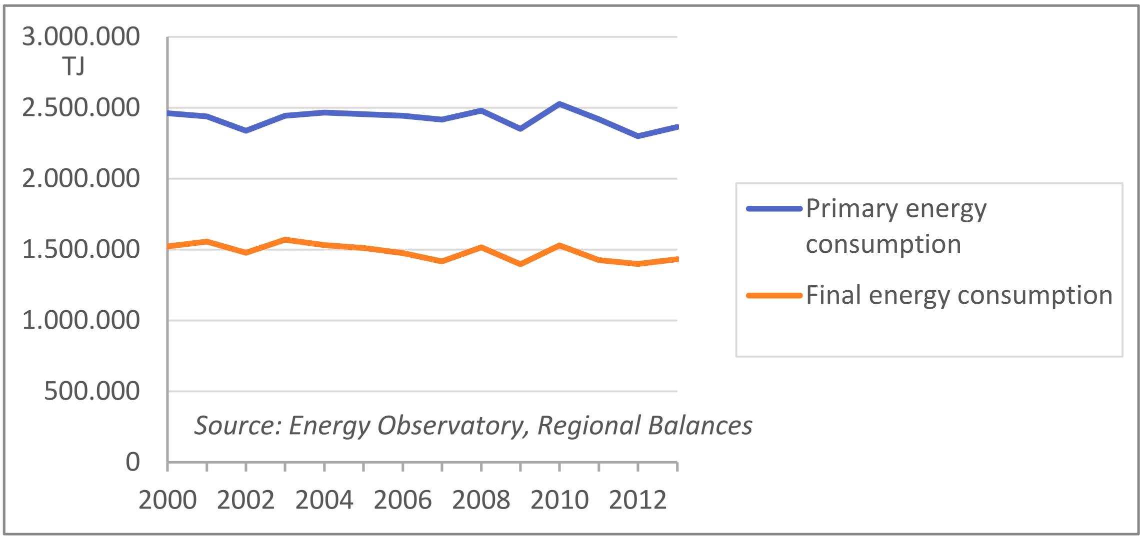
1.2.2 ENERGY CONSUMPTION TRENDS

The evolution of the final energy consumption (before climate correction) over the last three years (2011-2013), shown on Figure 4, can mainly be explained by the number of degree-days (see Figure 3) and the economic crisis (Figure 2). The dip in 2009 could be explained by the crisis, and the

[3] The simple degree-day method consists here in multiplying the yearly energy consumptions by the long term average number of heating degree-days and dividing it by the number of degree-days of the corresponding year.

rebound in 2010 by the economic recovery and to the high number of degree-days that year (highest value since 1996, see Figure 10).

Figure 4: Evolution of total energy consumption



Source: Energy Observatory, Regional Balances

The total primary energy consumption since the year 2000 is roughly stable. The low in 2002 is that of a warm year (the warmest year, after 2011 and 2007), while the dip in 2009 and the rebound in 2010 follow those of the final energy consumption, but more smoothly.

Since 2000, noteworthy evolutions are the fall of the share of coal, from 9% to 4% in 2013, and oil, from 44% to 40%, as well as the penetration of renewables, from 2% to 6% (see Figure 5 and Figure 6).

Figure 5: Total final energy consumption by energy carrier – 2000

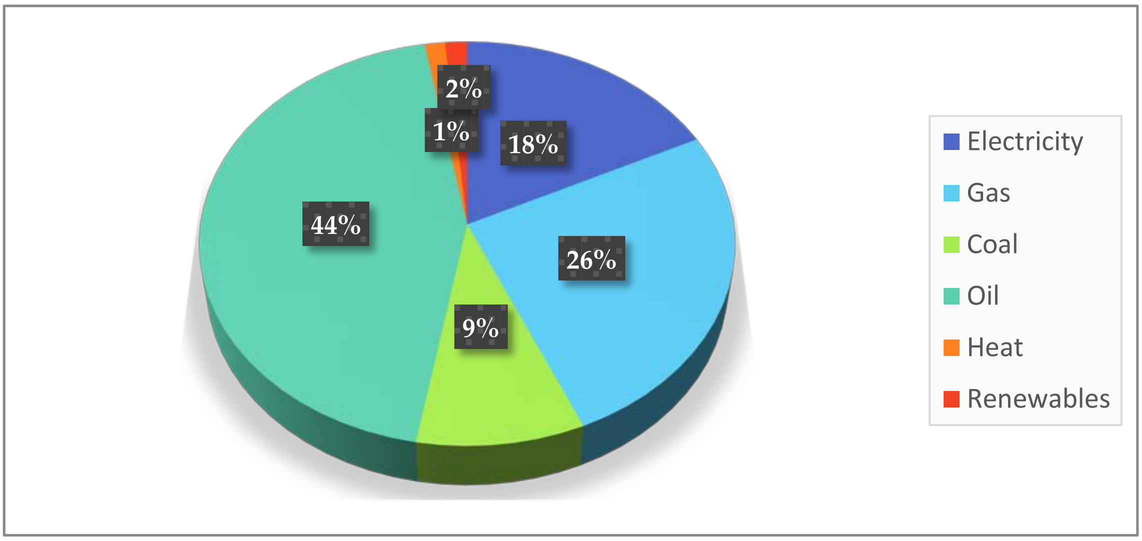
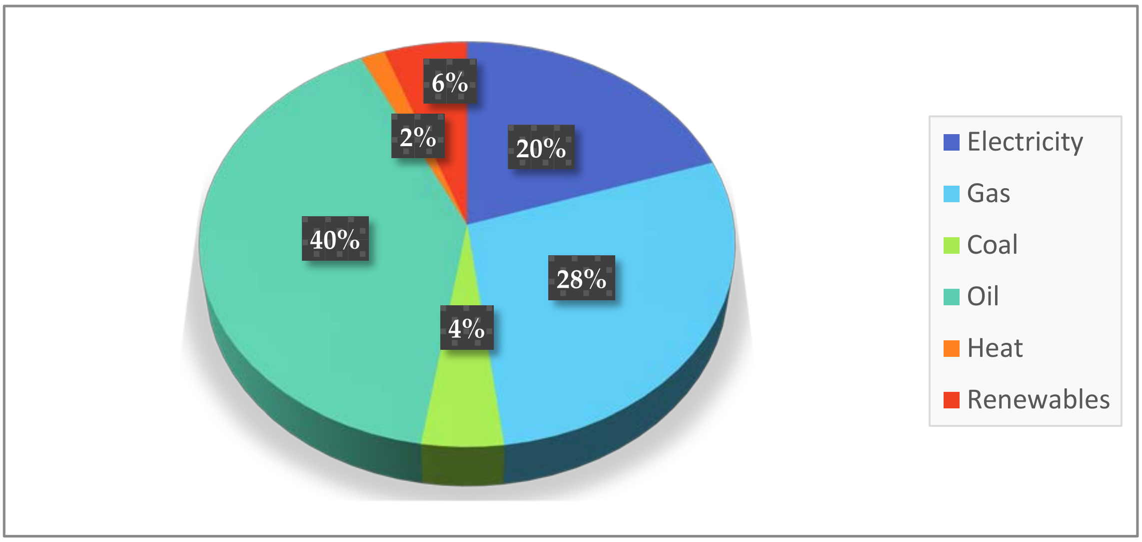


Figure 6: Total final energy consumption by energy carrier – 2013



The final energy consumption by major sector over the period 2000-2013 is shown on Figure 7 (before climate correction) and on Figure 8 (after climate correction). The main energy consumer is industry, but its share is diminishing. It is followed by the transport and the residential sectors. The 'tertiary + other[4]' sector has only about half the consumption of the residential one.

Figure 7: Final energy consumption by sector (ktoe) (before climate correction)

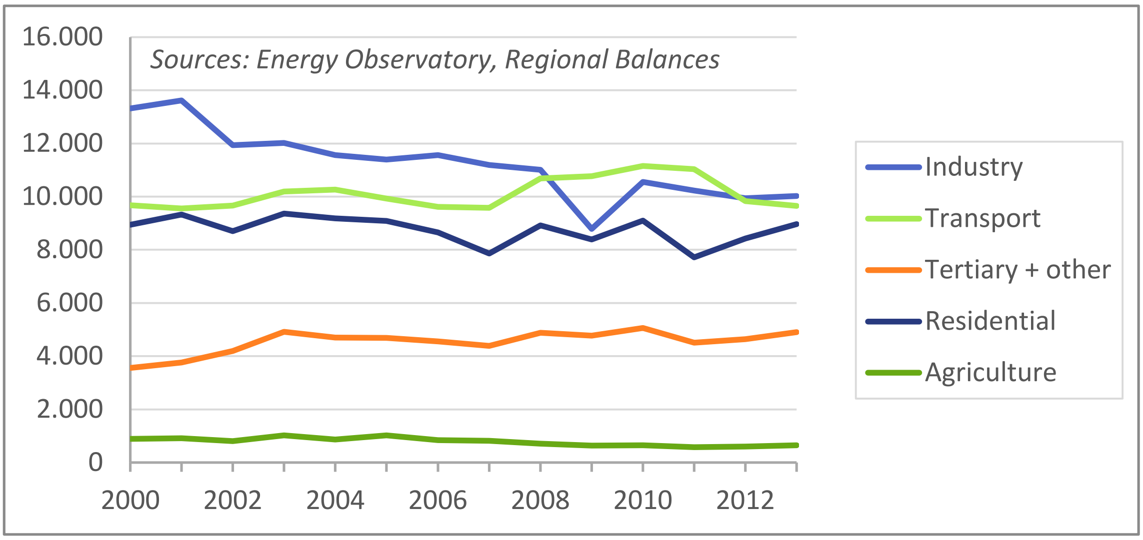


Figure 8: Final energy consumption by sector (ktoe) (after climate correction)

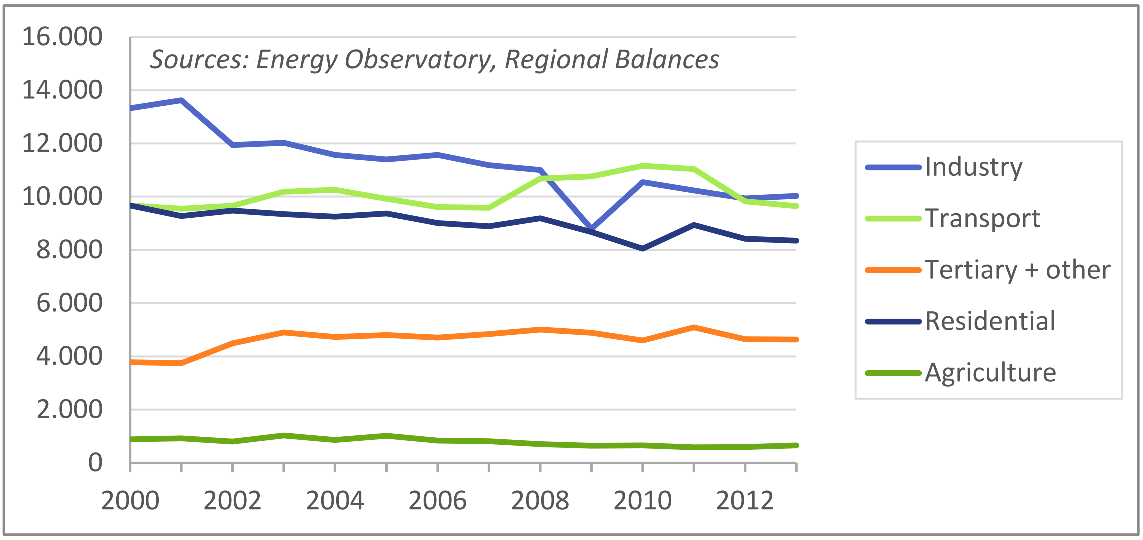
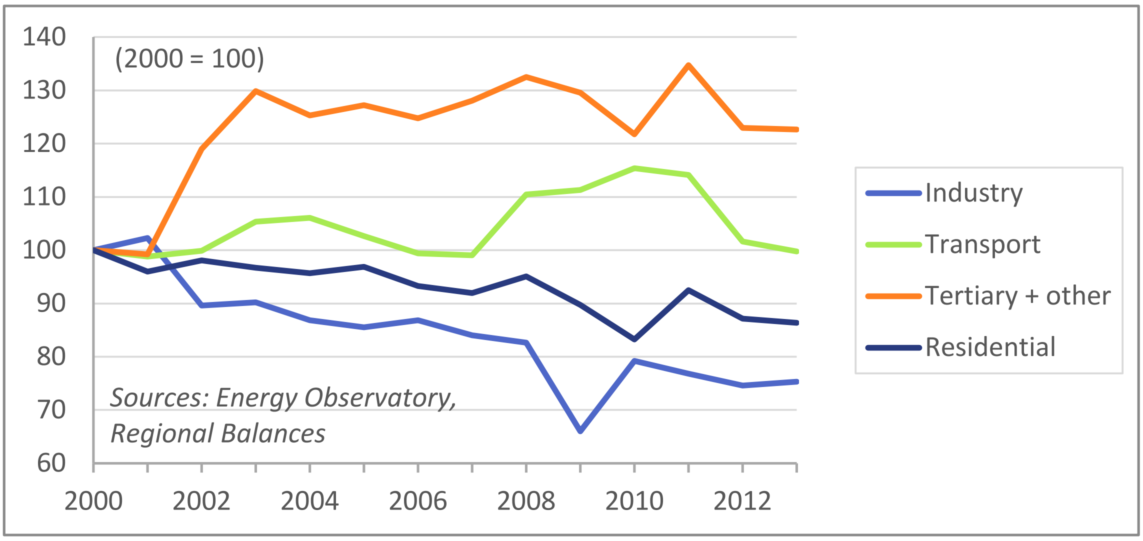


Figure 9 provides the evolution of the final energy consumption by sector after climate correction.

