Belgian National Debate on Carbon Pricing

FINAL REPORT

June 2018

This document has been produced in collaboration with Climact, PwC and SuMa Consulting

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CARBON PRICING:

GRADUALLY CORRECTING PRICES TO SUPPORT THE LOW CARBON TRANSITION

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EXECUTIVE SUMMARY

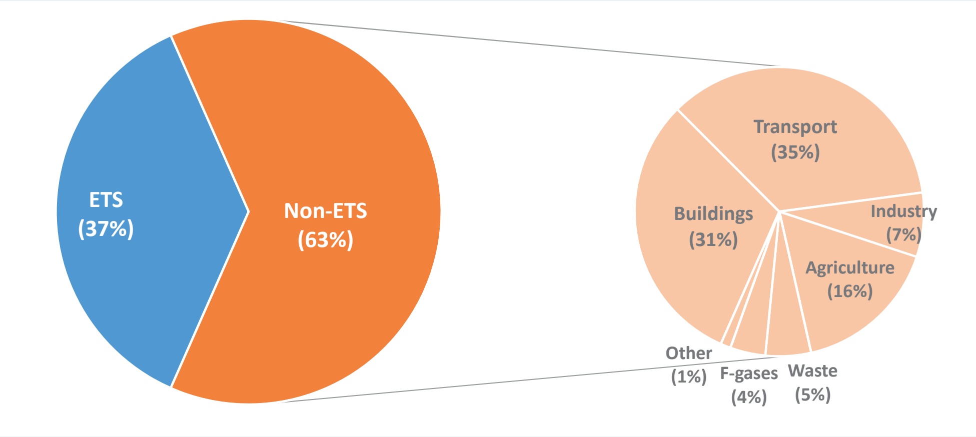
1 Context

In 2015, by adopting the Paris Agreement, its signatories committed to holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. In order to meet this ambition, urgent action is needed to significantly reduce, and ultimately phase out, greenhouse gas emissions. In line with this commitment, the European Union (EU) and Belgium, as a member state of the EU, have committed to reducing their emissions of greenhouse gases (GHG) by at least 80 to 95% by 2050 with respect to 1990. In this context, the EU has already developed a framework to reach 2030 medium-term objectives through the EU Emission Trading System (EU ETS) and the EU Effort Sharing Regulation, that are part of the broader Energy Union strategy. Under this EU framework, Belgium is to develop and implement an integrated national energy and climate plan, as well as a Long-term Low Emission Strategy (LTLES) to guide its transition towards a low carbon society.

Such a transition requires the implementation of a series of coordinated policies and measures at different levels. Previous analyses[1] have shown that, if the appropriate policies are implemented, the low carbon transition can stimulate economic activity, create jobs and contribute to grasping other benefits such as energy security and reduced air pollution.

The pricing of carbon is a measure that is currently being developed and adopted by an increasing number of countries around the world. EU Member States have been at the forefront in this respect, with, next to the EU ETS in 2005, pioneering countries such as Denmark and Sweden having implemented carbon taxes in the early nineties, while other countries introduced such a tax more recently, such as Ireland in 2010 and France in 2014. Outside of the EU, the adoption of carbon pricing initiatives has been accelerating as well, with interesting cases in amongst others China, Canada (British Columbia), New Zealand, Chile and South Africa.

Figure ES.1: 2016 emissions in Belgium – Share of ETS vs non-ETS sectors in total emissions and share of the different non-ETS sectors in total non-ETS emissions



Sources: NIR 2018 and MMR2018

[1] See for instance Berger, L., F. Bossier, Th. Bréchet, Th. Lemercier and J. Pestiaux (2016), *Macroeconomic impacts of the low carbon transition in Belgium*, Final Report, Study performed for the Federal Public Service Health, Food Chain Safety and Environment. Available at www.climatechange.be/2050.

In Belgium, only 37% of GHG emissions are priced via the EU ETS. The remaining 63% of emissions, representing about 74 $MtCO_2e$, are not subject to any explicit carbon price. Figure 1 illustrates the main sources of these non-ETS GHG emissions. The transport and the buildings sectors represent respectively 35% and 31% of total non-ETS emissions and together accounted for 49,4 $MtCO_2e$ in 2016. The remaining 34% of GHG emissions stems from the non-ETS industrial sector (7%), the agricultural sector (16%), the waste sector (5%) and from products used as substitutes for ozone depleting substances, leading to the emission of fluorinated gases (4%).

In order to analyse the potential modalities for implementing a carbon price in the Belgian non-ETS sectors, the Belgian federal Minister of Energy, Sustainable Development and Environment launched a national debate on this topic in January 2017. This report presents the results of this dialogue. The process was based on a thorough exchange among Belgian and foreign experts covering the public, private, academic, associative and trade unions' sectors. The approach was fact-based, fed by numerous analyses including benchmarking analyses, and was organized around a series of high-level events, technical workshops and bilateral meetings. The performed analyses and the identified options for the implementation of a carbon price outlined in the present report are based on the views and the expertise gathered on these occasions.[2]

2 Transversal issues

On the basis of the literature and of experiences from abroad, **three overall principles** have been identified that serve as a common framework for guiding carbon pricing implementation modalities.

- The **first principle** is **budget neutrality** which is perceived by all consulted actors as a key success factor for the concrete implementation of carbon pricing. Although budget neutrality can be understood in different ways, there is a common understanding that any revenues should not simply feed the public budget, but should rather lead to a corresponding amount of reduced taxation and/or transfers[3] to actors. These aspects are further developed below when the different possible uses of carbon pricing revenues are outlined.
- The **second principle** is the **long-term orientation of carbon pricing**, which should be taken into account from the outset. Indeed, the purpose of implementing a carbon price is not to penalize and impose a burden on actors in the short-term, but to set a credible price signal over time to progressively orient the decisions of citizens, companies and institutions towards low carbon behaviours and investments.
- **Finally,** although carbon pricing is a powerful instrument, it should be clear that it will, as such, not suffice on itself. Several barriers, including information failures and principal agent problems, influence the behavioral and technological choices of economic agents, as does the inherited physical and institutional infrastructure in which societal actors interact. Any successful pricing of carbon emissions therefore requires the **concomitant implementation of a broad package of specific measures**, at different levels.

Four key implementation issues that define the main modalities of implementation of any carbon price have then been identified: (i) the scope of carbon pricing, (ii) its price level and trajectory, (iii) the use of the collected public revenues and (iv) the alignment of this policy measure with other existing, forthcoming or yet to be defined policies.

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[2] The authors wish to thank all participants to the national debate for their contributions and the rich discussions that took place. The content of the report is, however, of the sole responsibility of the authors.

[3] The notion of budget neutrality could be extended beyond the definition retained here, namely the explicit allocation of revenues from carbon pricing to specific purposes. It could encompass, for instance, all related changes in energy taxation in general (which would include a loss in revenues from excise duties for instance) or be even broader and include all indirect and potentially positive, macroeconomic effects on economic activity and thereby on public revenues.

In terms of **scope**, an analysis of experiences abroad shows that almost all countries having implemented a carbon tax have chosen to apply it to the buildings and the transport sectors. Non-ETS industrial sectors are also covered most of the time, although sometimes with reduced rates or exemptions. In the agriculture sector, CO_2 emissions are often subject to the tax while non-CO_2 emissions are never covered. Finally, a number of countries implement a tax on fluorinated gases.

Regarding the **price trajectory**, most countries with a carbon tax have opted for gradually increasing prices. Moreover, countries having recently adopted such a tax, such as Switzerland or France for instance, have set a price trajectory in advance. Such an approach has the advantage of smoothly implementing the scheme while providing actors with clear expectations on the strength of the price signal in the mid-term, thereby already re-orienting their investment decisions.

Table 1 below illustrates three options for the level of a carbon price to be implemented in the non-ETS sectors in Belgium. A price of 10 €/tCO_2e would be set in 2020 and this price would (in real terms) rise in 2030 to between 40 €/tCO_2e (option A), namely the currently expected carbon price in the EU ETS sector, and 100 €/tCO_2e (option C), a level close to the price observed in the most ambitious countries such as France or Sweden, which also corresponds to the high end of the carbon price range recommended by the High-Level Commission on Carbon Prices (Stiglitz and Stern, 2017)[4]. An intermediate level, 70 €/tCO_2e (option B), has been selected and is used to perform most impact analyses. It is supposed that the carbon prices follow a linear trajectory, towards 100, 190 and 280 €/tCO_2e by 2050 for Options A, B and C, respectively. As shown in Table 1, the impact of such carbon prices on final fossil fuel prices are in the order of 2 to 4% in 2020 and between 11 and 26% in 2030 under option B.

Table ES.1: Options for carbon price trajectories (2020 and 2030) and illustration of their impact on fossil fuel final prices

Carbon price		Impact of carbon price							
		Diesel 2,71 kgCO_2e/l 1,4 €/l		Petrol 2,24 kgCO_2e/l 1,4 €/l		Heating oil 2,63 kgCO_2e/l 0,7 €/l		Heating gas 0,202 kgCO_2e/kWh 0,06 €/kWh	
	€/tCO_2e	€/l	%	€/l	%	€/l	%	€/kWh	%
2020	10	0,03	2%	0,02	2%	0,03	4%	0,00	3%
2030 - Option A	40	0,11	8%	0,09	6%	0,11	15%	0,01	13%
2030 - Option B	70	0,19	14%	0,16	11%	0,18	26%	0,01	24%
2030 - Option C	100	0,27	19%	0,22	16%	0,26	38%	0,02	34%

Sources: Emissions factors: IPCC; Weekly oil bulletin; Own calculations

The total level of **revenues from pricing carbon** in the non-ETS sectors will depend on the exact scope of the instrument and on its price trajectory. The maximum[5] total revenues under price trajectory B amount to 607 M€ in 2020 and 2599 M€ in 2030.

Potential uses of these revenues aligned with the principle of budget neutrality include:

1. **overall tax shifts;**
2. **direct redistribution or compensation;**
3. **support of the transition in specific domains.**

The last two potential uses are rather sector-specific and are further detailed below. Regarding a potential **tax shift**, experiences abroad and discussions with experts have led to the definition of two main options.

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4 Stiglitz, J. and N. Stern (2017), Report of the High-Level Commission on Carbon Prices, Carbon Pricing Leadership Coalition, The World Bank, 29 May. Available at www.carbonpricingleadership.org.

5 Assuming that agricultural non-CO_2 emissions and emissions of fluorinated gases are not priced and assuming that all emissions from the non-ETS industry are priced and generate revenues. When only the buildings and the transport sectors are accounted for, total revenues amount to 519 M€ in 2020 and 2085 M€ in 2030.