[4] 'Other' is calculated as a residue : final consumption – industry – transport – residential.

Figure 9: Evolution of final energy consumption by sector (after climate correction)



The jump for the 'Tertiary + other' sector between 2001 and 2003 is the result of the climate correction combined with a strong rise in oil products from 2000 to 2003, which remains unexplained. For transport, the reduction in 2012 is a reduction in fuel sales, confirmed by customs data but for which the federal administration has no explanation. Industry has been regularly decreasing (2009 crisis excluded), while the residential sector has been fluctuating around its value of 2000. Striking is the dip in industrial consumption in 2009, due to the crisis, and the rebound in 2010.

For the residential and tertiary sectors, one can clearly notice a dip in 2007 and 2011 (years with a low number of degree-days, as could be seen on Figure 3), and high energy consumption in 2010 (year for which there was a peak in the number of degree-days). In the residential sector, the peak in 2008 mainly relates to petroleum products and could possibly be explained by an increased storage of gasoil in the context of a strong fall of the price of gasoil in the second half of 2008; in the tertiary sector, a similar peak essentially results from a larger consumption of natural gas in a colder winter.

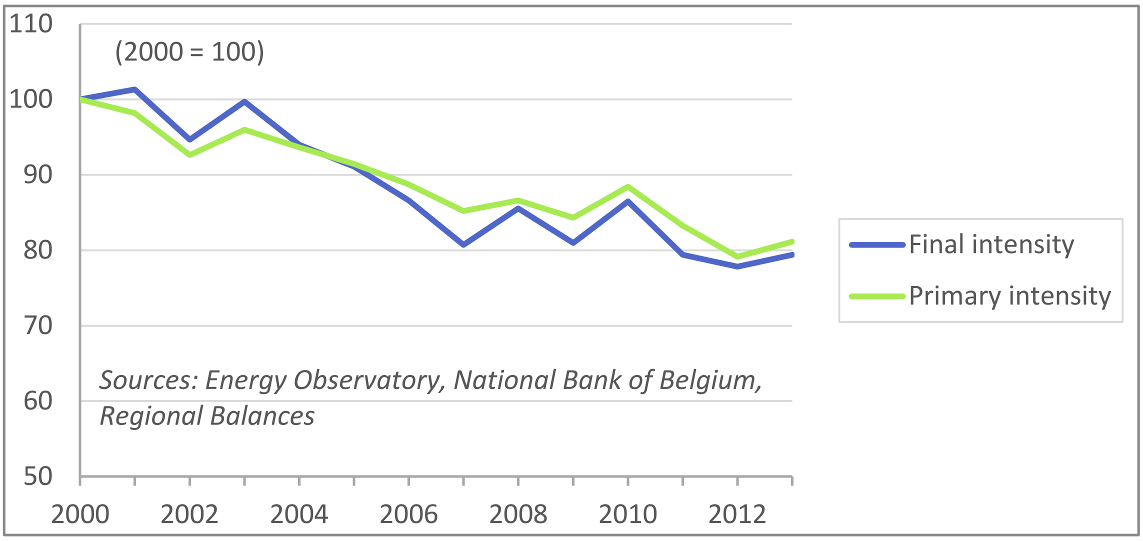
1.2.3 TRENDS IN ENERGY INTENSITY

1.2.3.1 ENERGY INTENSITY OF GDP

The energy intensity is obtained by dividing the energy consumption of a sector by its value added or, in case of the transport sector, by the GDP. It is an indicator of "economic" energy efficiency, in that it shows how much energy is being used to produce one unit of economic output.

Figure 10 shows the evolution of the energy intensity of both primary and final energy consumptions before climate correction. The general decreasing trend confirms the decoupling of energy consumption from the economic activity over the whole period. However, the reduction in energy intensity has taken place at a lower rate from 2008, probably as a result of the economic crisis.

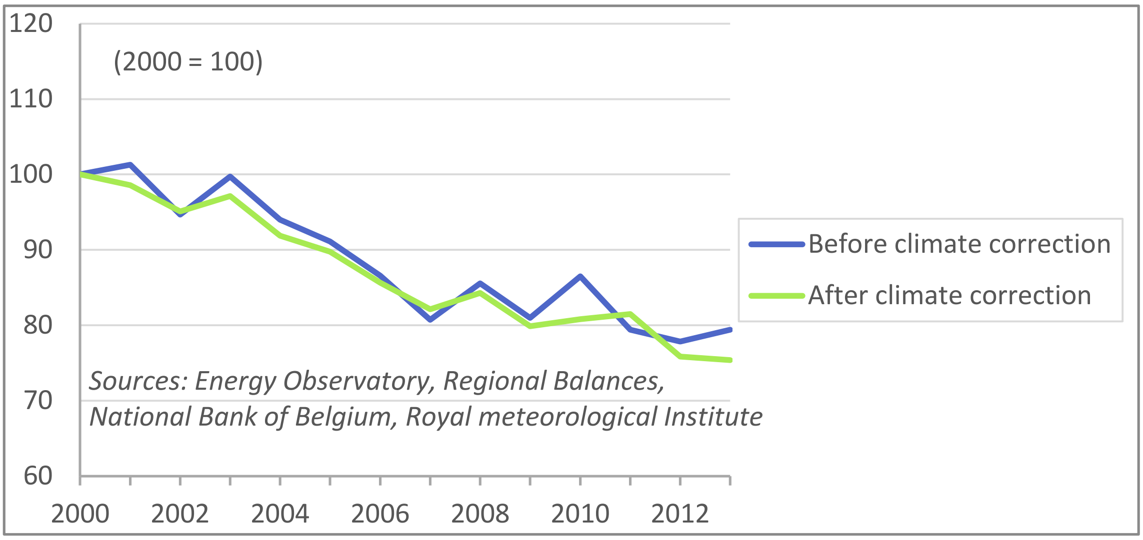
Figure 10: Evolution of the energy intensity (without climate correction)



The evolution in time should rather be appreciated after climate correction (i.e. at constant climate), which is shown on Figure 11 for the final energy consumption.

After climate correction (see the evolution of the number of degree-days on Figure 3), the curve becomes a little smoother, and the energy intensity of total final energy is generally decreasing, except in the years 2003, 2008 and 2011.

Figure 11: Evolution of energy intensity of total final energy



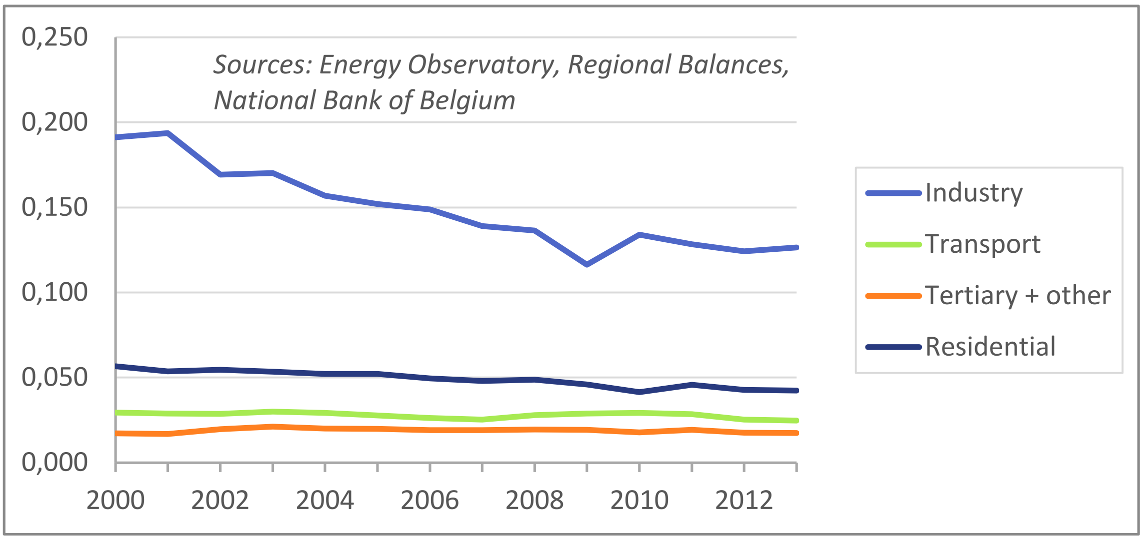
The anomaly observed for 2002-2003 relates to the residential sector. It should be noted that – based on the number of degree-days taken into consideration – 2002 is one of the hottest years of the period.

1.2.3.2 ENERGY INTENSITY BY SECTOR

Energy intensities after climate correction are shown by major end-use sector on Figure 12. They are defined as the energy consumption divided by the following, closely related, activity variables:

- value added, in the case of industry and the tertiary sector;
- private consumption of households (in euros), in the case of the residential sector;
- GDP, in the case of the transport sector.

Figure 12: Final energy intensity by sector (ktoe/M€) (after climate correction)



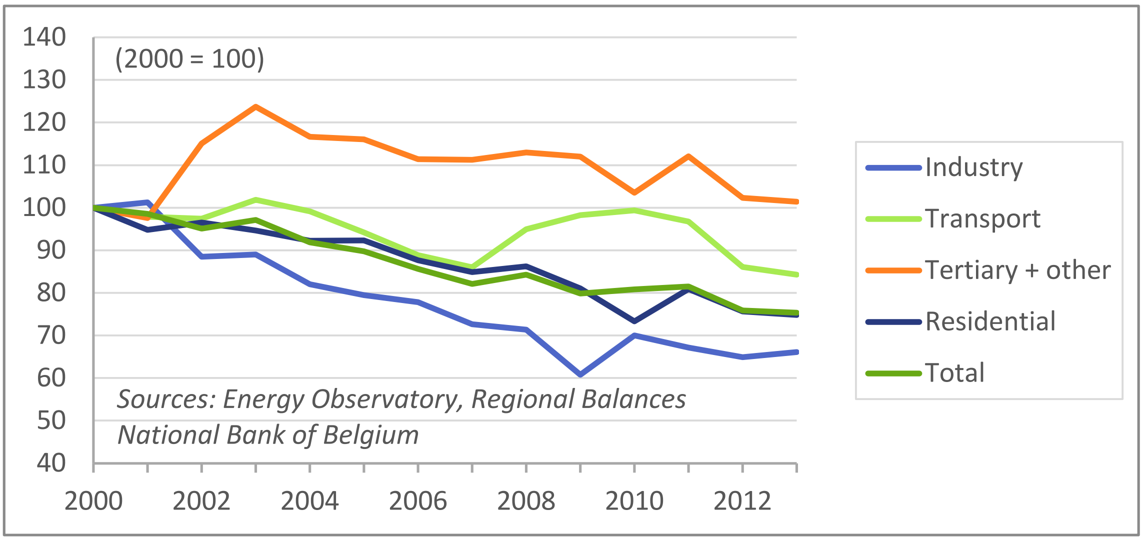
One can notice that, based on these definitions, the energy intensity of industry is much higher than those of the tertiary and the transport sectors. However, it is also decreasing faster (see Figure 13).

The general trend is decreasing (Figure 13), the largest decrease taking place in industry and the residential sector. For transport, the rise after 2007 is similar to that found in the energy consumption trend (Figure 9). Noteworthy is that in 2009 the impact of the crisis was a stronger decrease in industry, due to the fact that the most energy intensive industries were generally the most impacted by the crisis.

It should be stressed that these energy intensities remain imperfect measures, especially because the aggregated activity variables that are used are imperfect indicators of the actual activity changes[5]. These indicators are influenced not only by energy efficiency, but also by structural effects taking place within each sector (e.g. a switch towards activities with either a lower or a higher energy consumption per unit of value added).

[5] Not to mention the imperfection of the climatic correction in the residential and tertiary sectors.

Figure 13: Evolution of final energy intensity by sector (after climate correction)



In fact the overall energy intensity has decreased somewhat more than the average of the sectors. This reveals a structural effect corresponding to a shift away from industry (which has a higher intensity) towards less energy intensive sectors. Indeed, the share of industry in GDP is decreasing (Figure 2), while its energy intensity is much higher than that of the other sectors (Figure 12). This subject will be addressed in section 1.2.3.4.