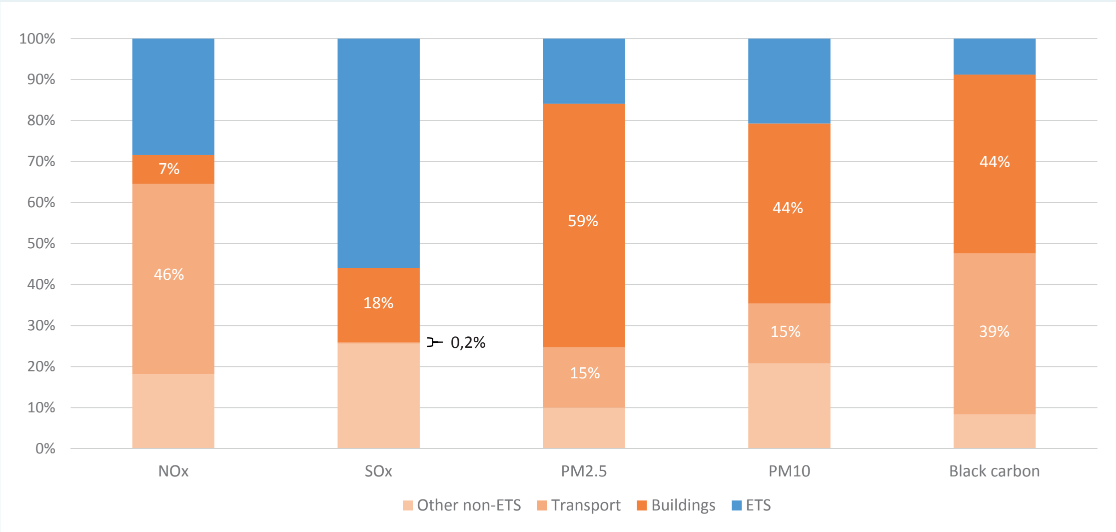
The first option is to use (part of) carbon pricing revenues to reduce **taxes on labour** such as social security contributions. Modelling exercises have quantified the positive impact of such a shift on employment and growth (see Berger et al., 2016). Still, uncertainties remain on the exact extent of the effect of this shift.

The second option is the **reduction of charges and levies on electricity**. While fossil fuel prices are generally lower, electricity prices in Belgium are higher than those observed in neighbouring countries, meaning that the fossil fuel-electricity prices spread is higher and that the incentives to electrify might be lower. Given the amount of expected revenues generated by the carbon price, any impact on final electricity prices is nevertheless expected to be relatively moderate.

It should not be forgotten that the low carbon transition necessarily involves a loss of public revenues from excise duties on fossil fuels[6]. Even though this is not directly linked to carbon pricing itself, the progressive reduction of such revenues will have to be accounted for in the mid/long-term together with the required evolution of the overall fiscal system and with the potentially positive impact on public finances of the macroeconomic stimulus generated by the transition.

Finally, any carbon pricing policy must be carefully aligned with a multitude of other policies and objectives at different levels, in particular environmentally harmful subsidies. By reducing the use of fossil fuels, the implementation of a carbon price could also generate other co-benefits related to the low-carbon transition, such as an improvement of our energy security and air quality. Figure 2, for example, shows that non-ETS sectors, in particular the buildings and the transport sectors, are by far responsible for the largest share of most air pollutants.

Figure ES.2: Source of emissions of air pollutants in Belgium, 2015



Source: NEC 2017

3 Buildings

Analyses show that current taxes on heating fossil fuels are relatively low and that the major concern of setting a carbon price in this sector is the potentially negative impact on vulnerable households. Discussions held during the debate allowed to identify clear options that could overcome this concern and that could be implemented in the short-term.

6 In 2017, total revenues from excise duties on energy amounted to about 6 billion €, i.e. about 2,5% of general government revenues in Belgium.

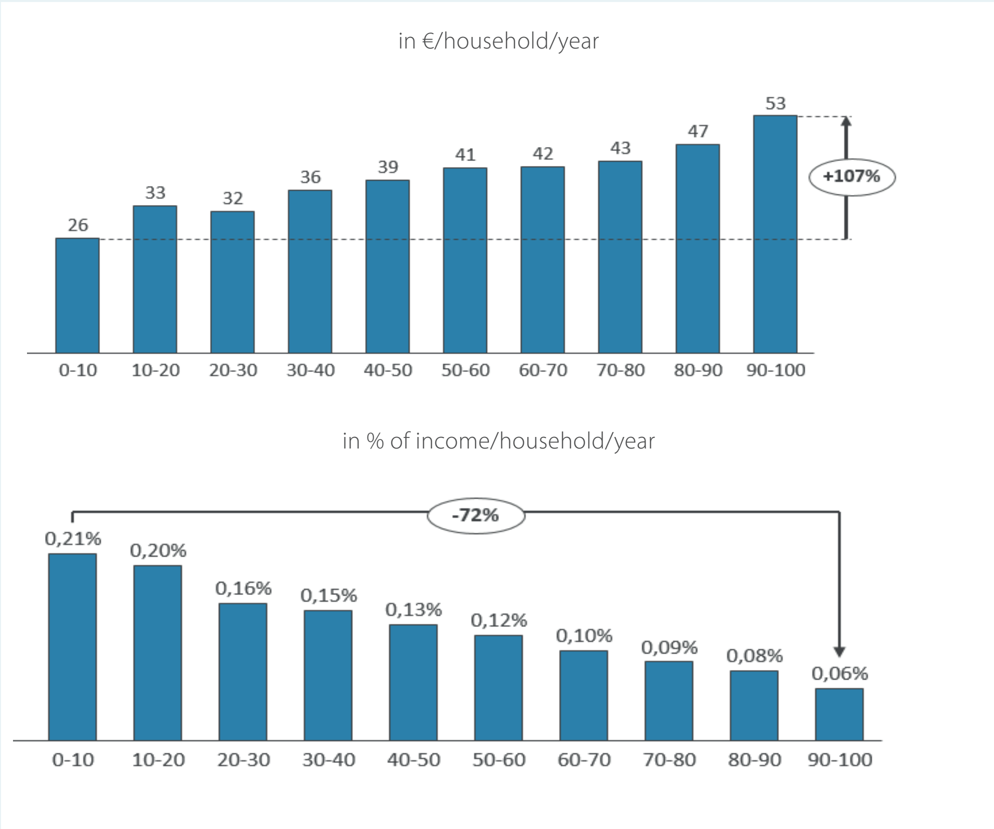
Context

GHG emissions in the buildings sector represented 31% of total Belgian non-ETS emissions in 2016. The buildings stock in Belgium is old as a large part of it has been built before the implementation of energy norms. Moreover, one third of the residential buildings is not occupied by their owner(s), which may hinder or slow down low carbon investments in those buildings. In terms of energy prices, Belgium has lower prices for both heating oil and natural gas than its neighbouring countries, by an amount corresponding to 59 €/tCO_2 (heating oil) and 44 €/tCO_2 (gas) w.r.t. the four neighbours (France, The Netherlands, Luxemburg and Germany), and to 117 €/tCO_2 (heating oil) and 90 €/tCO_2 (gas) w.r.t. the two main neighbours (France and The Netherlands).

Impacts and implementation modalities

In terms of scope, the option consists in introducing a carbon price in the form of an additional component of excise duties on all fossil fuels. Biomass would be excluded for practical reasons and would have to be dealt with through specific policies, including those aiming at controlling air pollution. Policy alignment on this matter is essential as biomass is the largest contributor to air pollution in this sector.

Figure ES.3: Average carbon contribution for heating by decile of income with a 10€/tCO_2 carbon price



Sources: Households budget survey, 2016; own calculations

The expected impact of the carbon price trajectory under option B corresponds to an **average annual carbon contribution of 32€ per household in 2020**, i.e. about 2% of the total energy bill. By 2030, the carbon contribution would increase up to 127€ per household. However, at the same time, the reduction of the energy demand following the introduction of the carbon price and the accompanying set of policies and measures would lead to a significant fall of the average energy bill (carbon contribution included), by about 10% w.r.t. its level in 2020. By 2050, the carbon contribution would amount to 51€ per household and the energy bill would be reduced by 47% w.r.t. its level in 2020.

Importantly, these average impacts potentially mask very different realities. First, an analysis of the impact of a carbon price of 10€/tCO_2e per income decile shows that, although absolute carbon contributions are significantly larger for higher incomes than for lower ones, these are much larger for lower income households when expressed as a percentage of their income (see Figure 3)[7]. In other words, without compensation measures the scheme is potentially regressive. Second, further analyses show that energy poverty is multi-faceted and that heterogeneity within income classes is significant. Carbon pricing revenues might then play a role in dealing with such concerns.

In terms of **revenues**, 159 M€ and 668 M€ would be collected on residential buildings in the years 2020 and 2030, and 60 M€ and 270 M€ would be collected on non-residential buildings in the years 2020 and 2030, under the assumption that the carbon price is fully implemented following price trajectory B.

The first option for the use of (part of the) revenues from pricing carbon emissions in the buildings sector aims precisely at dealing with such distributive issues. It consists in organizing a **lump-sum transfer to people at risk of energy poverty together with the financing of policies targeting those households**. The lump-sum transfer could take the form of energy vouchers that could be used for the payment of the energy bill as well as of low carbon investments (cf. France). They could potentially be linked to, reinforce and progressively replace current social tariffs and related measures. Next to these transfers, targeted policies would have to be developed at regional or local levels. The development and the actual implementation of these transfers and policies appear to be critical elements for pricing buildings' carbon emissions.

The second option consists in **fostering the transition** in three possible, different forms:

1. lump-sum transfers to every citizen (cf. Switzerland);
2. renovation programmes for households (cf. Ireland);
3. specific policies to support SMEs.

The low carbon transition is expected to lead to a drastic reduction of the energy bill even when carbon emissions are priced. However, to capture these gains, investments need to be made in building retrofitting and environmentally friendly heating technologies, mainly heat pumps. Our analyses show that, although the profitability of such investments is specific to each building and situation (e.g. whether a renovation is made only for energy savings motives or for other reasons), **the introduction of a carbon price significantly weighs on the profitability of the low carbon alternatives** and thereby fosters their implementation. Carbon pricing could therefore be an essential instrument **to support the different renovation strategies** and related policies currently under development at regional level.

4 Transport

Analyses show that, except for non-professional diesel, taxes on fuels are slightly lower than in the neighbouring countries, except Luxembourg. The main issue related to pricing carbon emissions in the transport sector is the potential impact on the competitiveness of the freight road transport sector. As was the case in the buildings sector, discussions held during the debate allowed to identify clear options to deal with such a concern that could be implemented in the short-term.

Context

GHG emissions in the transport sector represented 35% of total Belgian non-ETS emissions in 2016, with 20% for cars, and 14% for light and heavy-duty vehicles and buses. There are limited reduced excise rates or exemptions on motor fuels used for road passenger transport in Belgium and its neighbouring countries. Regarding road freight transport, a reimbursement scheme for 'professional' diesel is in place in Belgium. When these reimbursement schemes are taken into account, final prices in Belgium (incl. VAT) are lower than in its neighbouring countries (with the exception of Luxembourg). The difference with the average in

[7] The average carbon contribution is slightly larger here than the 32 € evaluated by 2020 (cf. above) due to a.o. changes in energy consumption levels between 2014 and 2020.

the four and in two (the Netherlands and France) neighbouring countries corresponds to a price of around 19 €/tCO_2e and 36 €/tCO_2e, respectively.

Regarding non-professional diesel, given the alignment of excise duties on diesel and petrol in Belgium, final prices tend to be higher than in its neighbouring countries. Implementing a carbon price in Belgium of 10 €/tCO_2e above the current excise duty rates would rise the differential by about 2 percentage points. Regarding petrol, final prices in Belgium (incl. VAT) are lower than in its neighbouring countries (with the exception of Luxembourg). The difference with the average in the four and in two (the Netherlands and France) neighbouring countries corresponds to a price of around 10 €/tCO_2e and 54 €/tCO_2e, respectively.

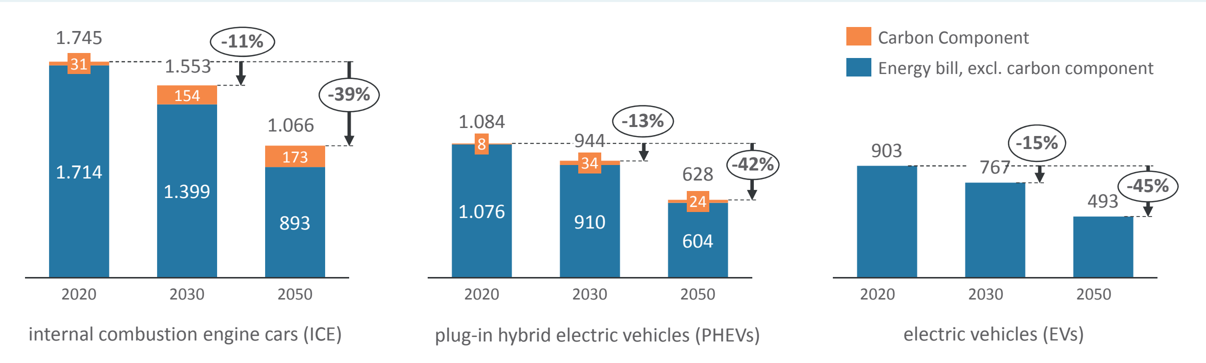
Impacts and implementation modalities

In this sector, **the suggested carbon price would cover the GHG emissions of all fossil fuels** (petrol, diesel and gas). The biomass component of fuels would be subject to the carbon price with, for instance, an emission factor equivalent to the corresponding fossil fuel (cf. France).

Two implementation options have emerged from the discussions and analyses:

- **Option 1: Implementation of the carbon price as an additional component to excise duties**. While the carbon price would apply to all vehicles indistinctively, freight transport would benefit from a specific treatment in order to address potential competitiveness concerns. For these actors, the actual carbon contribution would be limited to such a level that the final price of diesel (with reimbursement) roughly equals the price in the neighbouring countries. This can be done by increasing the current reimbursement of excise duties from which they benefit by the corresponding share of the carbon price. In order to maintain the price signal, that share could then potentially be introduced through the existing road pricing for heavy-duty vehicles by means of an approximation of the fuel consumption per type of truck. Under the same option, a variant could consist in applying the initial carbon price level (10 €/tCO_2e in 2020) within current taxation levels (cf. France).
- **Option 2: Implementation of the carbon price through a road pricing system instead of a component of excise duties.** For this option to be effective, the road pricing system would need to be smart and applicable to all vehicles and roads in Belgium. As the implementation of such a system in the three regions may require some time, it could be envisaged to start with the first option and possibly move thereafter to the second one.

Figure ES.4: Evolution of the average annual energy bill for passenger transport, by type of vehicle in the low-carbon scenario with Option B (in €/vehicle/year)



Source: Own calculations

In terms of impacts for road passenger transport, the **carbon contribution will differ according to the type of car**. As illustrated in Figure 4, the average annual carbon payment per car powered by an internal combustion engine (ICE) would amount to about 31€ by 2020, 154€ by 2030 and 173€ by 2050. However, due to improvements in technology, the energy bill related to these same vehicles would at the same time be reduced by more than 10% in 2030 and about 40% in 2050 w.r.t. 2020. For freight transport, carbon pricing would increase fuel cost payments, the second most important category of expenditures after labour costs. It would also increase load factors.

Analyses show that pricing carbon also positively and significantly impacts the profitability of electric cars with respect to ICE cars, in particular small and mid-size electric cars. Sensitivity analyses show that this result is robust to changes in energy prices.

In terms of **revenues**, 173 M€ and 591 M€ would be collected on passenger transport in the years 2020 and 2030, and 116 M€ and 556 M€ would be collected on freight transport in the years 2020 and 2030 under the assumption that the carbon price is fully implemented following trajectory B.

Besides general tax shifts away from labour and electricity, the proceeds collected from passenger transport could be redistributed through lump-sum transfers to households, used for infrastructure investments or used to promote low carbon modes that include electric mobility (e.g. charging network), public transport and active modes of transport. As for the share of revenues collected from pricing freight transport emissions, it could be used to cover investments in infrastructure, including active modes of transportation and multi-modality, or to finance a fund dedicated to technological innovation and deployment of all modes of freight transport.

Finally, **any pricing of transport emissions must be aligned** with a series of other policies and measures. A first incoherent policy is the favorable fiscal treatment of company cars and of other fossil fuel subsidies. A second point of attention is the implementation of air pollution policies for which synergies are obvious, not only regarding combustion emissions, but also particulates from tires and breaks in the transport sector. Finally, other fiscal policies might need to be reformed, in particular with regard to the support of low carbon alternatives.

5 Other sectors

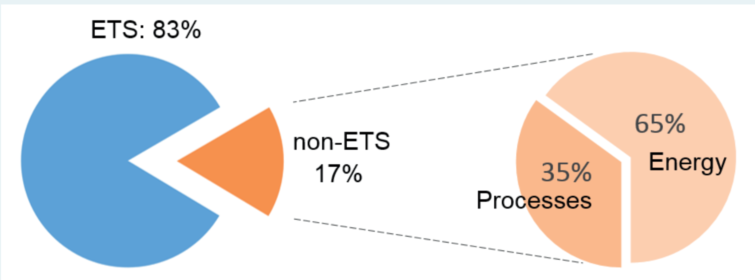
In each of the other sectors, namely non-ETS industries, agriculture, waste and fluorinated gases, carbon pricing implementation modalities need to account for the large heterogeneity within the sources of GHG emissions. In many of these sectors, a major point of attention is the potentially negative impact of a carbon price on competitiveness. Here again, implementation modalities, including an exemption from the carbon payment, reduced rates or specific compensation measures, allow to account for such concerns.

Industry

Context

The main sectors generating GHG emissions in the non-ETS industry are chemicals, food and drinks, textile, off-road emissions from industry and construction, manufacture of wood (products), glass, ceramics, cement, lime, plaster, etc. Non-ETS industry emissions amounted to 17% of total industry emissions, representing around 5,4 $MtCO_2e$ in 2016, as illustrated in Figure 5. 65% of those emissions stem from fuel combustion, 35% from processes. It is also observed that non-ETS industry relies more heavily on electricity than the ETS industry, in a context where electricity prices are mostly higher in Belgium than in the neighbouring countries, while gas prices are lower.

Figure ES.5: GHG emissions in industrials sectors in Belgium



Source: NIR 2018

Industry has already taken and continues to take action to reduce its fossil fuel consumption. For instance, in the sectors participating in voluntary agreements, the GHG emission intensity was reduced by 14,8% in the Walloon Region (excl. emissions from electricity production) and 10,4% in the Flemish Region (including emissions from electricity) during the period 2005-2015 and 2002-2014, respectively. Still, further emission reduction possibilities have been identified, in particular regarding the electrification of heating processes.

Impacts and implementation modalities

For implementing a carbon price in the non-ETS industries, two main options have been identified that take into account potential competitiveness concerns.

The first main option involves the gradual pricing of all fossil fuel emissions from combustion according to the retained carbon price trajectory (A, B or C), **except for the sectors at risk of carbon leakage**, for which the price would be capped at a level corresponding to the current fossil fuel (mainly gas) price gap (all taxes and levies included) with the neighbouring countries[8]. Regarding process emissions, special treatment (e.g. based on ETS practices and involving benchmarks) is likely to be required given the specific levers needed to reduce them. In order to be able to implement this option, further work needs to be undertaken for identifying the non-ETS sectors at risk of carbon leakage, for setting and periodically revising the price cap, and for dealing with specific features of process emissions. Two possible variants for the price level could be envisaged here:

1. using the ETS price (i.e. an average of past prices, to be regularly reviewed) instead of using one of the three proposed carbon price trajectories A, B or C to ensure consistency between the prices applied to ETS and non-ETS industries, or
2. implementing the first component of the carbon price trajectory (i.e. 10 €/tCO_2e in 2020) within the current taxation level for all sectors (at risk or not at risk of carbon leakage), after which the trajectory would apply.

The second main option would consist of reforming the existing regional systems of voluntary agreements to include an explicit carbon price in the evaluation of the projects or investments to be made. If this option is chosen, companies not bound by these voluntary agreements would be subject to a carbon price implemented through an additional carbon component on energy taxes, while companies that do sign the new agreement would be exempted from such a contribution. However, under these new agreements, companies would be obliged to implement a 'shadow carbon price' in the evaluation of all their projects or investments.

This would implicitly favour low-carbon investments without involving the collection of any levy. Such a reform would obviously require a revision of a series of parameters for the determination of the degree of profitability of the investments at stake. Here as well, a possible variant for the price level could be to use the ETS price (forecasted prices in this case, that would also have to be regularly reviewed) when setting the price trajectory, instead of using one of the three proposed carbon price trajectories A, B or C.

Regarding the **potential public revenues** generated by a carbon price implemented in the non-ETS industries, estimates greatly vary in function of the scope considered. Therefore, using a simplified assumption for the emissions trajectory up to 2050, maximum theoretical carbon revenues amounting to 55 M€ in 2020 and 286 M€ in 2030 have been estimated under the price trajectory B.

As to the **use of these revenues**, two possibilities have been identified:

- The first proposal entails to allocate part or all of these revenues to reduce either labour taxes or taxes and levies on electricity. However, for the impact on the final electricity price or on the labour costs to be perceptible for the non-ETS industries, revenues from other important emitting sectors would need to be allocated to such a tax shift.
- A second, potentially complementary possibility identified is to accompany industries, in particular the small and medium-size enterprises (SMEs), in the transition through the financing of accompanying measures, like for instance setting up a fund for innovation.

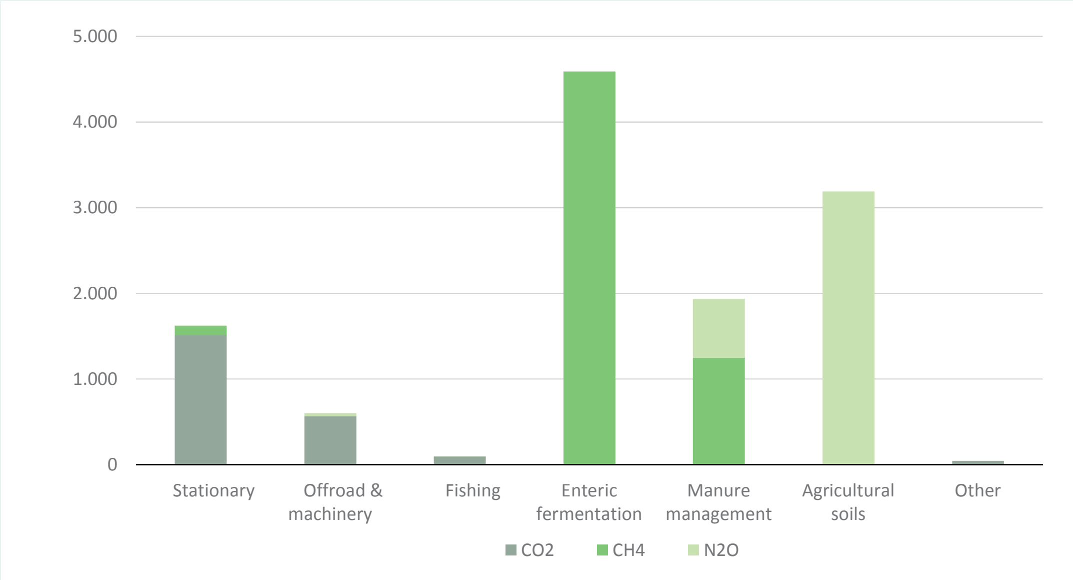
[8] And potentially other countries if relevant.