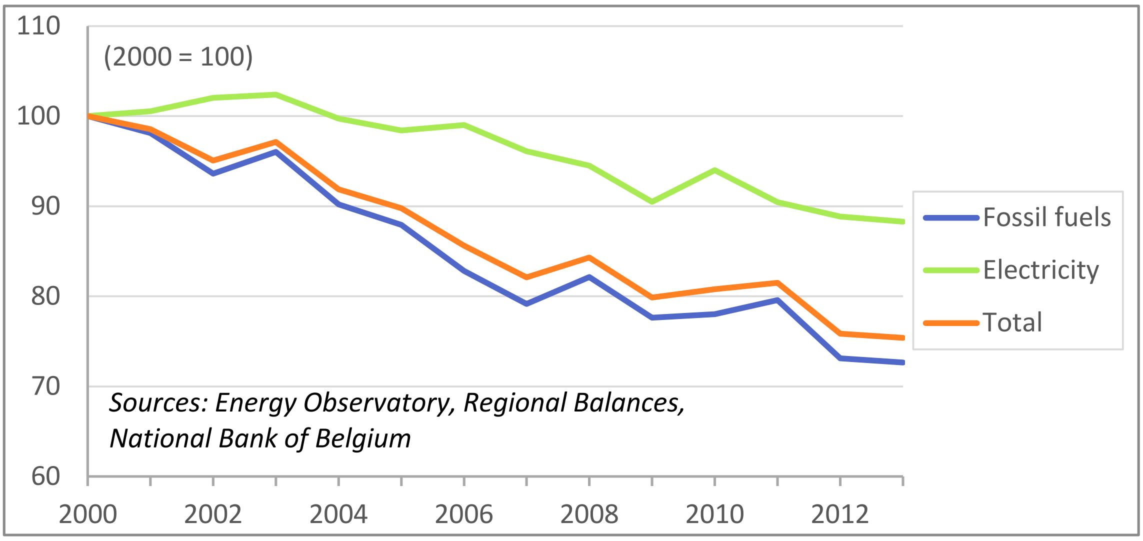
1.2.3.3 ENERGY INTENSITY OF GDP FOR FUELS AND ELECTRICITY

On Figure 14, the energy intensity of total final consumption (defined as energy consumption divided by GDP) is calculated separately for fuels and electricity. Fuels are often largely substitutable amongst each other, and may hence be considered jointly, while electricity is mostly tied to specific uses.

Overall, both intensities have been decreasing over the period. For electricity, the intensity declined by about 10% from 2003 to 2009. The rebound in 2006 is due to an increase in electric steel production of about 800 kt, while that of 2010 mainly results from a significantly increased consumption in the chemical industry.

For fuels, the energy intensity shows a generally decreasing trend; the rise in 2008 is due in particular to the rise in the transport consumption.

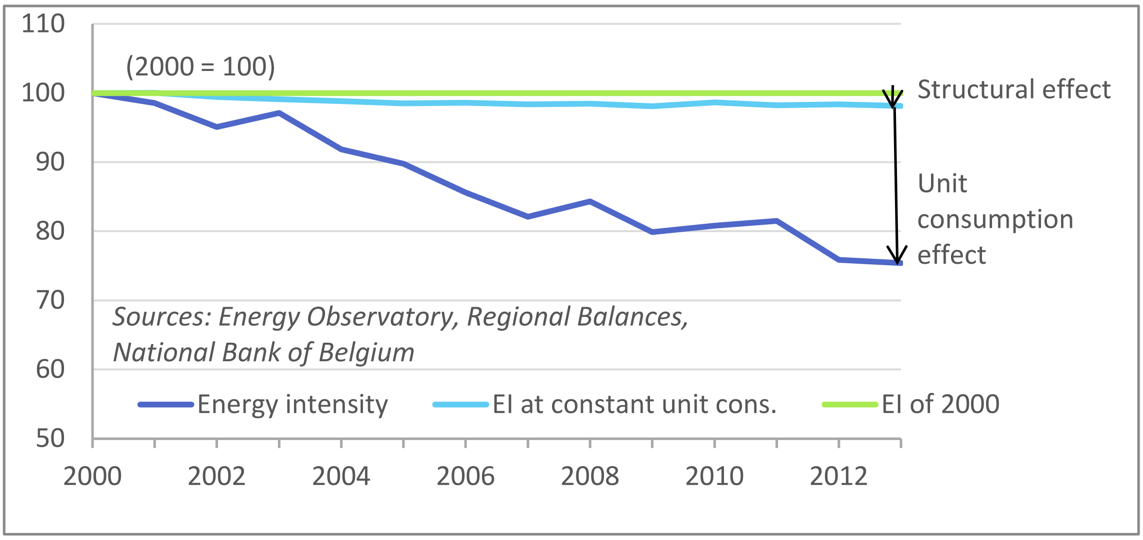
Figure 14: Energy intensity of total final energy consumption



1.2.3.4 IMPACT OF STRUCTURAL CHANGE

The reduction in 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 on Figure 15 (after climate correction). The way this decomposition was calculated is described in Annex 1.

Figure 15: Energy intensity and macroeconomic structural effect (after climate correction)



The unit consumption effect (representing 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) would keep their unit consumptions constant and equal to those of the year 2000.

The structural effect at year t is calculated as the difference between:

- the energy intensity at year t assuming that the unit consumptions are those of the year 2000 and
- the energy intensity in 2000 (=100).

It represents the effect of the relative change in importance between the sectors that have different energy intensities.

Compared with 2000, the reduction in energy intensity reached in 2013, which amounts to 25%, consists essentially of a unit consumption effect (of about 23%) and to a small extent to a structural effect (2%). It should be reminded, however, that the unit consumption effect is itself partly influenced by structural effects happening within each of the four sectors, in particular by structural changes within industry (such as the shutdown of oxygen steel production while the pharmaceutical industry is growing).

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 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 (e.g., by industrial branch), and preferably use activity variables expressed in physical units. Such analyses are carried out using the ODEX indicator, presented below.

1.3 THE ODEX INDICATOR

A conventional way of measuring the overall energy efficiency improvement of a sector is to use the energy intensity (energy consumption divided by value added or GDP, as mentioned above). However, this indicator 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.

In order to address this drawback, the ODYSSEE project has developed the ODEX indicator, which aims to better reflect the evolution of the technical efficiency of energy use of a sector, at whatever aggregation level.

This 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 or production indices instead of in monetary terms. More precisely, it is equal to the observed energy consumption divided by the energy consumption that would have taken place had the unit consumptions remained those of the base year. In practice, in order not to be dependent on a particular base year, it is calculated as a 'chained index' (the base year for each year t being the year t-1) and smoothed out by taking a 3-year moving average[6].

Of course it implicitly takes into account the impact of all energy saving measures (whether or not policy driven), including technical progress and behavioural changes.

Within the project it has been decided to calculate all the ODEX indicators (hence also those presented in this report) as 3-year moving averages, which has as effect to smooth the curves. Besides, no ODEX indicator could be calculated for the tertiary sector, because of a lack of adequate data.

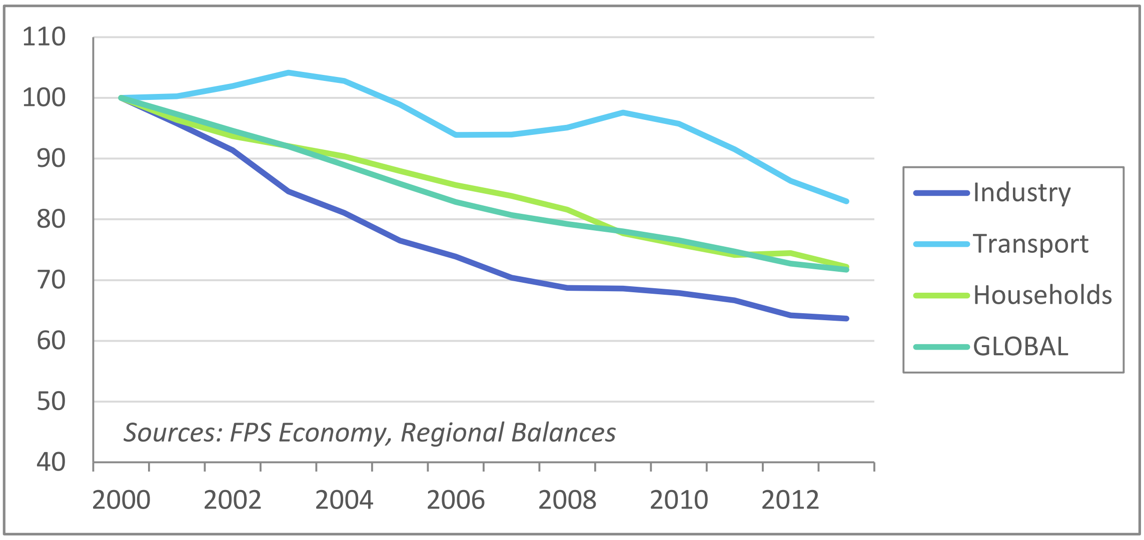
It should be stressed that the value of an energy efficiency indicator depends on the way energy efficiency is defined (i.e., which activity variable is used), and hence to what extent structural effects (such as the switch from oxygen to electric steel, from a house to an apartment, from a car to public transportation…) are considered as energy efficiency improvements.

The choice of indicator is arbitrary, it depends on what one is looking for. For example, for buildings, one could define energy efficiency as:

- The average energy consumption per dwelling (the case of ODEX[7]);
- The average energy consumption per person;
- The average energy consumption per square meter.

Figure 16 shows the ODEX indicators by sector and the overall ODEX. As measured by this indicator, energy efficiency improved on average by 2,5%/year between 2000 and 2013.

Figure 16: ODEX by sector and Overall ODEX



[6] For a description of the ODEX indicator, see [8], [9].

[7] After correction for climate and central heating, as will be shown in section 2.1.3.

Industry achieved the largest improvement, on average 3,4%/year – partly due to structural effects in the chemical and the iron & steel industries –, with a slowdown since the economic crisis.

In the household sector the progress was steady, of on average of 2,5%/year. The transport sector experienced fluctuations, with periods of rising energy efficiency index, leading to an average improvement of 1,4%/year.

1.4 ENERGY EFFICIENCY POLICY BACKGROUND

Belgium is a federal state, in which energy efficiency is a competence of the three Regions (Flanders, Wallonia and Brussels-Capital), with supporting measures from the federal government.

1.4.1 ENERGY EFFICIENCY TARGETS

In the framework of Art. 3 of the EED directive[8], Belgium has set an 'indicative energy efficiency target' of 18% reduction in primary energy consumption by 2020 relative to the 'Primes 2007' baseline. This produces a saving of 9,6 Mtoe. The corresponding final energy saving is 7,1 Mtoe (82,6 TWh). In practice, given the fixed baseline, this comes down to a target of 43,7 Mtoe for the primary energy consumption (32,5 Mtoe for the final energy consumption) in 2020 [3].

For 2016, the target set in the context of the ESD directive 2006/32/EC [4] is the sum of the commitments made by the three regions, which amounts to a final energy saving of 27,5 GWh.

1.4.2 ENERGY EFFICIENCY POLICIES

1.4.2.1 THE MURE POLICY MEASURES DATABASE

The main energy efficiency policy measures are represented in the MURE database, together with their main characteristics (www.measures-odyssee-mure.eu). For each measure, the database comprises its code, its title, a number of 'descriptors' (Reference, Status, Active period, Semi-quantitative impact, and mention as to whether it is a European measure, a NEEAP[9] measure or an Article 7 measure of the EED directive), a 'detailed description' and, where available, a quantitative impact evaluation. A list of these measures with some of their descriptors is given in Annex 2.

In principle, only national measures are to be considered in the database. However, as the competences for energy efficiency are distributed pertain to the three regions, with support

[8] Energy Efficiency Directive : Directive 2012/27/EU [7].

[9] National Energy Efficiency Action Plan, in the framework of the ESD directive [2].

measures from the federal government, the policy measures have, in the case of Belgium, been introduced in MURE by competent entity (federal government or region). The name of the relevant authority (Flanders, Wallonia, Brussels or Federal government) is mentioned in the title of each measure.

Besides the national measures, the main EU-wide measures, which are common to all EU Member States (mainly EU directives), are also introduced in the database.

Policy measures are generally subject to a number of decisions written down in legislation (laws, royal decrees, regional government decrees…), which it would be cumbersome to take into account individually. Measures are often subject to improvements or adaptations, at different dates. Therefore it is not always easy to distinguish between a 'new measure' and the modification of an existing measure. Given this circumstance and the fact that regional measures are taken into account separately, the measures are represented at a relatively aggregated level, some of which comprising a significant number of 'sub-measures' or 'actions' all contributing to the same goal. This may explain the fact that some measures have an old starting date, although they comprise new components or have been significantly modified in a recent year. The details of the content and the modifications are mentioned in the 'detailed descriptions' of the measures.

The impact evaluations, in terms of energy savings, are those taken from the 3rd NEEAP [2]. It should be noted that in this plan, except for Ecodesign and Ecolabelling, the federal measures are not evaluated separately from the regional measures, as they are generally supporting regional measures and their impact could overlap with the latter.

1.4.2.2 RECENT ENERGY EFFICIENCY MEASURES

Belgium submitted its third National Energy Efficiency Action Plan (NEEAP) to the European Commission in 2014 [2]. This plan (which contains the three regional NEEAPs) describes the policy measures of the federal and the regional authorities, and provides an estimate of the impact of the measures.

The regions have, each for its own territory, implemented the EPB directive [1]; promoted further energy efficiency by households and tertiary buildings through grants, compulsory audit schemes, awareness raising programmes, etc.; fostered energy savings in industry by signing voluntary agreements with industry (Flanders, Wallonia); implemented mobility measures; and promoted renewable energies and cogeneration by setting up green and CHP certificates systems.