Agriculture

Context

In the agriculture sector, emissions from fuel combustion represented around 19% of this sector's GHG emissions in 2016, while the remaining emissions were generated by enteric fermentation, agricultural soils and manure management activities (see Figure 6). Even though the emission reduction potential in the agricultural sector is limited when compared to other sectors, several levers for reducing fuel combustion and non-CO_2 emissions have been identified. When considering and implementing climate policies, the Belgian agriculture's key characteristics should be taken into account, among others that it is an export-oriented sector, that the greenhouse crops sector has already made an important switch to natural gas with cogeneration and that the agriculture sector could have an important role to play in the context of reaching net-zero/negative emissions in the long term, through maintaining and even increasing carbon in soils.

Figure ES.6: 2016 GHG emissions in agriculture per type of gas (in ktCO_2e)



Source: NIR 2018

Impacts and implementation modalities

The main option identified for implementing a carbon price in this sector, is to **apply a carbon price** (with a price trajectory A, B or C) **to all energy-related fossil fuel emissions from non-stationary sources (offroad vehicles and machinery) through (increased) energy taxes**, given that these sources are currently mostly exempted from taxes on energy in Belgium, which is not the case in our neighbouring countries, with the exception of Luxembourg. As for energy-related fossil fuel emissions from **stationary sources, which mainly originate from greenhouses, an approach similar to the one proposed for the non-ETS industrial sectors** is suggested. Either a carbon price is implemented but capped at a level corresponding to the fossil fuel (gas) price gap with respect to neighbouring countries in case of a risk of carbon leakage, or voluntary agreements are signed that foresee the introduction of a carbon price in investment assessments.

Analyses also show that **putting a price on non-CO_2 emissions** (enteric fermentation, manure management and soils) **would currently not be appropriate**, mainly due to the difficulty to accurately measure those emissions at the source level. These emissions should therefore be addressed through specific policies, aimed at redirecting consumption patterns towards agricultural products with a low-carbon impact. However, despite these implementation barriers, the impacts and feasibility of putting a price on the non-CO_2 GHG content of agricultural products (at product market level) could meanwhile be analysed.

Estimated maximum carbon public revenues from the agriculture sector under the price trajectory B would amount to 23 M€ in 2020 and 122 M€ in 2030. Other than using these revenues for reducing labour or electricity taxes, the two options discussed in the context of this debate are the financing of specific programs supporting the transition of the agricultural sector, or a lump-sum transfer to farmers, for which a basis would need to be determined.

Waste

Context

Non-ETS GHG emissions stemming from the waste sector amounted to 3,8 $MtCO_2e$ in 2016 (representing 5% of total Belgian non-ETS emissions that year), of which around two thirds originate from waste incineration with recuperation of electricity and heat. The other main sources of emissions from the sector are solid waste disposal and waste water treatment and discharge.

The key lever for reducing emissions in the waste sector is reducing the amount of waste. Even though municipal waste per capita has decreased substantially in Belgium between 2007 and 2016, waste incineration per capita has remained stable during the same period. While emissions from waste disposal are projected to decrease considerably, emissions from waste incineration with production of electricity and heat are projected to remain significant, totalling around 2$MtCO_2e$/year in a mid-term horizon. Therefore, even if substitution possibilities at the level of waste treatment are limited, introducing a carbon price could contribute to reducing the amount of waste and increase recycling rates by internalizing the externality.

Impacts and implementation modalities

Non-energy related CO_2 emissions originating from the incineration of waste could thus be subject to a **carbon price integrated into the current environmental incineration taxes**. These taxes could be converted into carbon equivalent taxes, and if the carbon price trajectory is higher, the level of these taxes could be raised by the corresponding gap. The main advantage of such an option is that its administration is based on an existing system that fully integrates any cross-border shopping effects as the tax is applicable to all waste from Belgian origin. Regarding the other sources of GHG emissions from the waste sector, that are projected to decline significantly in a business-as-usual scenario, it could still be envisaged to price them in order to contribute to foster alternatives, including waste reduction. The carbon price could also here be potentially included into existing environmental taxes, provided that these taxes have been introduced with the purpose to reduce the amount of waste. Estimated maximum **public carbon revenues** from the waste sector amount to 30 M€ in 2020 and 159 M€ in 2030 under price trajectory B. Regarding the use of these revenues, other than using them for reducing labour or electricity taxes, envisaged options include devoting them to specific programs for the transition of the sector and/or to support measures promoting a circular economy.

Fluorinated gases

Context

Emissions of fluorinated gases currently represent around 2-3% of the global GHG emissions. Nevertheless, these emissions are rising rapidly worldwide and projections indicate they could reach up to 20% of global GHG emissions in 2050, if no measures are taken on fluorinated gases and the other GHG emissions are reduced or contained. In Belgium, total emissions of fluorinated gases from product uses as substitutes for Ozone Depleting Substances (ODS) almost reached 3 $MtCO_2e$ in 2016. The largest (weighted) share of fluorinated gases is used for air conditioning, refrigeration and heat pumps, followed by foam blowing agents, aerosols and fire extinguishers.

Legislation at international and EU levels has been adopted with the objective to progressively phase out fluorinated gases. The recent Kigali Amendment (KA) to the Montreal Protocol as well as specific EU legislation are the main drivers of the projected phase out in Belgium and should put the country on a path towards reaching its 2050 objectives. Consequently, prices of 'old' fluorinated gases tend to rise significantly. **The extent to which the implementation of a GHG price on fluorinated gases in Belgium**

is relevant must therefore be evaluated against these developments and account for the fact that Belgium imports fluorinated gases.

Implementation modalities

Any implementation of a carbon price in Belgium could benefit from the experience of several European countries that have implemented or are in the process of implementing a tax on fluorinated gases with diverse modalities. The price could be set at a level corresponding to the carbon price trajectory in the other sectors (with possibly reduced rates in function of e.g. the source of the substance). In terms of scope, **several options can be envisaged that would all require further investigation** before they can be implemented concretely. Based on experiences from abroad, a GHG price could be applied on imported gases in function of the source of the substance (virgin, recycled, reclaimed) and its application could be subject to the location of its use (Belgium, other EU Member State, non-EU Member State). Moreover, a support for the destruction of a given amount of F gases could be considered in several scenarios. The special gas SF_6, used in Medium and High Voltage Switchgear and controlled within a specific legal framework, may follow a differentiated pathway depending on the availability of alternatives. Finally, any concrete proposal for the implementation of a carbon price on fluorinated gases should ensure that traffic as well as loopholes or the development of a black market are avoided.

6 Conclusions

The pricing of carbon or GHG emissions is a measure that is regarded by most academics and policy experts as an essential policy to gradually drive our economy towards low-carbon alternatives, that should be central to any effective climate policy package. The discussions held in the context of this national debate clearly demonstrate that, although several concerns potentially arise from the implementation of a carbon price, it is possible to define the necessary modalities that overcome these concerns in the different sectors. In this respect, choosing the appropriate uses of the public revenues generated by the carbon price appears to be crucial and will be a key success factor for the concrete implementation of the mechanism and for its support by most if not all actors.

For the buildings and the transport sectors, that together account for about two thirds of total Belgian non-ETS emissions, a limited number of clear-cut options for implementing a carbon price has been identified. Analyses show that the impact of a carbon price is manageable for these identified options, especially when carbon pricing revenues are used to compensate for its potential adverse impacts and to finance complementary measures, including measures that foster the transition by supporting low carbon alternatives. Only few practical, well-defined implementation issues remain open that could be dealt with fairly smoothly based on inspiring lessons from the carbon pricing schemes implemented abroad.

Experiences from abroad show as well that pricing GHG emissions in most of the other sectors is also feasible, provided that their specificities are adequately accounted for. The debate has shown that potential competitiveness and other specific concerns need to be properly taken into account. Options in these sectors have been identified that deal with these concerns, but that also require further analyses before being ready to be implemented.

Both the implementation of a carbon price and the use of its revenues will require a high degree of coordination between the different authorities in order to ensure policy alignment. Guaranteeing policy coherence at all levels is essential for the measure to deliver its full potential in mitigating climate change and to grasp the many opportunities linked to the low carbon transition. In any case, the current climate and energy policy context, and in particular the necessity to develop measures towards mid-term and long-term goals in the context of the integrated national energy and climate plan and of the future Belgian Long-term Low Emission Strategy, is a unique opportunity to implement an overarching and transversal measure such as carbon pricing.

* * *

1 Introduction

Belgium, as a signatory to the Paris Agreement, is committed to contributing to reaching the long term objective of limiting the global temperature rise to well below 2°C, while pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. This requires domestic reductions in greenhouse gas (GHG) emissions of at least 80 to 95% by 2050 with respect to 1990. As a member state of the European Union (EU), Belgium's climate objectives are embedded within the broader EU climate policy. The emissions in the industrial sector and the power sector are dealt with at the European level through the EU Emission Trading System (EU ETS). For the sectors outside of the EU ETS, Belgium is committed to reaching its GHG emission reduction objectives under the 2021-2030 EU Effort Sharing Regulation. These legislations are part of the broader Energy Union strategy that aims at ensuring that Europe has secure, affordable and climate-friendly energy. It includes a proposal on the governance of the Energy Union, in the context of which Belgium must develop and implement an integrated national energy and climate plan, as well as a Long-term Low Emission Strategy (LTLES) in order to frame its transition towards a low carbon society.

Such a transition requires the implementation of a series of coordinated policies and measures at different levels. The pricing of carbon or GHG emissions is a measure that is currently being adopted by an increasing number of countries around the world. The objective of carbon pricing as an instrument is to give a price signal in the long term in order to direct investment decisions and drive behaviours towards low carbon activities. Even though carbon pricing is regarded as a key instrument for reducing GHG emissions, it can, however, not be seen as a standalone measure and miracle solution, but rather as a central policy within a broad package of policies and measures to reach long term emission reduction objectives.

Although emissions from large industries and from the electricity sector are already priced via the EU ETS, carbon emissions from the other sectors, representing 63% of the total national GHG emissions, are not explicitly priced in Belgium. In January 2017, a national debate on carbon pricing has been launched by the Belgian federal Minister of Energy, Sustainable Development and Environment with the objective to analyse the potential modalities for implementing a carbon price in the sectors that are not part of the EU ETS. This document intends to summarize the work undertaken in the context of this debate by presenting the main results of the shared analyses and the different options identified to implement a carbon price in the Belgian non-ETS sectors.