The main measures taken by the federal government are tax reductions (for energy efficiency investments by households and for the purchase of low CO2 emission cars), the transposition of the EU directives on labels and Ecodesign, and the promotion of public transport by railway. However, the tax reductions for energy investments by households was stopped in 2012, except for roof insulation, and that for clean cars no longer applied from 2013.

An important new measure taken up by the regions is the transposition of Art. 7 of the EED directive. For this, all three have decided not to impose quantitative energy efficiency obligations on energy suppliers or distributors, but rather, as alternative[10], to achieve equivalent results, mainly by awarding grants for energy saving investments and signing voluntary energy-efficiency agreements with industry, but also through regulation [5].

More detail about the policy measures are given in the sectoral chapters of this report.

1.4.2.3 QUANTITATIVE IMPACT EVALUATIONS

In the framework of the NEEAPs, the EU Member States had to undertake a particular effort to quantitatively evaluate the impact of their measures, in terms of final or primary energy savings, as well ex-ante (for the years 2016 and 2020) as ex-post (for the years 2010 and 2012). These impact evaluations are those that have been introduced in the MURE database.

A general overview of the measure impact evaluations is given in Table 2.

Table 2: Overview of the measure impact evaluations

Sector	Main objectives and measures	Final energy savings (GWh)		
		2012	2016	2020
Cross-sectoral	Public service obligation on electricity distribution network operators in Flanders	7.983	11.405	14.630
	Promotion of renewable energy and cogeneration through a Green Certificates system (3 regions)	1.237	3.201	4.188
Industry	Voluntary agreements with industry 2003-2020:			
	• Flanders:	6.253	10.866	15.479
	• Wallonia:	6.229	6.885	3.944
Buildings	Implementation of the Energy Performance of Buildings (EPB) directive, including previous K-level regulations (3 regions)	2.433	4.175	5.256
	Subsidies for energy saving investments in Wallonia and Brussels	2.609	5.983	7.543
	Transposition and implementation of the Labelling and Ecodesign directives			
Transport	Diverse set of measures in the transport sector in the three regions	2.813	7.915	9.650
Agriculture	Flanders - Subsidies for energy saving measures in horticulture (greenhouses)	831	1 045	1.045

Source: data from MURE, which are based on NEEAP3 [2].

[10] As allowed by Art. 7(9).

1.4.2.4 GENERAL CROSS-CUTTING MEASURES

The main cross-cutting measures are given in Table 3. The other measures are presented in each of the sectoral chapters that follow.

Table 3: Main general cross-cutting measures

Code	Title	Final savings 2012 (GWh)	Final savings 2016 (GWh)	Final savings 2020 (GWh)
GEN-BEL9	Flanders - Promotion of photovoltaic solar panels via green certificates, preceded by subsidies	1.710	2.049	2.648
GEN-BEL14	Flanders - Imposing RUE-public service obligations on the electricity distribution network operators	7.983	11.405	14.630
GEN-BEL4	Wallonia - Green Certificates for renewable electricity and high yield cogeneration	289	644	1.000
GEN-BEL6	Wallonia - Subsidies for cogeneration	400	747	1.088
GEN-BEL8	Flanders - Promotion of qualitative cogeneration via cogeneration certificates (excluding ETS sites, which are included under measure IND-BEL22)	475	508	540

The largest contribution stems from measures GEN-BEL14, the public service obligation in Flanders. It should be noted that this measure mainly corresponds to grants for energy efficiency investments (mainly in dwellings) which for Brussels and Wallonia are taken into account in the residential and tertiary sectors (Table 4 and Figure 6).

2 ENERGY EFFICIENCY IN BUILDINGS

2.1 ENERGY EFFICIENCY TRENDS IN THE HOUSEHOLD SECTOR

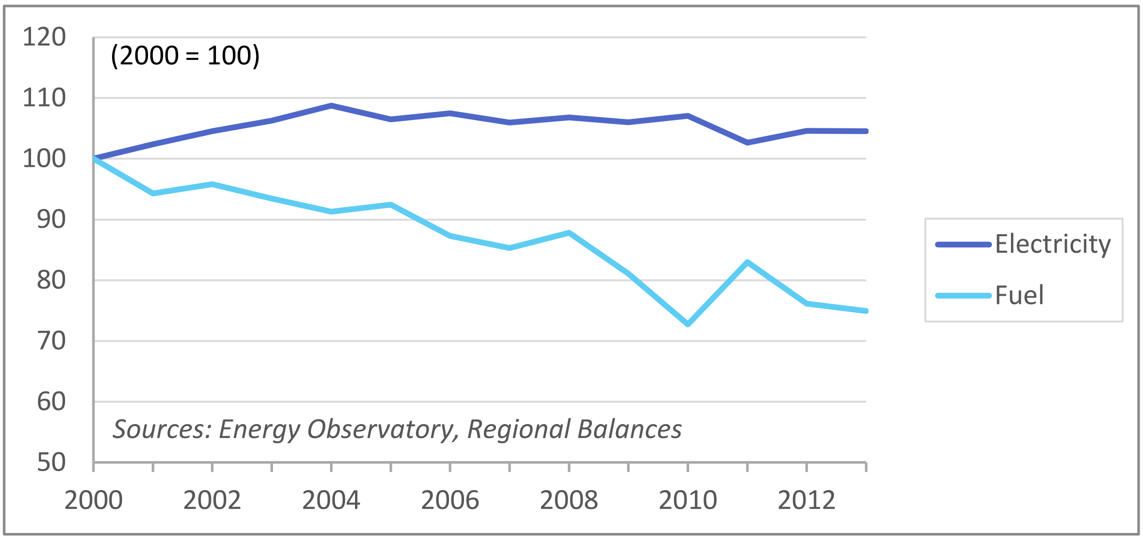
2.1.1 CONSUMPTION PER INHABITANT

Per inhabitant, the (climate corrected) fuel consumption of households has steadily decreased over the whole period. The stronger decrease in 2010 and the increase in 2011 are entirely due to the climatic correction: indeed, the actual energy consumption was lower in 2011 than in 2010, but the number of degree-days was 27% higher in 2010 than in 2009 and 34% lower in 2011 than in 2010[11].

On the other hand, the electricity consumption per inhabitant has remained rather stable after 2004.

The federal statistics on energy consumption for the residential sector are only disaggregated by fuel, not by type of use (space heating, water heating or other uses), which limits the possibilities to calculate indicators.

Figure 17: Residential energy consumption per inhabitant (after climate correction)



In this sector fuels and electricity are substitutes, and the penetration of electric heating is significant, in particular through the penetration of heat pumps. Therefore in the analysis below the total energy consumption for heating (fuels and electricity) has been considered instead of the sole fuel consumption.

[11] This shows that the climate correction through the degree-days method remains imperfect, especially in the case of years with extreme climates.

2.1.2 DECOMPOSITION OF THE TREND IN ENERGY CONSUMPTION FOR SPACE HEATING

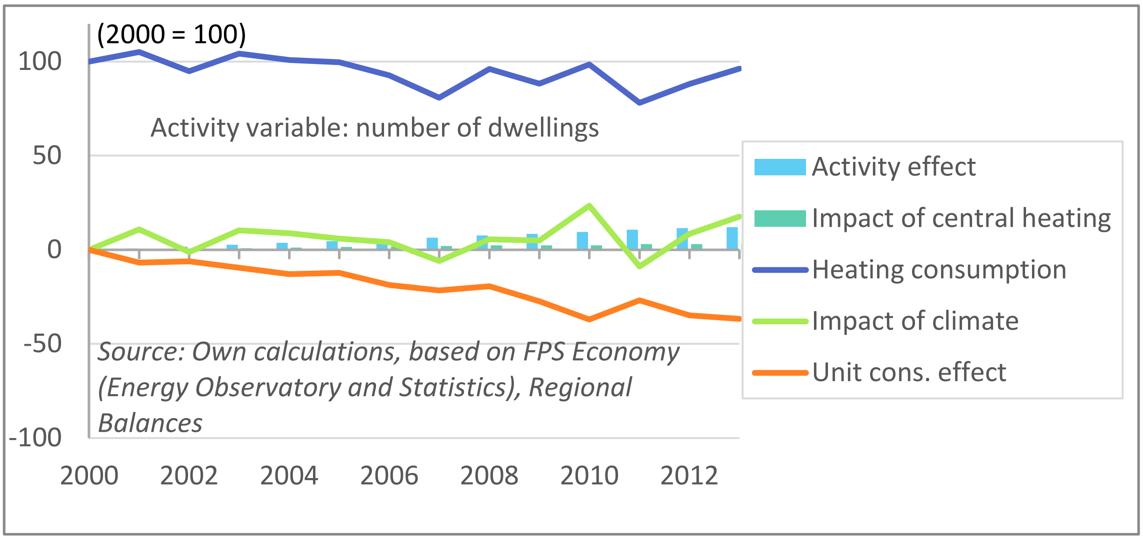
Figure 18 decomposes the evolution of the energy consumption for space heating[12] since 2000 in the following components:

- the impact of an activity variable, chosen here as the number of dwellings;
- the impact of the climate (derived from the number of degree-days);
- the impact of the increased penetration of central heating (which tends to increase the energy consumption);
- the unit consumption effect, corresponding to energy savings; it shows the evolution of the energy consumption per dwelling, after correction for the climate and the penetration of central heating.

The impact of the climate is the difference between the observed energy consumption and the climate corrected energy consumption (calculated as indicated in section 1.2.1). The activity effect is calculated as the evolution that the climate corrected energy consumption would have it was directly proportional to the activity variable.

As to the impact of the penetration of central heating, it is assessed as the difference between the average, climate corrected, consumption per dwelling with the consumption that would have taken place had the penetration rate of central heating remained constant. The calculation is based on the assumption that a dwelling without central heating consumes 25% less than a centrally heated dwelling.

Figure 18: Residential energy consumption for space heating (before climate correction) and variation since 2000



[12] The share of space heating in the energy consumption of households is based on default data from ENERDATA, data from [13] and own modelling.

The activity effect is regularly rising and reaches 12,0% (of the energy consumption in 2000) in 2013. The impact of central heating is also regularly rising, but much smaller, contributing to an increase in energy consumption of 3,3% in 2013.

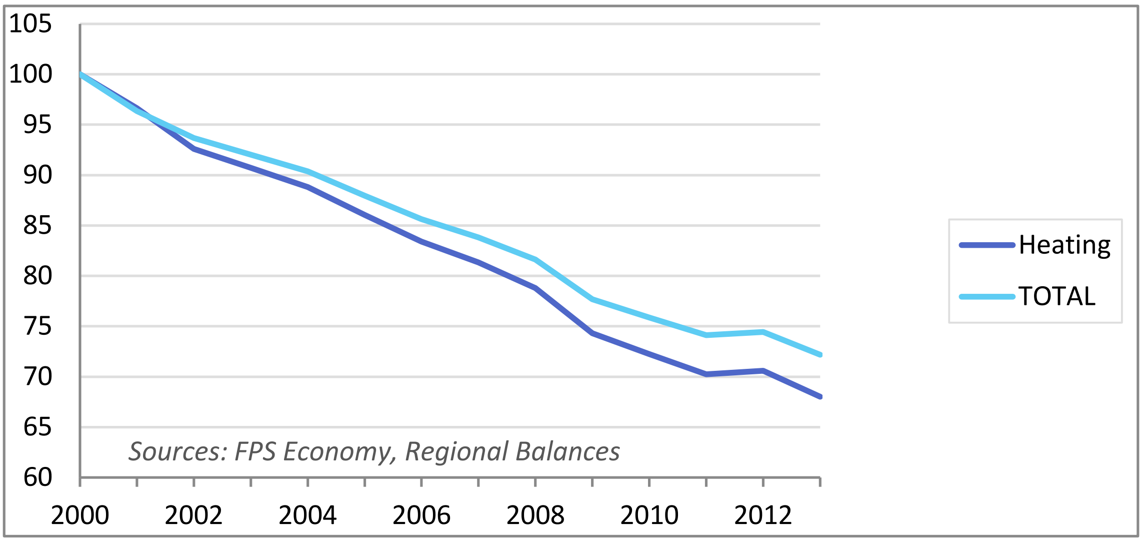
As to the climate effect, it shows rather large variations, and reaches 17,6% in 2013. It is the main factor explaining the higher fuel consumption in 2010 and 2013.

The unit consumption effect, which is calculated as a residue, can be interpreted as representing the energy savings, including behavioural effects such as reduced indoor temperatures, for example as a reaction to higher energy prices. The graph shows regularly increasing energy savings reaching the remarkable value of 37% in 2013.

2.1.3 THE ODEX INDICATOR FOR THE RESIDENTIAL SECTOR

Figure 19 shows the evolution of the ODEX indicator for the households sector.

Figure 19: Households ODEX



This indicator is calculated as the average energy consumption per dwelling, after correction for the number of degree-days and the increased penetration of central heating (see section 1.3 for further comments on its calculation).

Over the period 2000-2013, there has been a steady improvement in energy efficiency in the residential sector, by on average 2,5%/year. For heating alone, this improvement was 2,9%/year.

2.2 ENERGY EFFICIENCY TRENDS IN THE TERTIARY SECTOR

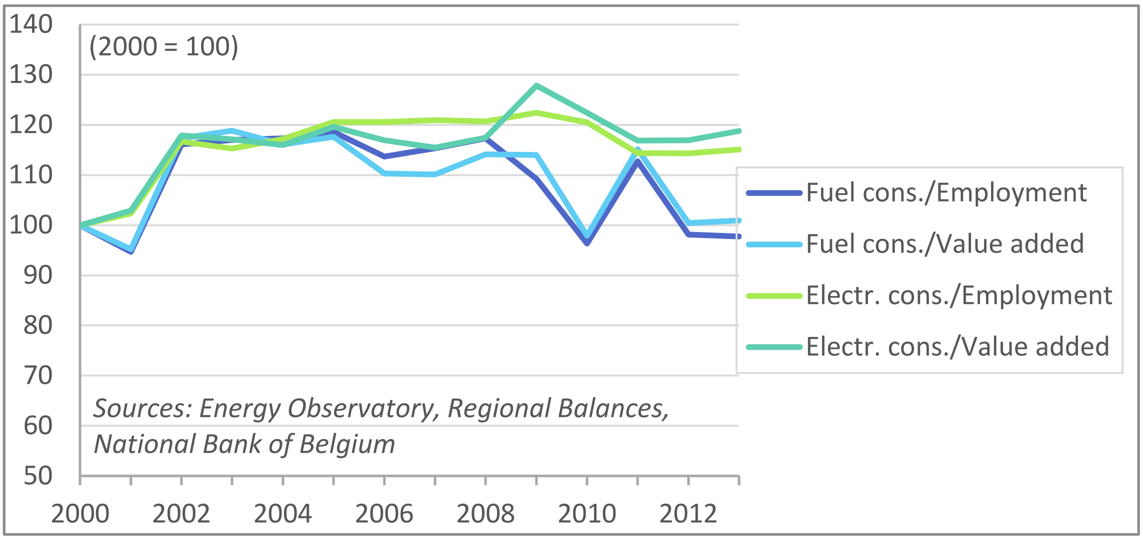
2.2.1 UNIT CONSUMPTIONS

For the tertiary sector different activity variables can be considered. Figure 20 shows the evolution of the energy consumption per employee and per unit of value added, for fuels and electricity.

Overall, there has been relatively little difference between the evolution of value added and employment, so that the energy consumption per unit of value added and the energy consumption per employee are rather similar. The largest difference is between fuels and electricity. For the fuel consumption, the indicators fluctuate, but, after the high growth until 2003[13], there is an overall downward trend. Whereas for electricity, the unit consumptions are rather stable since 2002, which could be explained by the fact that electricity savings are hidden by the increased penetration of electric devices.

The extreme values observed for 2010 and 2011 can be explained by the climate correction, in the same way as for the residential sector (Figure 17).

Figure 20: Tertiary sector - Ratio Energy consumption/Activity



2.2.2 DECOMPOSITION OF FUEL CONSUMPTION

Figure 21 is a decomposition analysis similar to the one made for the residential sector in Figure 18, 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.

Up to 2005, the fuel consumption has continued, though at a slower pace, the rising trend of the nineties. Since then, however, it has significantly declined.

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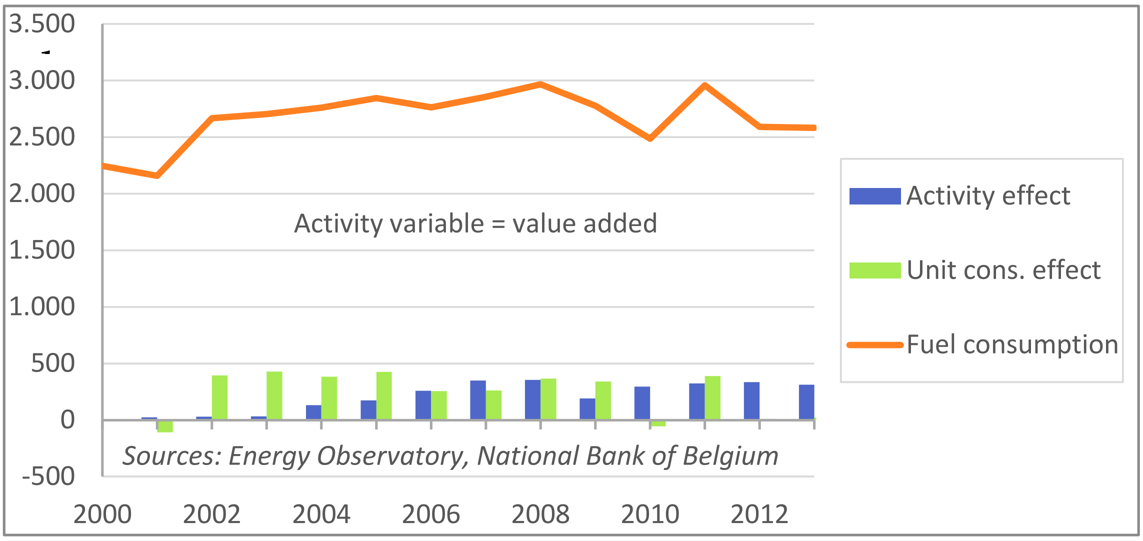
[13] Due to the jump in energy consumption referred to about Figure 9 in section 1.2.2.

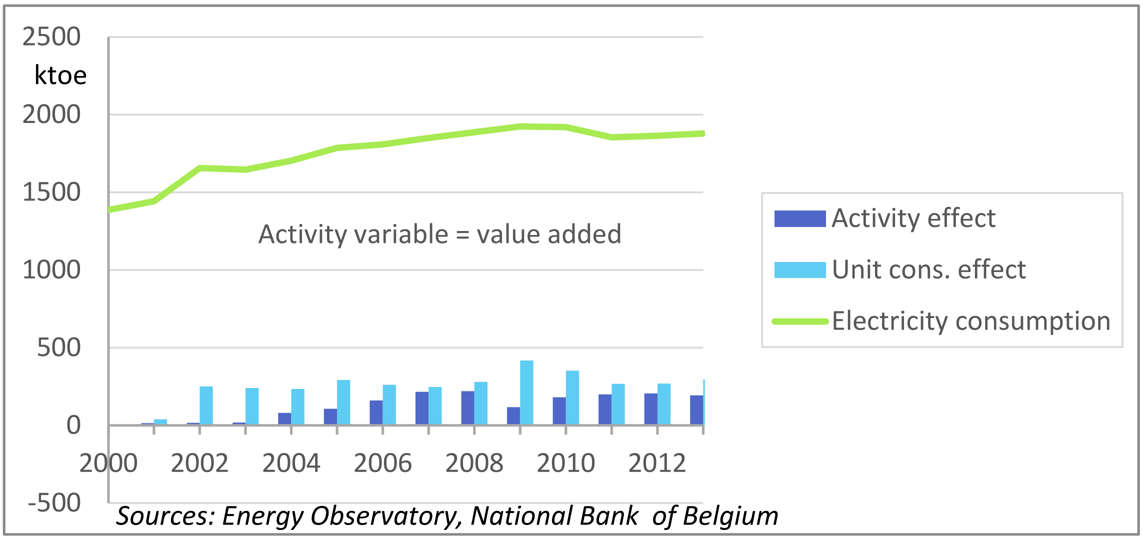
Figure 21: Fuel consumption in tertiary sector (after climate correction) and variation since 2000



The activity variable used for the decomposition is the value added of the sector. The positive unit consumption effect (increase in the fuel consumption per unit of value added) is due to the jump in fuel consumption between 2000 and 2003 mentioned above. The picture would have looked quite different had the base year been 2002 for example. In 2009, the activity effect has become very small, because of the economic crisis.

For the electricity consumption, displayed on Figure 22, the main effect since 2000 is the unit consumption effect. The latter is likely to result from the increasing use of new applications of electricity, amongst which computer and other office equipment. However, it levelled off since 2010, probably at least partly as a result of the impact of policies such as Ecodesign and Energy Star.

Figure 22: Electricity consumption in tertiary sector and variation since 2000



2.3 ENERGY EFFICIENCY POLICIES

The main measures of the building sector are presented in Table 4 and Table 5, for the household and the tertiary sectors respectively, together with the impact evaluations from the 3rd NEEAP [2].

Recent measures are the reinforcement of the EPB regulations for new buildings in the three regions (measures HOU-BEL8, HOU-BEL25, HOU-BEL29). The federal tax deductions for households (HOU-BEL1) was abolished from 1 January 2012 (except for roof insulation). Wallonia has revised its grant system for households in 2015 (HOU-BEL30).

Table 4: Main measures in the household sector

Code	Title	Final savings 2012 (GWh)	Final savings 2016 (GWh)	Final savings 2020 (GWh)	
HOU-BEL19	Federal government - K-level thermal regulations of residential buildings (in use prior to the EPB directive)				§
HOU-BEL23	Brussels - Assist households proactively with regard to energy and eco-construction to improve the quality and energy comfort of their residence	0	18	50	
HOU-BEL16	EU-related: Energy Labelling of Household Appliances (Directive 92/75/EC) - Federal Government - Labels on electrical household appliances				
HOU-BEL10	Brussels -– Energy grant for households	460	929		
HOU-BEL30	Wallonia - Financial incentives for RUE investments in buildings	1.889	4.404	6.742	
HOU-BEL29	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Flanders - Insulation and energy performance regulation for buildings	1.932	3.171	4.288	*
HOU-BEL26	Brussels - Develop and promote exemplary buildings - BATEX (with virtually zero consumption and of high environmental quality)				§§
HOU-BEL25	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Brussels - Act structurally on the demand through progressive reinforcement of the requirements of the EPB regulations in the residential sector	111	367		**
HOU-BEL8	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Wallonia - Thermal regulation for buildings	390	637	968	***
HOU-BEL24	Flanders - Reduction in property tax for energy-efficient new residential buildings				****

* Including the impact of TER-BEL28

** Including the impact of TER-BEL7

*** Including the impact of TER-BEL20

**** Included in HOU-BEL29

§ Included in HOU-BEL29, HOU-BEL8 and HOU-BEL25

§§ Included in TER-BEL16

In the NEEAP, the residential and the tertiary sectors are aggregated under the building sector. Therefore the impact of some measures is only given for the building sector as a whole.

The main contribution is that of HOU-BEL30 (grants for energy saving investments in Wallonia). As mentioned earlier, the corresponding measure for Flanders is measure GEN-BEL14, classified under

'General cross-cutting measures'.

Table 5: Main measures in the tertiary sector

Code	Title	Final savings 2012 (GWh)	Final savings 2016 (GWh)	Final savings 2020 (GWh)	
TER-BEL13	Flanders - Subsidies for energy saving measures in horticulture (cultivation under glass)	831	1045	1045	§
TER-BEL17	Wallonia - Subsidies for RUE investments in Public Buildings	260	650	801	
TER-BEL21	Brussels -– Energy grant for tertiary sector				***
TER-BEL18	Wallonia - Public lighting (including EPURE) + traffic lights	156	163	169	
TER-BEL28	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Flanders - Insulation and energy performance regulation for tertiary buildings				*
TER-BEL16	Brussels - Develop and promote exemplary buildings - BATEX (with virtually zero consumption and of high environmental quality) in the tertiary sector	19	57		
TER-BEL20	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Wallonia - Thermal regulation for tertiary buildings				**
TER-BEL7	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Brussels - Act structurally on the demand through progressive reinforcement of the requirements of the EPB regulations in the tertiary sector				****
TER-BEL19	Flanders - Reduction in property tax for energy-efficient new tertiary buildings				*****
TER-BEL14	Brussels - Impose a plan for reduction of energy consumption on major consumers ("PLAGE": Local Action Plan for Energy Management)	54	62		
TER-BEL15	Brussels - Make performance of an energy audit mandatory for any building of more than 3500 m² not allocated to housing upon renewal of its environmental permit	16	78		

§ Mentioned for information. This measure pertains the agricultural sector, which in MURE is taken up in the tertiary sector (which is not the case for the ODYSSEE database and indicators.