The national debate was divided in several steps and comprises a high level kick-off event as well as a wrap-up high-level event with broad participation, and five technical workshops in a smaller setting of experts and selected stakeholders to ensure active and in-depth technical discussions. Two of these technical workshops were of transversal nature, while the three other workshops covered specific sectors or gases: one workshop covered the buildings sector, another one concerned the transport sector and the third one covered the non-ETS industry, agriculture and waste sectors as well as Fluorinated gases (F gases)[1]. The relevant Belgian stakeholders and experts, whether they belong to the public, private, academic, associative or trade unions' sector, have been involved throughout the debate, be it through their active participation during the technical workshops or through bilateral meetings with the administration and its consultants[2]. In order to ensure policy coherence, experts from the other federal and from regional administrations have been closely involved in the process. The different presentations made during the

[1] See Figure A.1.1 of Appendix 1 for an illustration of the process of the national debate.

[2] The authors wish to gratefully acknowledge and thank all participants to the national debate on carbon pricing for their contributions and the rich discussions that took place throughout the debate. It is important to note, however, that the present report on the discussions held during the different workshops organized under this initiative, the analyses shared and the identified implementation options are the sole responsibility of the project research team and thus do not necessarily reflect the views of the participants as listed in Appendix 1 or their organizations.

technical workshops are listed in Appendix 1 and are made available on our website[3]. Finally, next to the formal process, a large number of bilateral meetings with other experts have also enriched the analyses.

The working method under the national debate has been to systematically identify the different sources of GHG emissions that are not part of the EU ETS and to analyse the impact and implementation modalities of pricing those sources of emissions. The analysis is fact-based, building on specific impact analyses, existing research studies, analyses and recommendations, lessons learned from other countries having implemented a carbon price in the non-ETS sectors, as well as benchmark analyses related to the prices of energy in neighbouring countries. These analyses were prepared by a team consisting of experts from the Belgian Federal Climate Change Service and from an independent consortium of consultancy firms Climact, PwC and SuMa Consulting. They were complemented by specific analyses made by the participants to the debate.

This document is organised as follows:

- **Section 2** describes the overall context of the debate. The low carbon transition context and the role of carbon pricing therein is presented together with the sources and the evolution of GHG emissions in the non-ETS sectors, as well as a preliminary analysis of existing taxes related to energy use in Belgium and its neighbouring countries. The analyses on GHG emissions and energy taxes will be further developed in each section covering a specific sector.
- **Section 3** presents the transversal issues and the methodology for the analyses at sector level. It starts with an explanation of the overall principles underpinning the debate, followed by an overview of the key implementation issues of carbon pricing (scope, price trajectory, use of carbon revenues and policy alignment), to end with a note on the sectoral approach methodology.
- **Sections 4 to 8** present our analyses as well as the identified carbon pricing key implementation issues and options for the main non-ETS sectors and gases. It concerns the buildings sector (Section 4), the transport sector (Section 5), the non-ETS industry (Section 6), the agriculture and waste sectors (Section 7) and the F gases (Section 8), where each section includes a specific chapter on the context, on prices and taxes, the evaluation of impacts, policy alignment, and on carbon pricing key implementation issues and options.
- **Section 9** presents preliminary insights on a few important transversal aspects identified throughout the debate, i.e. air pollution, practical implementation issues and communication to the public.
- Finally, **section 10** presents an overview of possible options and perspectives for implementing a carbon price in the non-ETS sectors in Belgium.

[3] See www.klimaat.be/2050 / www.climat.be/2050 / www.climatechange.be/2050

2 Context

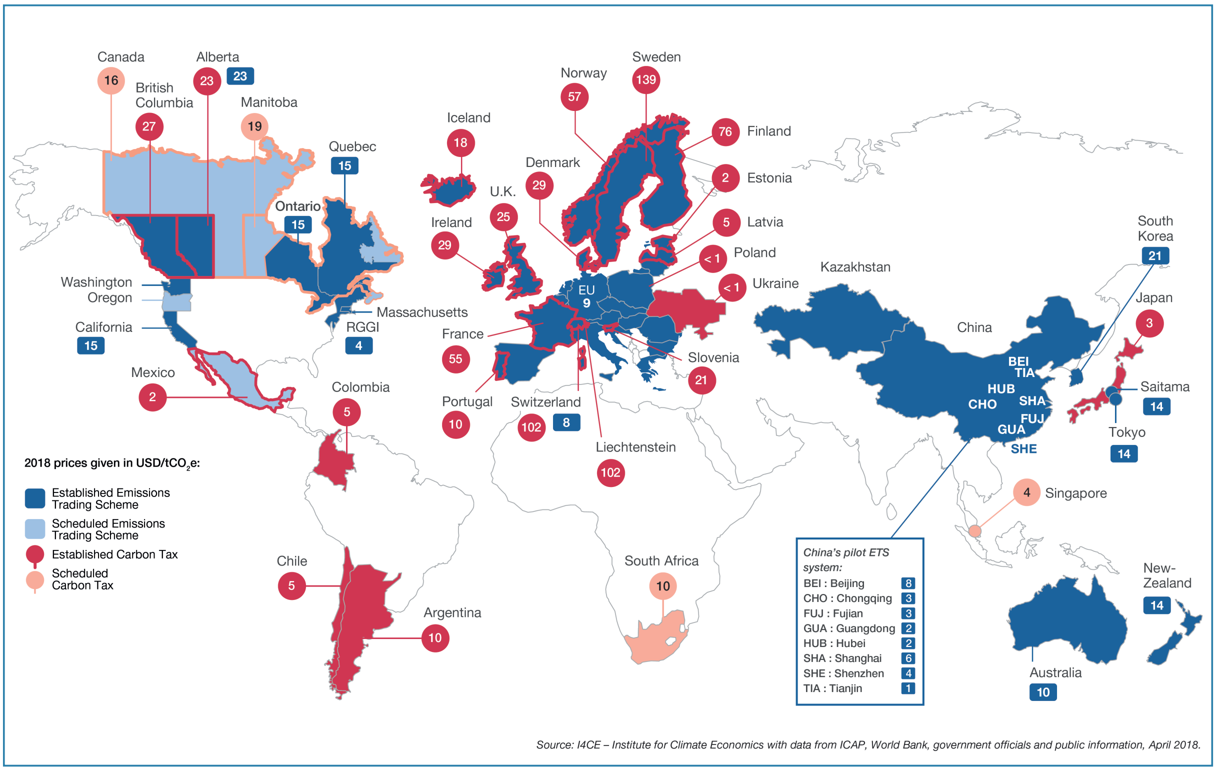
2.1 CARBON PRICING IN THE WORLD

KEY MESSAGES

The adoption of carbon pricing initiatives is accelerating worldwide under the form of either emissions trading schemes or carbon taxes. European countries have been the pioneering countries and several of them have implemented national carbon taxes to complement the EU Emissions Trading System covering energy intensive industries and the electricity production sector.

Carbon pricing is developing worldwide. Currently, 46 countries and 26 provinces or cities representing about 60% of the world GDP have implemented a carbon pricing scheme (I4CE, 2018). In 2017, about 15% of world GHG emissions were covered by a carbon price, much above the 5% share observed in 2010 (World Bank, 2017). Pioneering countries, namely Denmark, Finland, Norway and Sweden started implementing carbon taxes in the early nineties. Since 2005 and the launch of the EU Emissions Trading System (EU ETS), the adoption of carbon pricing initiatives has been accelerating worldwide, on all continents, from British Columbia to New Zealand, from Chile to South Africa.

Figure 1: Carbon pricing in the world



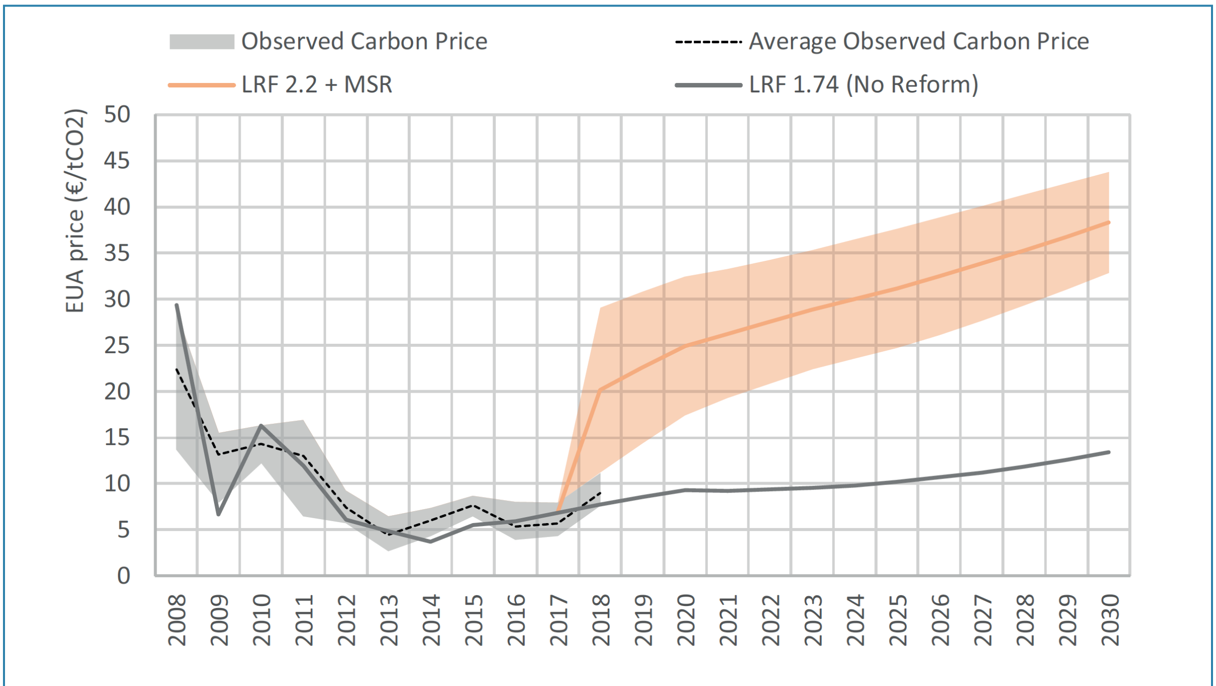
Source: Institute for Climate and Economics, April 2018

European countries are clearly at the forefront of such initiatives. Besides the EU ETS covering emissions from electricity production and energy intensive industries (i.e. about 45% of total GHG emissions in the EU), an increasing number of European countries have adopted carbon taxes that cover the emissions from sectors that do not take part to the EU ETS. Scandinavian countries have been joined for instance by Switzerland in 2008, Ireland in 2010 or France in 2014.

The prospects for the two major emitters, namely China and the USA, to adopt carbon pricing policies are encouraging. After a pilot phase of several years covering 8 cities or regions, China has formally decided to launch in 2018 a national emissions trading system, which will extend the coverage of global GHG emissions by carbon pricing to between 20 to 25% (I4CE Global Carbon Account, 2018). The system will firstly cover energy production emissions before being extended to energy intensive industrial sectors. In the USA, besides regional initiatives, several legislative proposals on carbon pricing have been regularly submitted. The "Conservative case for carbon dividends" deserves particular attention as this recent proposal (2017) emanates from influential US economists and politicians who held key governmental positions.