* Included in HOU-BEL29

** Included in HOU-BEL8

*** Included in HOU-BEL10

**** Included in HOU-BEL25

***** Included in HOU-BEL28

3 ENERGY EFFIENCY IN TRANSPORT

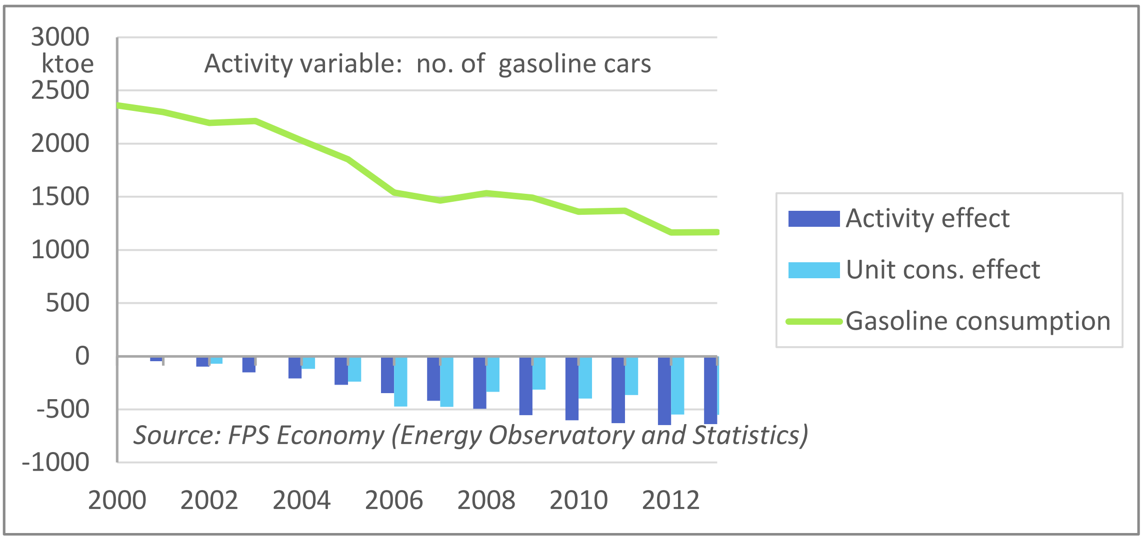
3.1 ENERGY EFFICIENCY TRENDS

3.1.1.1 ANALYSIS BASED ON THE NUMBER OF CARS

The federal energy 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 has followed a steadily decreasing trend. This evolution can be decomposed between an activity effect and a unit consumption effect, which is done on Figure 23, where the activity variable used is the number of gasoline cars. This figure shows that the decrease in fuel consumption since 2000 is mainly due to the activity effect (decrease in number of gasoline vehicles), but also to a significant extent to the unit consumption effect (average annual gasoline consumption by car).

Figure 23: Gasoline consumption in road transport and variation since 2000



Source: FPS Economy (Energy Observatory and Statistics)

For road transport by diesel vehicles such an analysis is not possible, because of the missing data on the energy consumption of diesel cars.

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 from gasoline to diesel, which is likely to have occurred mostly for the highest mileages, thereby reducing the average mileage of gasoline cars.

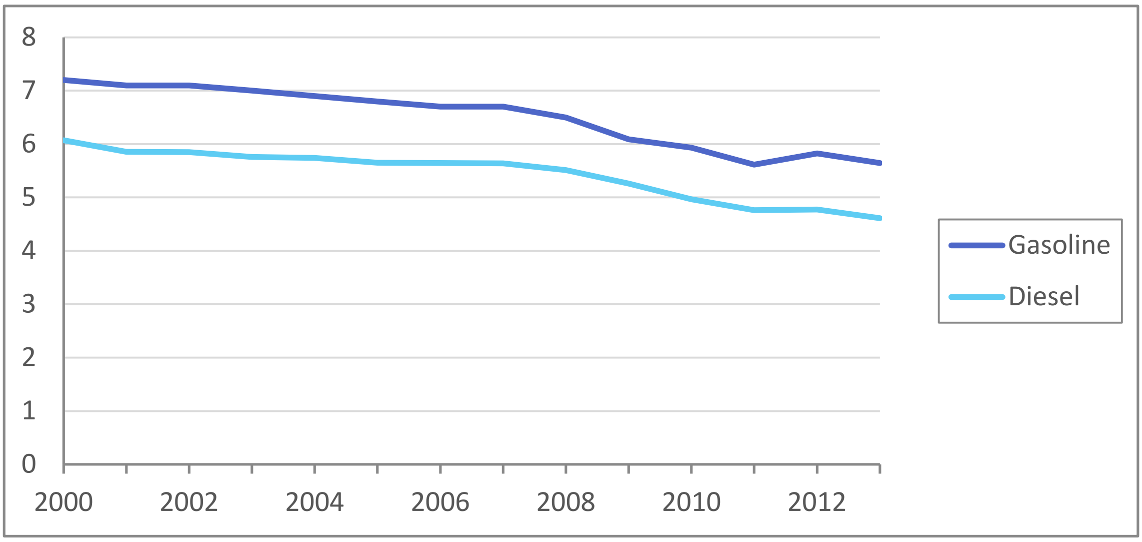
The data does not allow to distinguish between the contribution of behaviour (in particular the average mileage) and that of efficiency improvement.

3.1.1.2 SPECIFIC CONSUMPTION OF NEW CARS

Figure 24 shows the evolution of the average normalised specific consumption of new cars, based on the test cycle of Directive 93/116/EC. It is the average for the Belgian market of cars manufactured by members of the European, Japanese and Korean automobile construction associations (ACEA, JAMA and KAMA).

The data are based on the reporting of Member States according to Decision No 1753/2000/EC and Regulation (EC) No 443/2009 [6] and represent the average for all new cars registered in the Belgian territory [7].

Figure 24: Average specific fuel consumption of new cars (l/100 km)



Source: European Commission [8]

There has been a steadily decreasing trend in the average fuel consumption of both gasoline and diesel new registered cars. Between 2000 and 2013, the decrease has reached 21,6% for gasoline cars and 24,0% for diesel cars, on the basis of the normalised manufacturers' data. Given the shift towards diesel cars, the average specific CO_2 emissions went down from 164,87 g CO_2/km in 2000 to 124,0 g CO_2/km in 2013 (a reduction of 24,8%).

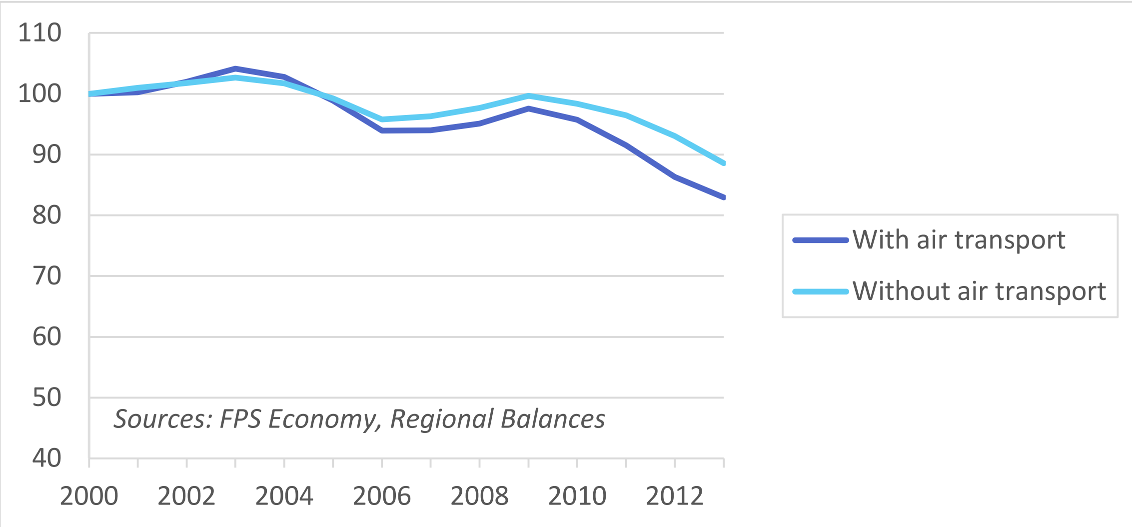
3.1.1.3 FREIGHT TRANSPORT

The total consumption of diesel fuel is known, but it cannot be used here, because a large fraction of it (about two thirds[14]) 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). Therefore it is not possible to split into its different components the fuel consumption for freight transport by road.

3.1.1.4 ODEX INDICATOR FOR TRANSPORT

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

Figure 25: Transport ODEX



This indicator is only a rough indicator, for reasons of data availability. It takes into account the road, rail and air transport[15] modes, for both passenger and goods transport. For road transport, it represents the evolution of the average energy consumption per vehicle or per passenger. Besides, because of a lack of disaggregation of the energy consumption data between types of vehicles, the various types of road vehicles are taken into account in a simplified way, on the basis of car equivalents[16].For river transport, the official (federal) energy consumption statistics are not enough reliable.

[14] It was 61,5% in Wallonia in 2012 [12].

[15] Domestic and international.

[16] Converting the actual stock of vehicles into a stock of car equivalents is based on a coefficient reflecting the difference in average annual consumption between each type of vehicle and the car. If, for instance, a motorcycle consumes on average 0,15 toe/year and a car 1 toe/year, one motorcycle is considered to be equal to 0,15 equivalent cars ("Definition of the energy efficiency

Over the period 2000-2013 the indicator has been fluctuating. The periods of rise are due to the fact that the energy consumption for road transport has increased faster than the stock of vehicles. On average, the efficiency improvement reached 1,4%/year between 2000 and 2013.

3.2 ENERGY EFFICIENCY POLICIES

The main measures of the transport sector, as well as their impacts as evaluated in the 3rd NEEAP [2] are presented in Table 6.

These measures generally represent a large set of diverse individual actions. For details see the descriptions in the MURE database (www.odyssee-mure.eu).

Table 6: Main measures in the transport sector

Code	Title	Final savings 2012 (GWh)	Final savings 2016 (GWh)	Final savings 2020 (GWh)
TRA-BEL20	Flanders - Mobility management measures and measures that bring about a shift in the choice of transport	1863	6558	9239
TRA-BEL12	Brussels - Measures in the transport sector (IRIS II Mobility Plan, COBRACE code, etc.)	191	884	
TRA-BEL19	Wallonia - Financial incentives or funding devoted to transport	537	251	189
TRA-BEL4	Wallonia - Saving measures for transport in the public sector	222	222	222

Striking is that a much larger impact is expected in Flanders than in Wallonia. The difference may be related to the use of a top-down approach in Flanders versus bottom-up method in Wallonia or to a lower number of measures.

index ODEX", www.odyssee-indicators.org). The conversion coefficients used are 0,15 for motorcycles, 15 for buses and 4 for trucks and light vehicles.

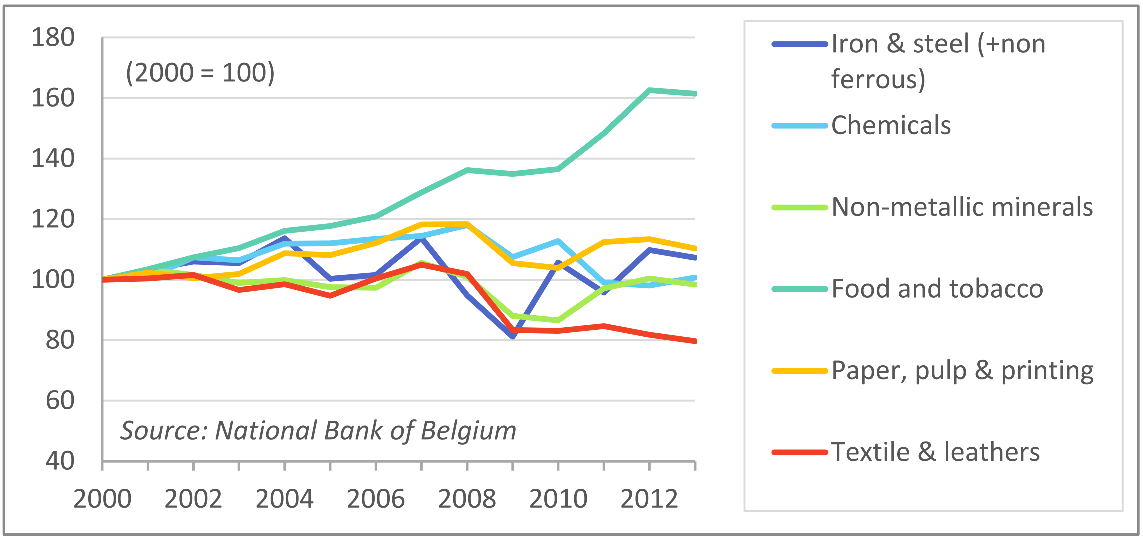
4 ENERGY EFFICIENCY IN INDUSTRY

4.1 ENERGY EFFICIENCY TRENDS

4.1.1 OVERALL CONTEXT

Figure 26 shows the evolution of value added by main industrial branch since the year 2000. There is a significant dispersion across sectors, the food and tobacco sector having the largest growth, the textile industry the largest decline. The impact of the economic crisis can be seen as soon as 2008 for the iron & steel industry (and non-ferrous metals), in 2009 for the remaining branches. This impact also differs across sectors: textile, primary metals (iron& steel and nonferrous metals), chemicals and paper all had a strong decline in 2009, while the food industry was only marginally affected. While primary metals, non-metallic minerals and paper, pulp & printing recovered in subsequent years, in 2013 chemicals and textile & leathers were still below their levels in 2009.

Figure 26: Evolution of value added by industrial branch

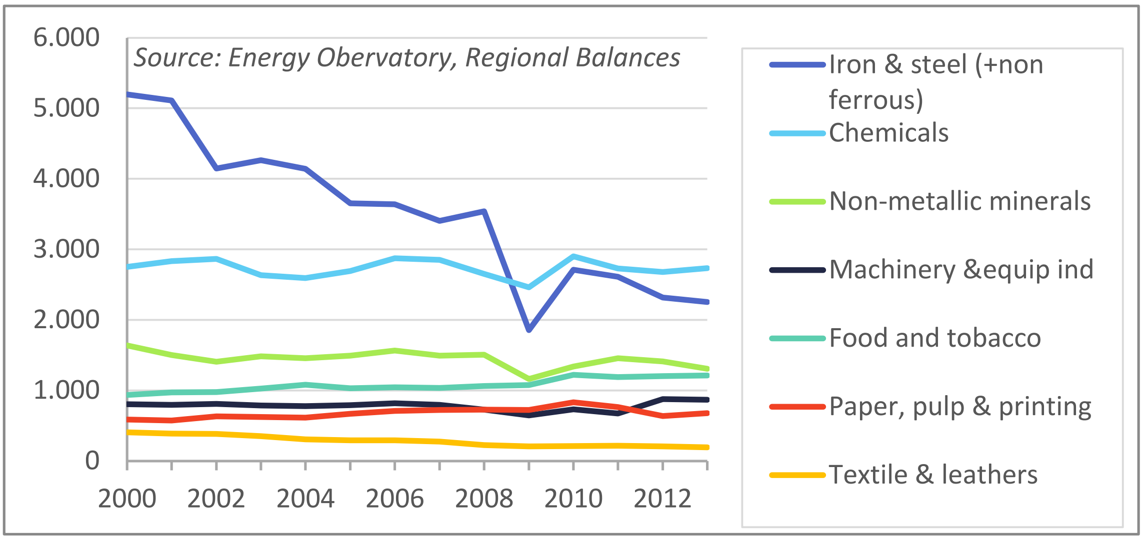


4.1.2 ENERGY CONSUMPTION TRENDS

The energy consumptions by branch are shown on Figure 27.

By far the two largest consumers are iron & steel and chemicals. The first has seen its consumption strongly decline, and almost halved between 2008 and 2009, due to the crisis, and partially rebound in 2010. The consumption of the second has remained more stable overall.

Figure 27: Energy consumption by industrial branch (ktoe)



The non-metallic minerals sector (essentially cement, lime and glass production) had a pretty stable consumption over the entire period, except for a lower level in 2009, while the food & tobacco sector experienced a continuous growth.

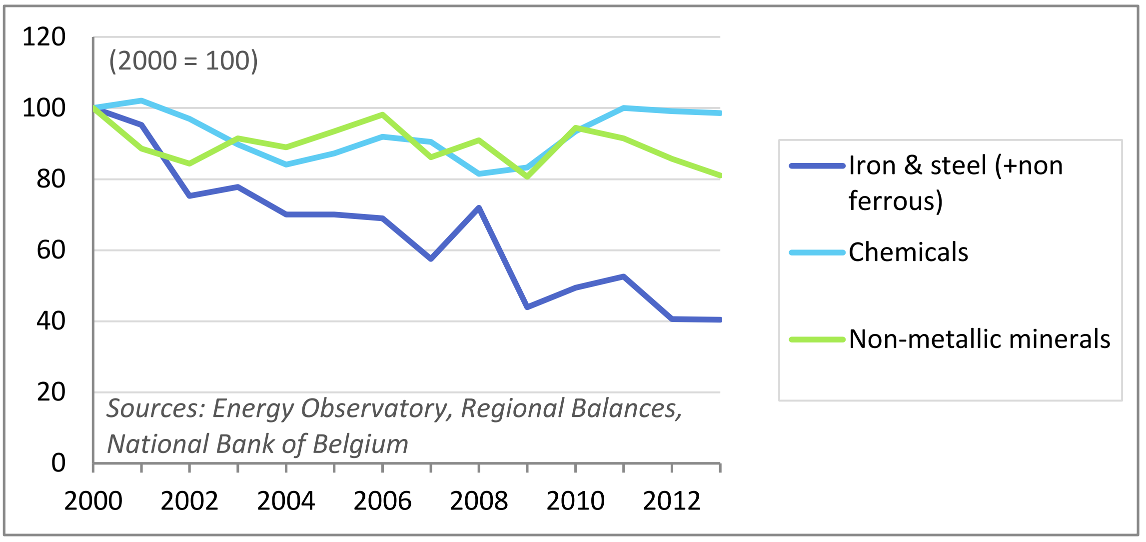
Among the remaining sectors, the consumption of paper, pulp & printing increased up to 2010 and fell afterwards, while that of textile & leathers has lost importance.

4.1.3 ENERGY INTENSITY TRENDS/UNIT CONSUMPTION TRENDS

4.1.3.1 ENERGY INTENSITIES BY BRANCH

Figure 28 and Figure 29 display the evolution of the (final) energy intensity (total energy consumption/value added in constant prices) for the main industrial branches. They show some rather large fluctuations.

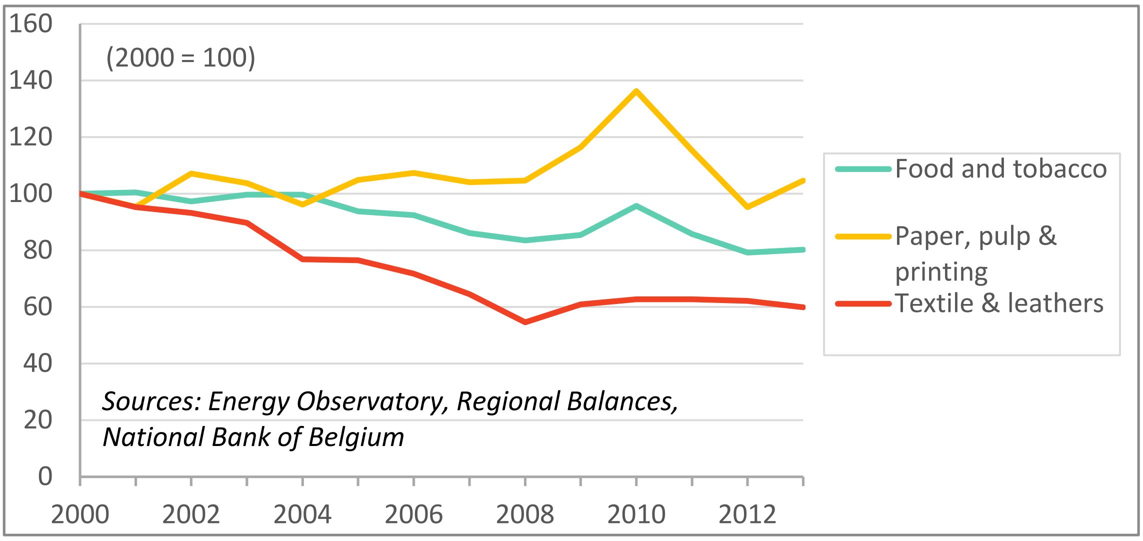
Figure 28: Evolution of energy intensity by industrial branch (1/2)



Overall, the energy intensity of the steel industry has a clear downward trend. The peak in 2008 is due to a drop of 17% in value added (the energy consumption rose a little); this coincided with a dip in steel production, where process lines were hence not running at full load. The non-metallic minerals sector has seen its energy intensity deteriorate (increase) between 2002 and 2006; in the later years the situation improved, except in 2010. As to the chemical industry, its intensity has substantially worsened in 2010 and 2011, due to both an increase in energy consumption in 2010 and a drop in value added in 2011.

The energy intensity of the paper, pulp & printing industry (Figure 29) experienced a strong growth in 2009 (because of a drop in value added) and in 2010 (because of a rise in energy consumption). After a regular decline, the intensity of the food & tobacco branch showed a similar increase in 2010 (because of a rise in energy consumption for a stable value added), while the textile sector stabilised after a period of decreasing trend up to 2008.

Figure 29: Evolution of energy intensity by industrial branch (2/2)



4.1.3.2 INTER-BRANCH STRUCTURAL EFFECTS

This section examines the extent to which 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 branches:

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

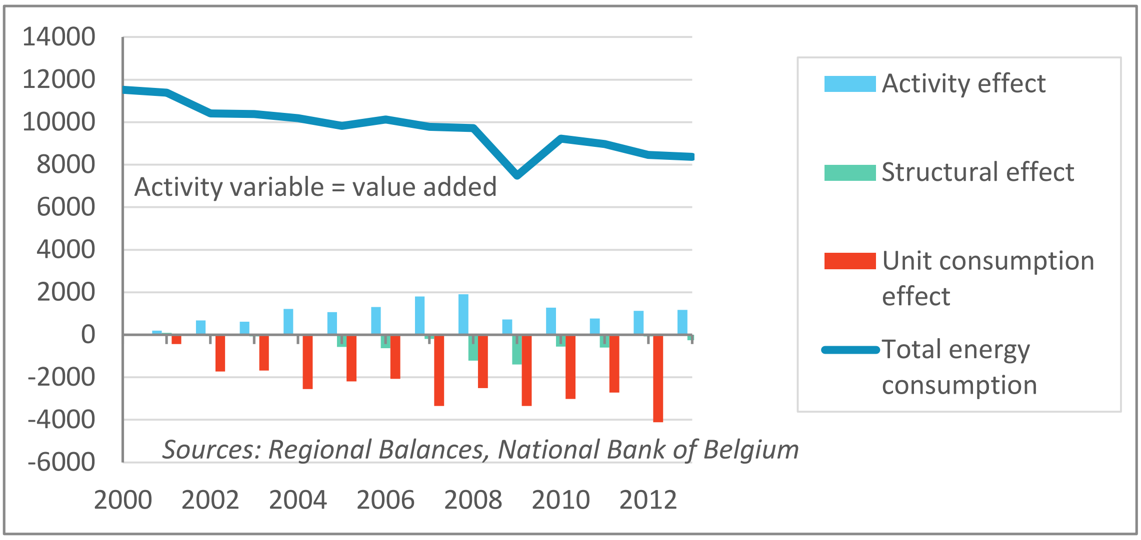
The "other industrial sectors" are not included, because they are too heterogeneous. These 7 branches actually represented 90% of the total energy consumption of industry in 2000.

On Figure 30, the variation in energy consumption since 2000 (consumption minus consumption in 2000) is separated into three effects: an activity effect, a structural effect and a unit consumption effect.

The activity effect is the evolution of energy consumption that would have taken place if the unit consumptions had remained those of the base year 2000. 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 energy consumption and the energy consumption that would have been obtained had the energy intensity remained equal to that of 2000.

The largest contribution to the variation in energy consumption since 2000 comes from the unit consumption effect. The second effect by size is the activity effect, which increases the energy consumption and which reached a positive peak in 2008. The structural effect has had a negative contribution which was largest in 2009, but in 2013 this effect has practically disappeared.

Figure 30: Total energy consumption in industry and variation since 2000



It should be remembered that the structural effect is calculated using the energy intensities of the reference year, in this case 2000. The results are sensitive to the choice of that reference year.

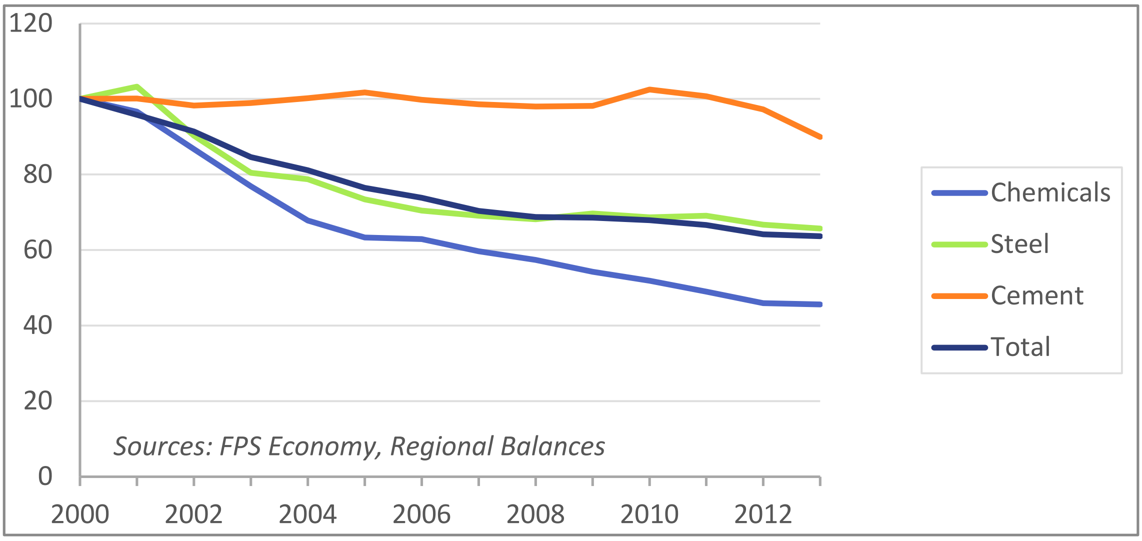
It should also be kept in mind that this analysis remains approximate, because the activity variable used (value added) is only an imperfect indicator of the activity level of each sector. This is also why unit effects are influenced by intra-branch structural effects, and therefore only imperfectly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

Moreover, 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 more slowly than the value added).

4.1.3.3 ODEX INDICATOR FOR INDUSTRY

Figure 31 shows the evolution of the ODEX indicator for three main branches and for industry as a whole for the period 2000-2013. The overall indicator has been calculated using a disaggregation in 9 branches: Chemicals, Steel, Non ferrous metals, Cement, Other non metallic minerals, Paper, Food, Machinery and fabricated metals, Textile. For Steel, Cement and Paper, the activity variable is the production level in tonnes; for the remaining branches, it is the industrial production index. The energy consumption for cement production is an extrapolation of Walloon data.