As we shall see below, the levels of the carbon prices differ markedly from one initiative to the other. In particular, prices emanating from emissions trading schemes tend to be lower than carbon taxes and are often considered as not being sufficiently high to drive investment decisions towards low carbon alternatives. These concerns have led to a debate in the EU in the context of the much lower than expected level of the EU ETS Allowance prices that dropped from about 20-25 €/tCO_2e in 2008 to 5-10 €/tCO_2e in the last five years. Still, two recently adopted reforms, namely the strengthening of the cap (by increasing the linear annual reduction factor form 1,74% to 2,2%) and the adoption of a 'Market Stability Reserve' scheme (MSR), will further limit the supply of quotas on the market. Under no further demand shocks, it is expected that these reforms will push EUA prices upwards. According to recent modelling exercises by Quemin and Trotignon (2018), EUA prices could rise to levels in the range of 30 to 40 €/tCO_2e by 2030 under no new external shocks, as illustrated in Figure 2. Other price forecasts by market analysists lead to similar levels (see for instance Marcu et al., 2018).

Figure 2: Illustration of potential impact of ETS reform on EUA price



Source: Quemin and Trotignon (2018) (ZEPHIR modelling)

If such assessments turn to be correct, GHG emissions covered by the EU ETS would then be priced at a level that could significantly weigh on investment decisions. The extent to which projected price levels are appropriate to drive the low carbon transition in the energy intensive sectors is, however, a matter of debate among stakeholders.

In what follows, we do not address such a debate that is taking place at the EU level in order to focus on sectors that are not part of the EU ETS. Still, when relevant, the EU ETS policy context is accounted for in the analyses, in particular for the industrial sectors.

2.2 UNPRICED EMISSIONS IN BELGIUM

KEY MESSAGES

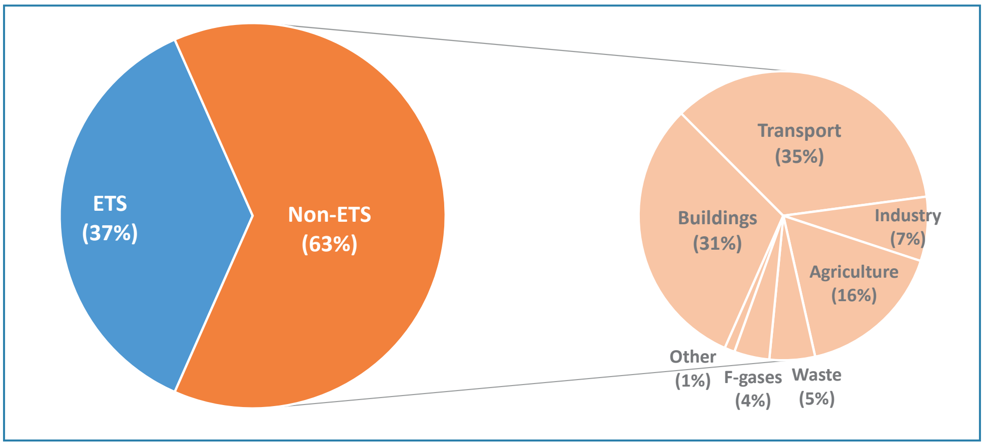
Unpriced, non-ETS emissions account for about two thirds of total greenhouse gas emissions in Belgium. Two thirds of these non-ETS emissions stem from the transport and the buildings sectors, while the other emission sources are relatively diverse.

Under current policies, non-ETS emissions are projected to stabilize at current levels, much above the proposed target for the year 2030 and the low carbon trajectory.

Throughout the debate, our approach has been to systematically identify the different sources of non-ETS emissions. It should be noted that the 'territorial' approach of emissions was considered here instead of the 'embedded emissions' or consumption approach. Indeed, despite its relevance, the latter cannot be measured accurately and as a consequence no official reporting based on this approach is performed. Moreover, the different possible embedded emission factors applicable to most products is a matter of discussion, as is the potential compatibility with world trade rules of pricing such emissions.

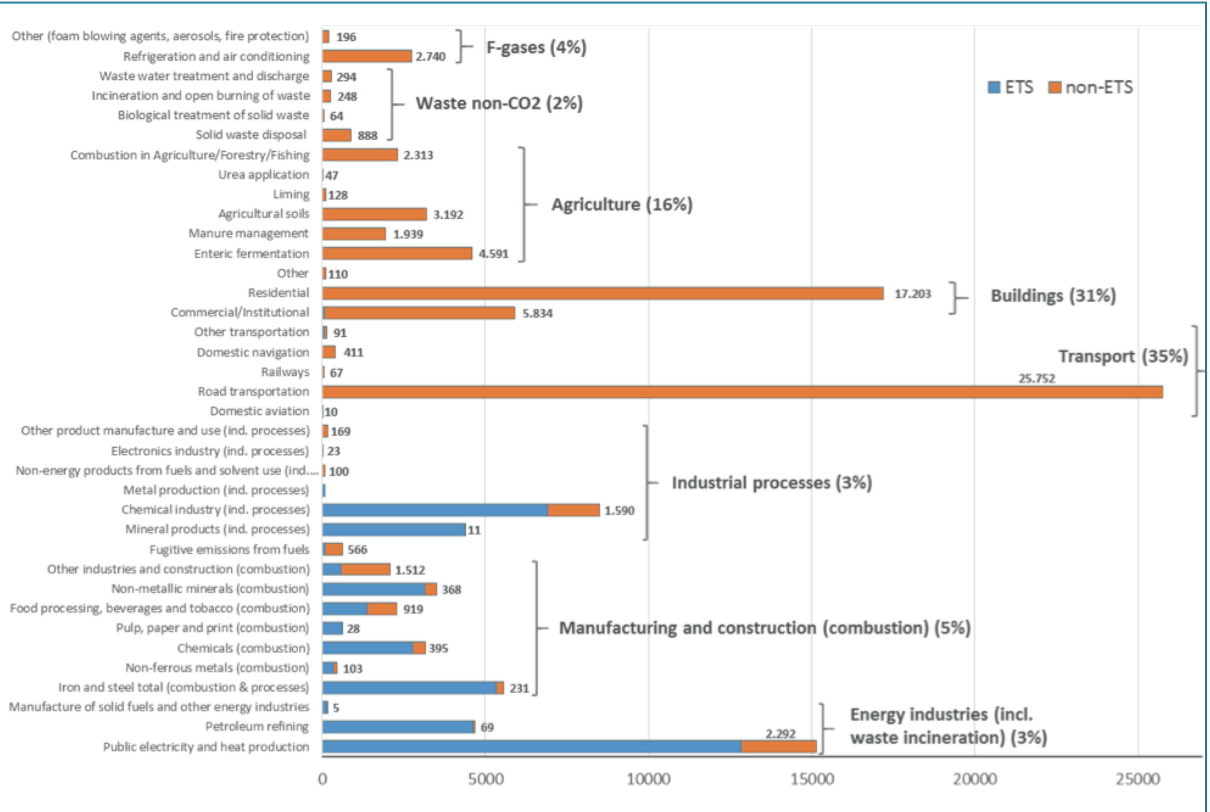
In 2016, 37% of GHG emissions in Belgium were priced via the EU ETS. The remaining 63% emissions, about 74 $MtCO_2e$, are not subject to any explicit carbon price. As illustrated in Figure 3, the main sources of these emissions outside the EU ETS relate to energy combustion in the transport sector, mostly road transport (35% of total non-ETS emissions) and in the residential and commercial buildings sector (31%). These two sectors accounted for 49,4 $MtCO_2e$ emitted in 2016. The remaining 34% originates from a variety of sources, mostly in the non-ETS industrial sector (7%), the agricultural sector (16%), the waste sector (5%) and via the use of products used as substitutes of ozone depleting substances leading to the emission of fluorinated gases (4%).

Figure 3: 2016 emissions in Belgium – Share of ETS vs n-ETS sectors in total emissions and share of the different n-ETS sectors in total non-ETS sector emissions



Source: NIR 2018, MMR reporting 2018

Figure 4: ETS vs non-ETS 2016 GHG emissions in Belgium by category (CRF) in $ktCO_2e$ and in percentage of total non-ETS emissions



Source: NIR 2018, MMR reporting 2018

Diving into the details of the national GHG inventory allows to better understand the variety of sources, especially in the sectors other than buildings and transport. These are provided in Figure 4. In the agriculture sector, emissions from energy combustion represent only about one fifth of the emissions, the remaining being non-CO_2 emissions stemming from animals and soils. In the industrial sectors, non-CO_2 (process) emissions also represent a significant share, while emissions from combustion originate from a set of different, heterogeneous industries. In the waste sector, the largest share of GHG emissions stems from the release of CO_2 by incinerators generating electricity and heat, far beyond non-CO_2 emissions caused by waste disposal. Finally, most products responsible for the release of F gases are used for refrigeration and air conditioning purposes.

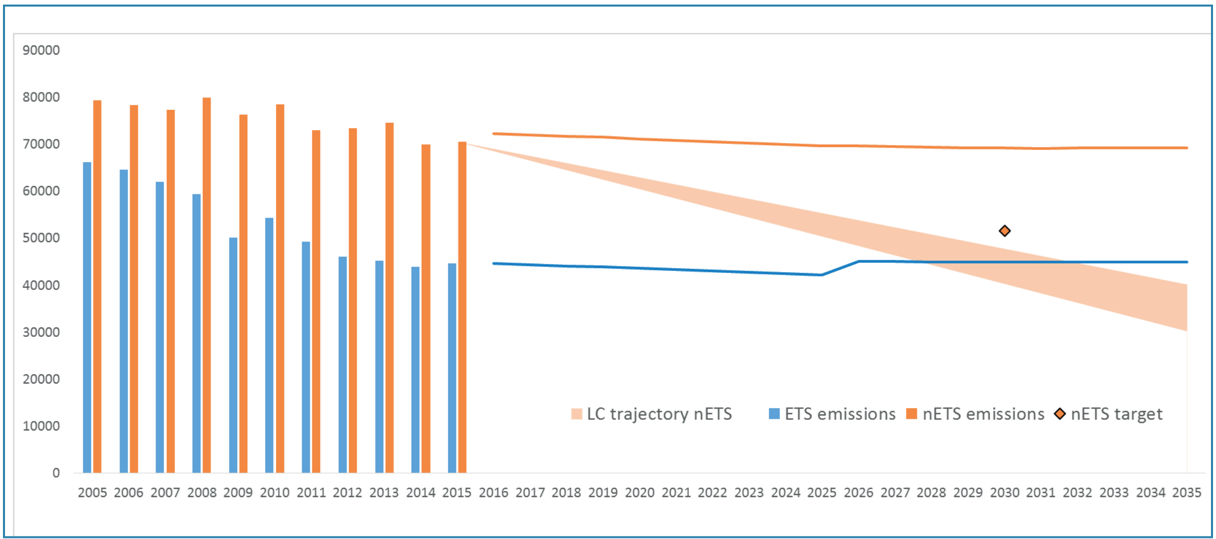
Sections 4 to 8, that are devoted to the sectoral analyses, provide further details on the sources of emissions in each sector.

In terms of trends, non-ETS GHG emissions in Belgium have decreased by 11% since 2005. The reduction pace has been much lower than the decrease in the ETS sectors, where emissions have dropped by 32% over the same period. The share of non-ETS emissions in total emissions has therefore risen, from 55% in 2005 to 63% in 2016.