Figure 31: Industry ODEX



The three branches represented on the graph show quite different evolutions. Overall, the improvement reached 36% between 2000 and 2013 (3,4%/year). This is partly due to structural effects in the chemical and the iron & steel industries. The former achieved an improvement of 5,9%/year (its industrial production index more than doubled, over the period[17], when its energy consumption remained stable), while the latter switched from oxygen to electric steel, thereby becoming more energy efficient per tonne of steel produced. For cement, the index remained rather stable, but is influenced by shifts in the relative shares of the dry and wet routes.

[17] It should be noted that its value added hardly changed over the same period (Figure 26).

4.2 ENERGY EFFICIENCY POLICIES

The main measures for industry in the MURE database are presented in Table 7. They essentially consist of the voluntary agreements signed in Flanders and Wallonia. In each of these regions, a new set of agreements has recently been launched, covering the period 2014-2020. Note that the impacts of these measures include the ETS[18] sites.

Table 7: Main measures in industry

Code	Title	Final savings 2012 (GWh)	Final savings 2016 (GWh)	Final savings 2020 (GWh)
IND-BEL22	Flanders - Voluntary agreements in energy intensive industry	6.253	10.866	15.479
IND-BEL21	Wallonia - Voluntary agreements with industry	6.229	6.885	3.944
IND-BEL23	Wallonia –- Subsidies for energy saving investments in industry (excluding buildings)	17	18	18

[18] Emission Trading System, under European directive 2003/87/EC.

5 REFERENCES

[1] "Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast)".

[2] "Belgian Energy Efficiency Action Plan according to the Directives 2006/32/EC and 2012/27/EU article 24.2 Annex XIV part 2, April 2014, https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-pl".

[3] "Notification of the indicative national energy efficiency target 2020 for Belgium According to the requirements of the Energy Efficiency Directive 2012/27/EU (http://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/)," 2013.

[4] "Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC".

[5] "Notification of the alternative approach to EE Obligation Scheme for Belgium according to the requirements of the Energy Efficiency Directive 2012/27/EU Article 7.9 and Annex V".

[6] "Regulation (EC) No 443/2009 of 23 April 2009 setting emission performance standards for new passenger cars as part of the".

[7] European Environment Agency, "Monitoring CO2 emissions from new passenger cars in the EU: summary data for 2013," 2014.

[8] European Commission, "Reducing CO2 emissions from passenger cars - Monitoring of CO2 emissions - Decision 1753/2000 (repealed) and Regulation EC 443/2009 - http://ec.europa.eu/clima/policies/transport/vehicles/cars/documentation_en.htm".

[9] "Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC".

[10] ODYSSEE-MURE project, "Definition of the energy efficiency index ODEX (www.odyssee-indicators.org)".

[11] D. Bosseboeuf, “Measuring energy efficiency progress in the EU: the energy efficiency index ODEX, presentation at ECEEE Summer Study 2005”.

[12] ICEDD, “Bilan énergétique de la Wallonie 2012 - Bilan de l'industrie et bilan global,” 2014.

[13] VITO, ICEDD, Statistics Belgium, “Energy Consumption Survey for Belgian households, study accomplished under the authority of EUROSTAT, FPS Economy, VEA, SPW, Brussels Environment,” 2012.

6 ANNEXES

ANNEX 1: 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 energy 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.

ANNEX 2: LIST OF BELGIAN POLICY MEASURES IN MURE

In the list below, the measures are ranked by sector and by starting year.

Code	Title	Type	Starting Year	Ending Year	NEEAP Measure	EU-related Measure	Quantitative Evaluation
HOU-BEL32	Brussels - Labelling and certification for sustainable buildings (household sector)	Information/Education			Yes	No	No
HOU-BEL19	K-level thermal regulations of residential buildings (in use prior to the EPB directive)	Legislative/Normative	1985	2009	Yes	No	No
HOU-BEL23	Brussels - Assist households proactively with regard to energy and eco-construction to improve the quality and energy comfort of their residence	Information/Education	1996		Yes	No	YES
HOU-BEL15	EU-related: Performance of Heat Generators for Space Heating/Hot Water (Directive 92/42/EEC) - Federal government - Minimum efficiency requirements for new central heating boilers (household sector)	Legislative/Informative, Legislative/Normative	1998		No	YES	No
HOU-BEL16	EU-related: Energy Labelling of Household Appliances (Directive 92/75/EC) - Federal Government - Labels on electrical household appliances	Legislative/Informative	1998		Yes	YES	No
HOU-BEL13	Federal government - Reduced VAT for renovation of old buildings	Fiscal/Tariffs	2000		No	No	No
HOU-BEL31	Brussels - Act structurally on the supply by stimulating the sustainable building sector (household sector)	Information/Education	2000		Yes	No	No
HOU-BEL34	Wallonia - Training and information on rational use of energy (household sector)	Information/Education	2002		Yes	No	No
HOU-BEL1	Federal government - Tax deduction for energy saving measures in residential buildings	Fiscal/Tariffs	2003		Yes	No	No
HOU-BEL10	Brussels - Energy grant for households	Financial	2003		Yes	No	YES

Code	Title	Type	Starting Year	Ending Year	NEEAP Measure	EU-related Measure	Quantitative Evaluation
HOU-BEL30	Wallonia - Financial incentives for RUE investments in buildings	Financial	2005		Yes	No	YES
HOU-BEL29	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Flanders - Insulation and energy performance regulation for buildings	Legislative/Informative, Legislative/Normative	2006		Yes	YES	YES
HOU-BEL35	Wallonia - Public service obligation - gas and electricity invoices (household sector)	Unknown	2006		Yes	No	No
HOU-BEL22	Federal Government - Fund for the Reduction of the overall Energy Costs (FRCE) in residential buildings	Financial	2007	2014	Yes	No	No
HOU-BEL26	Brussels - Develop and promote exemplary buildings - BATEX (with virtually zero consumption and of high environmental quality)	Financial	2007		Yes	No	YES
HOU-BEL36	Brussels - Alternative financing of sustainable building renovation (social green loan, third party investor, FRCE) (household sector)	Financial	2007		Yes	No	No
HOU-BEL8	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Wallonia - Thermal regulation for buildings	Legislative/Normative	2008		Yes	YES	YES
HOU-BEL25	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Brussels - Act structurally on the demand through progressive reinforcement of the requirements of the EPB regulations in the residential sector	Legislative/Informative, Legislative/Normative	2008		Yes	YES	YES
HOU-BEL24	Flanders - Reduction in property tax for energy-efficient new residential buildings	Fiscal/Tariffs	2009		Yes	No	YES
HOU-BEL38	EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Transposition of recast Ecodesign directive 2009/125/EC	Legislative/Normative	2010		Yes	YES	No

* This measure was transferred to the regions from January 2015.

Code	Title	Type	Starting Year	Ending Year	NEEAP Measure	EU-related Measure	Quantitative Evaluation
TER-BEL24	Brussels - Labelling and certification for sustainable buildings (tertiary sector)	Information/Education/Training			Yes	No	No
TER-BEL1	Federal government - K-level thermal regulation of tertiary buildings in Belgium (in use prior to the EPB directive)	Legislative/Normative	1986	2009	No	No	No
TER-BEL5	Federal government - Minimum efficiency requirements for new central heating boilers (tertiary sector)	Legislative/Normative	1997		No	No	No
TER-BEL4	EU-related: Energy Labelling Office Equipment (Energy Star) - Federal government - Energy Star label for office equipment	Information/Education/Training	1999		No	YES	No
TER-BEL23	Brussels - Act structurally on the supply by stimulating the sustainable building sector (tertiary sector)	Information/Education/Training	2000		Yes	No	No
TER-BEL25	Wallonia - Training and information on rational use of energy (tertiary sector)	Information/Education/Training	2000		Yes	No	No
TER-BEL13	Flanders - Subsidies for energy saving measures in horticulture (cultivation under glass)	Financial	2001		Yes	No	YES
TER-BEL17	Wallonia - Subsidies for RUE investments in Public Buildings	Financial	2004		Yes	No	YES
TER-BEL21	Brussels - Energy grant for tertiary sector	Financial	2004		Yes	No	YES
TER-BEL18	Wallonia - Public lighting (including EPURE) + traffic lights	Financial	2005		Yes	No	YES

Code	Title	Type	Starting Year	Ending Year	NEEAP Measure	EU-related Measure	Quantitative Evaluation
TER-BEL14	Brussels - Impose a plan for reduction of energy consumption on major consumers ("PLAGE": Local Action Plan for Energy Management)	Legislative/Informative	2006		Yes	No	YES
TER-BEL26	Wallonia - Public service obligation - gas and electricity invoices (tertiary sector)	Information/Education/Training	2006		Yes	No	No
TER-BEL28	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Flanders - Insulation and energy performance regulation for tertiary buildings	Legislative/Informative, Legislative/Normative	2006		Yes	YES	YES
TER-BEL8	Wallonia - Information on rational use of energy in public buildings	Financial, Information/Education/Training	2007		Yes	No	No
TER-BEL16	Brussels - Develop and promote exemplary buildings - BATEX (with virtually zero consumption and of high environmental quality) in the tertiary sector	Financial, Information/Education/Training	2007		Yes	No	YES
TER-BEL22	Brussels - Alternative financing of sustainable building renovation (social green loan, third party investor, FRCE) (tertiary sector)	Financial	2007		Yes	No	No
TER-BEL7	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Brussels - Act structurally on the demand through progressive reinforcement of the requirements of the EPB regulations in the tertiary sector	Legislative/Informative, Legislative/Normative	2008		Yes	YES	YES
TER-BEL20	EU-related: Energy Performance of Buildings (Directive 2002/91/EC) - Wallonia - Thermal regulation for tertiary buildings	Legislative/Informative, Legislative/Normative	2008		Yes	YES	YES
TER-BEL19	Flanders - Reduction in property tax for energy-efficient new tertiary buildings	Fiscal/Tariffs	2009		Yes	No	YES
TER-BEL29	EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Transposition of Recast Ecodesign Directive 2009/32/EC	Legislative/Normative	2011		Yes	YES	No

Code	Title	Type	Starting Year	Ending Year	NEEAP Measure	EU-related Measure	Quantitative Evaluation
TER-BEL15	Brussels - Make performance of an energy audit mandatory for any building of more than 3500 m² not allocated to housing upon renewal of its environmental permit	Legislative/Informative	2012		Yes	No	YES

Code	Title	Type	Starting Year	Ending Year	NEEAP Measure	EU-related Measure	Quantitative Evaluation
IND-BEL9	Federal Government - Tax deduction for energy saving investments by companies	Fiscal/Tariffs	1993		Yes	No	No
IND-BEL22	Flanders - Voluntary agreements in energy intensive industry	Co-operative Measures	2003	2020	Yes	No	No
IND-BEL4	Flanders - Energy efficiency criteria in environmental permits	Legislative/Informative	2004		No	No	No
IND-BEL21	Wallonia - Voluntary agreements with industry	Co-operative Measures	2004	2020	Yes	No	No
IND-BEL23	Wallonia - Subsidies for energy saving investments in industry (excluding buildings)	Financial	2005	2015	Yes	No	YES

Code	Title	Type	Starting Year	Ending Year	NEEAP Measure	EU-related Measure	Quantitative Evaluation
TRA-BEL18	Federal Government - Modulation of the road and circulation taxes	Fiscal	2001		No	No	No
TRA-BEL9	Federal Government - Modification of the starting circulation tax	Fiscal	2002	2005	No	No	No
TRA-BEL20	Flanders - Mobility management measures and measures that bring about a shift in the choice of transport		2003	2012	Yes	No	YES
TRA-BEL12	Brussels - Measures in the transport sector (IRIS II Mobility Plan, COBRACE code, etc.)	Financial, Infrastructure, Legislative/Informative, SocialPlanning/Organisational	2004		Yes	No	YES
TRA-BEL17	Federal Government - Improvement of multimodal transport systems	Infrastructure	2005		No	No	No
TRA-BEL4	Wallonia - Saving measures for transport in the public sector	Infrastructure	2008		Yes	No	YES
TRA-BEL19	Wallonia - Financial incentives or funding devoted to transport	Co-operative Measures , Financial, Fiscal, Infrastructure	2008		Yes	No	YES

Code	Title	Type	Starting Year	Ending Year	NEEAP Measure	EU-related Measure	Quantitative Evaluation
GEN-BEL11	Federal Government - Minimum efficiency requirements for new central-heating boilers on liquid fuels gas with a capacity>400 kW	Non-classified Measure Types	1997		No	No	No
GEN-BEL9	Flanders - Promotion of photovoltacc solar panels via green certificates, preceded by subsidies	Financial Measures, Legislative/Normative Measures, Market-based Instruments	1998	2020	Yes	No	YES
GEN-BEL14	Flanders - Imposing RUE-public service obligations on the electricity distribution network operators	Financial Measures, Legislative/Normative Measures	2003		Yes	No	YES
GEN-BEL4	Wallonia - Green Certificates for renewable electricity and high yield cogeneration	Market-based Instruments	2004		Yes	No	YES
GEN-BEL6	Wallonia - Subsidies for cogeneration	Financial Measures	2004		Yes	No	YES
GEN-BEL7	Wallonia - Subsidies for the cogeneration in the public sector	Financial Measures	2005		Yes	No	No
GEN-BEL8	Flanders - Promotion of qualitative cogeneration via cogeneration certificates	Legislative/Normative Measures, Market-based Instruments	2005		Yes	No	YES