As shown in Figure 5, the latest official projections in a scenario "with existing measures" foresee a stabilization of GHG emissions in both the ETS and the non-ETS sectors in the long term. In 2030, these projections indicate a reduction of non-ETS emissions of less than 13% with respect to 2005, which represents a gap of 17,6 $MtCO_2e$ or 22 percentage points with respect to the -35% Belgian target under the Effort Sharing Regulation.

Indicative, linear low carbon trajectories for the non-ETS sector are also depicted. The upper range corresponds to the linear trajectory between 2015 and 2050 leading to a reduction of GHG emissions in the agriculture, transport and buildings sectors consistent with the CORE low carbon scenario of the "Scenarios for a low carbon Belgium by 2050" study (see hereafter). The lower range corresponds to the full decarbonisation of the non-ETS sector by 2050[4]. Compared to these trajectories, the gap in 2030 rises to respectively 21 and 29 MtCO_2e.

Figure 5: GHG emissions in the ETS and non-ETS sectors in Belgium (ktCO_2e): historical data, projections under existing measures and indicative low carbon trajectories



Source: National Climate Commission (2017a, 2017b), own calculations

2.3 LOW CARBON TRANSITION

KEY MESSAGES

Low carbon scenarios are characterized by a large reduction of energy demand and by a significant rise in the share of electricity in the energy mix.

Analyses of the macroeconomic impacts of the transition show that (i) the transition does not necessarily negatively impact macroeconomic indicators such as production and employment, (ii) a carbon price is, on its own, not sufficient to put the economy on a low carbon trajectory, and (iii) implementing a carbon price, on top of a series of low carbon actions and measures, can have a positive impact on macroeconomic indicators.

The pricing of emissions in the sectors that are part of the EU ETS takes place within a long term perspective, in the context of our international and EU commitments to move towards a low carbon economy. Pricing emissions in the non-ETS sectors must also be considered in this long term low carbon transition context.

Low carbon scenarios

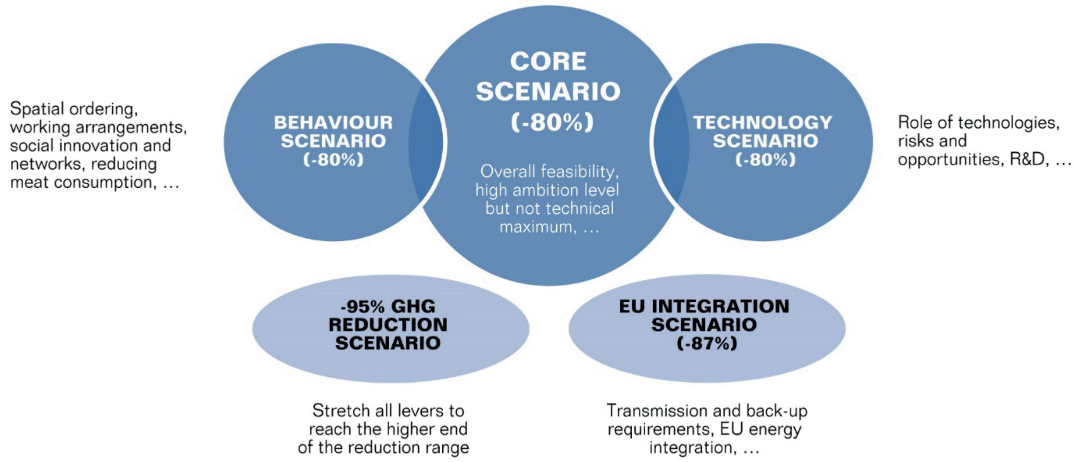
Some of the analyses performed in the context of this carbon pricing debate are therefore based on low carbon scenarios. In the study 'Scenarios for a Low Carbon Belgium by 2050', various scenarios have been developed to reduce Belgian emissions by 80% to 95% compared to 1990 levels by 2050 (see www.

[4] The EU long term emission reduction objective is to reduce GHG emissions in all sectors by 80 to 95% in 2050 with respect to 1990. Under the CORE scenario, the GHG emission reductions in the agriculture, transport and buildings sectors amount to respectively 46%, 79% and 87% in 2050 w.r.t. 1990 (73% overall). Under the "-95%" scenario (not depicted here), they reach 52%, 99% and 100% respectively. For the sake of clarity, the lower range low carbon trajectory for the non-ETS sector depicted in Figure 5 corresponds to a full decarbonisation by 2050.

climatechange.be/2050). These scenarios were developed and analysed via a transparent open-source model based on intensive consultations with Belgian and foreign experts and stakeholders. This approach is similar to the one adopted by the Walloon region earlier on and by the Flemish and the Brussels Capital regions thereafter[5]. Although the assumptions underpinning these four analyses are not necessarily fully harmonized, they result in very similar characteristics of the low carbon transition.

In the study 'Scenarios for a Low Carbon Belgium by 2050', a sectoral approach was used to understand the types and the levels of changes that are technically possible in each sector. For each emission reduction lever identified, a range of ambition levels was built to ensure that a wide range of potential futures could be tested. These levers and their possible ambition levels underpin the Belgian version of the OPEERA[6] model that was developed to construct possible scenarios with a 2050 horizon. On this basis, five decarbonisation scenarios were built and analysed, three of them leading to domestic GHG reductions of 80% in 2050 with respect to 1990. These five scenarios are illustrated in Figure 6.

Figure 6: Illustration of the 5 decarbonisation scenarios for Belgium



Source: Climact and Vito (2013)

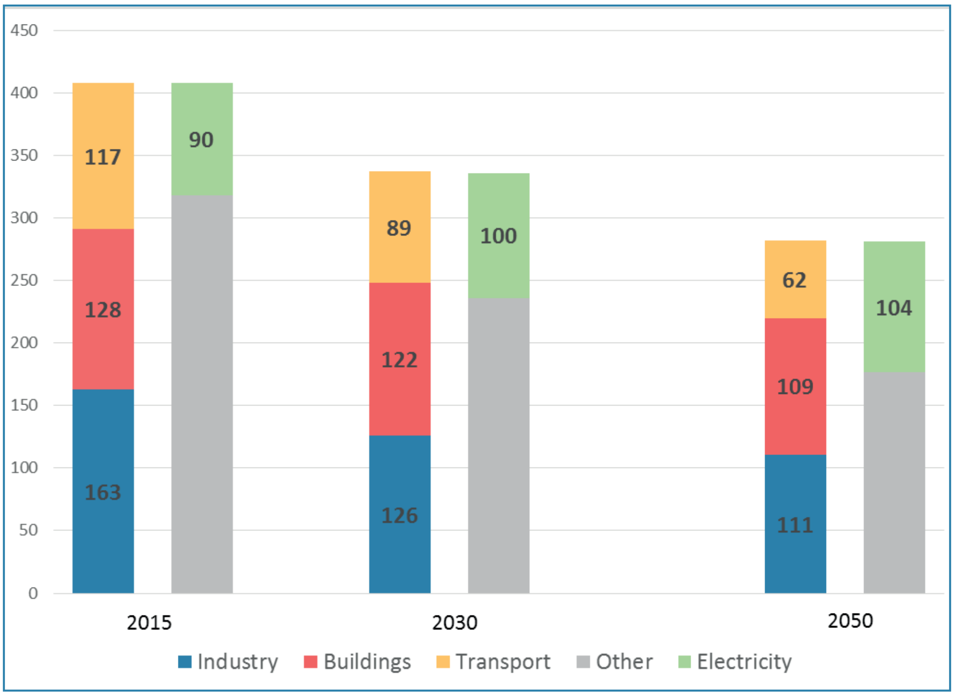
A first important message that emerges from these scenario analyses is the crucial contribution of **energy efficiency** stemming from both technological and behavioural levers: energy demand decreases by more than 30% over the 2015-2050 period in the CORE low carbon scenario.

A second important conclusion is the **electrification** of the energy mix. Although energy demand falls drastically, electricity demand rises due to the electrification in the buildings sector (mostly heat pumps), the transport sector (electric vehicles) and, where possible, in industry. Figure 7 illustrates this effect for the CORE scenario, where the share of electricity in the energy demand rises from 22% in 2015 to 37% in 2050.

5 See respectively www.wbc2050.be, http://www.vlaamseklimaattop.be/verkennende-studie-2030-2050-Vlaanderen and http://www.environnement.brussels/thematiques/air-climat/climat.

6 OPEERA stands for Open-source Emissions and Energy Roadmap Analysis.

Figure 7: Electrification:
energy demand in the CORE low carbon scenario (TWh)



Source: Climact (2017), Climact and Vito (2013)

As we shall see, these results, which also emerge from the low carbon scenarios developed in the Walloon, Flemish and Brussels-capital regions, must be taken into account when designing any carbon pricing scheme as they have important implications for the analysis of its potential impacts.

Macroeconomic impacts of the low carbon transition in Belgium

An analysis of the macroeconomic impacts of these technical scenarios has been performed in 2016.[7] Macroeconomic modelling shows that a drastic reduction of GHG emissions is compatible with an economic growth that is comparable to the level of – but different in terms of content from – the growth observed in a business-as-usual scenario. The low carbon transition may also lead to net job creation, although impacts are mixed at sector level. The same holds for competitiveness: a net gain for industrial sectors is observed, provided that the international context and the specificity of certain companies and value chains are adequately taken into account when defining policies and measures. Finally, emission reduction policies may lead to considerable advantages in many other fields, in particular regarding air pollution.

The drivers of the macroeconomic effects are the additional investments required by the transition. Although these investments come at a cost, they lead to substantial energy savings in all sectors of the economy (as mentioned above). Investments and reduced energy bills stimulate economic activity in Belgium, in particular when the other, EU and non-EU, countries join the low carbon transition and also stimulate production.

Another potential driver of growth is carbon pricing in the non-ETS sectors. Macroeconomic simulations with the HERMES model show that, when public revenues from carbon pricing are recycled back to the economy in the form of reduced labour costs, economic growth is further stimulated. In these simulations, carbon pricing (with redistribution) is thus not a necessary condition for additional growth, but it contributes to stimulating economic activity.

More details on the impact of the CORE scenario on GDP, exports, jobs, households income and firm's gross operating surplus in the year 2030 is provided in Appendix 2.

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[7] See http://www.climatechange.be/2050/en-be/scenario-analysis/.

2.4 ENERGY PRICES AND TAXES

KEY MESSAGES

Compared to the other EU member states, Belgium has one of the lowest implicit tax rates on energy and the second lowest level of public revenues from energy taxes when expressed as a percentage of GDP. Compared to its neighbouring countries over time, it has had the lowest implicit tax rate on energy since 1995, the differences being significant but overall slightly decreasing since 2014.

Prices for the selected energy products, both excl. and incl. taxes and levies, have in general evolved in a similar way in Belgium. Price fluctuations over time can therefore mainly be attributed to fluctuations of commodity prices, while taxes and levies have generally remained more or less stable throughout the years. A similar evolution is noticed in the neighbouring countries.

Fiscal revenues and expenditures stemming from excise duties on energy products amounted to around 6 billion € (2017) and 2 billion € (2016), respectively. Diesel used as motor fuel is the energy product generating most of the revenues, while diesel used as heating fuel is the energy product involving most of the fiscal expenditures, followed by reimbursements of professional diesel.

This Section first presents the broad picture of energy taxation in Belgium in comparison with the other European countries. The evolution of the price and tax levels of the main energy vectors in Belgium are then illustrated. Finally, fiscal revenues and expenses related to energy products in Belgium will be briefly touched upon in this section. Sections 4 to 8, which are devoted to the sectoral analyses, provide further details and a more in-depth analysis on prices and taxes (standard rates, reduced rates, exemptions) for each sector, in Belgium and its neighbouring countries.

The broad picture

Several organizations including the IMF, OECD and the European Commission have, over the past few years, regularly stated that Belgium should shift towards more environmentally-related taxes, and in particular energy-related taxes.[8] Indeed, as Figure 8 below clearly shows, Belgium has one of the lowest implicit tax rates on energy[9] within the EU-28 (it ranked 22nd with a rate of almost 152 €/toe in 2016). When comparing Belgium to its neighbours over time since 1995, as can be seen in Figure 9, it has had and still has the lowest implicit energy tax rate, the difference with its neighbours being significant throughout the years, although decreasing since 2014 with all neighbours except France.

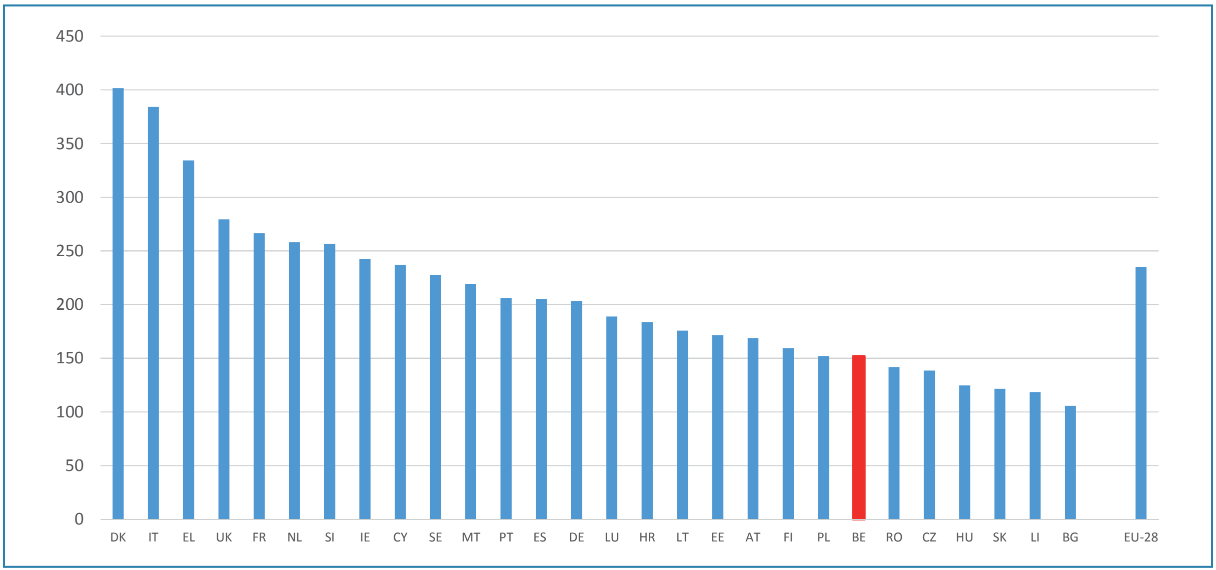
When we have a look at the energy tax revenues[10] as a % of GDP within the EU-28 for the year 2016 (see Figure 10), we notice that Belgium ranks second last with a share of 1,42%, while our neighbours' energy tax revenues are between 1,54% (Germany) and 1,9% (The Netherlands), and the EU-28 average is 1,88%.

8 See among others IMF's 2016 country report, OECD's 2015 Economic Surveys for Belgium and European Commission's recommendations for Belgium through the European Semester.

9 The implicit tax rate on energy is defined as the ratio of energy tax revenues to final energy consumption calculated for a calendar year. Energy tax revenues are measured in constant price euros and final energy is expressed in tonnes of oil equivalent. The implicit tax rate on energy is not influenced by the size of the tax base and provides a measure of the effective level of energy taxation. Source: http://ec.europa.eu/eurostat/statistics-explained/index.php/Environmental_tax_statistics

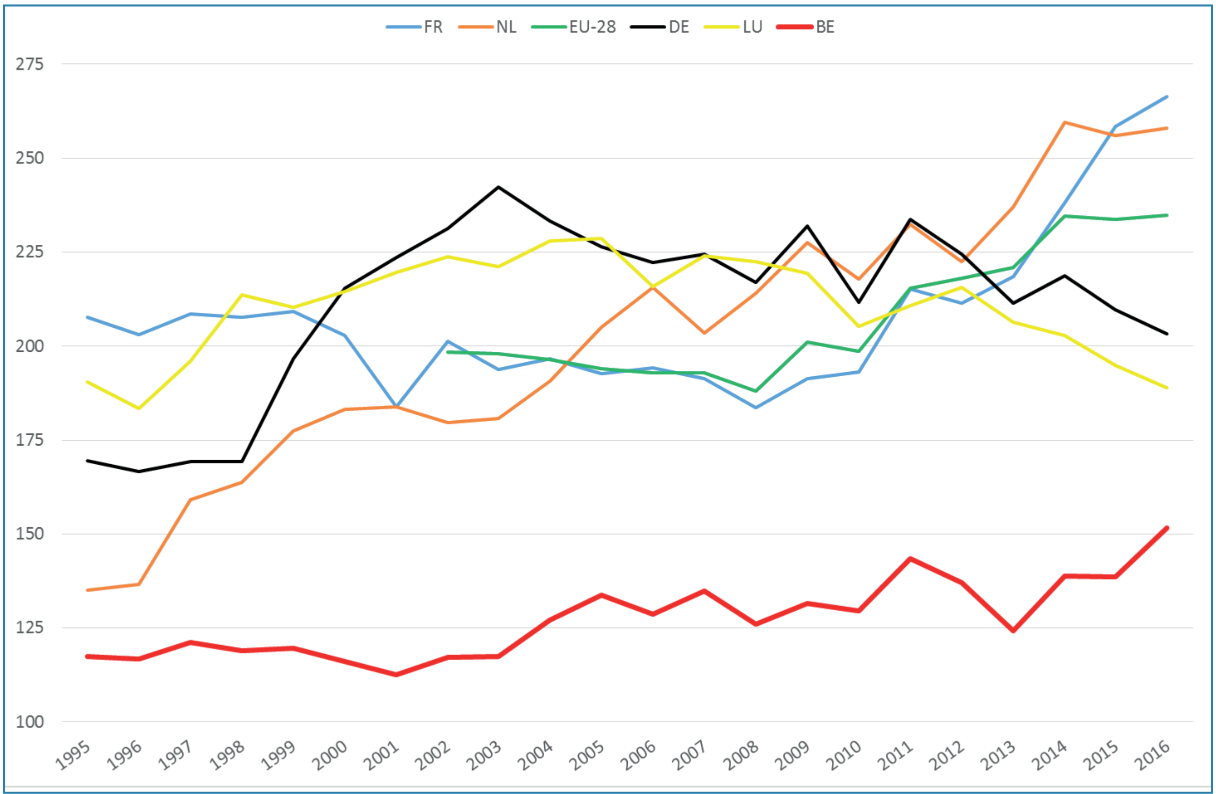
10 Total energy tax revenues include taxes on energy use paid by households, in industry and construction, agriculture, forestry and fishing, transportation and storage and in the services sector.

Figure 8: Implicit tax rate on energy: EU comparison (€/toe)



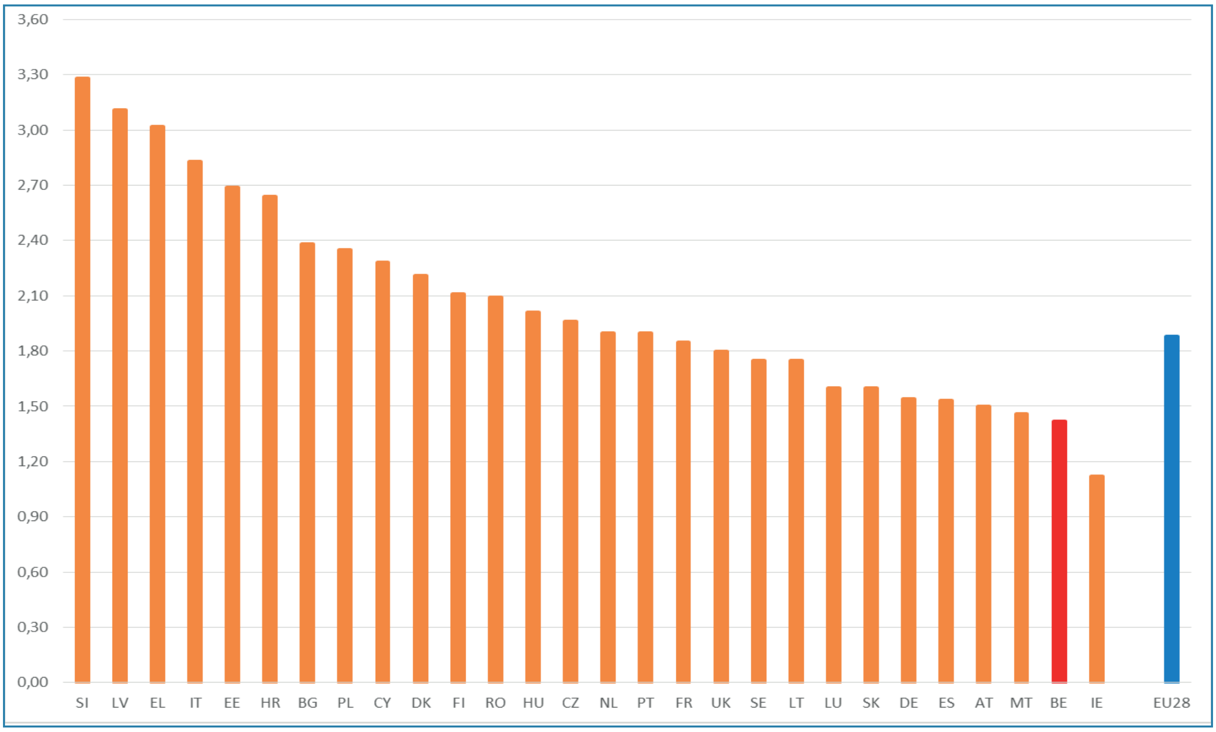
Source: Eurostat

Figure 9: Evolution of implicit energy tax rate: comparison with neighbouring countries (€/toe)



Source: Eurostat

Figure 10: Energy tax revenues per country (as % of the GDP, 2016)



Source: Eurostat

As to its average evolution between 2005 and 2014, we notice that energy tax revenues have on average decreased by 2% in Belgium. Germany and Luxemburg have also had negative evolutions, while France and The Netherlands have had a slightly positive evolution of energy tax revenues over the same period of time.

Energy prices and their evolution over time for a selected number of energy vectors in Belgium

In this section, we will focus on consumer prices in Belgium and their evolution over time for the following energy products:

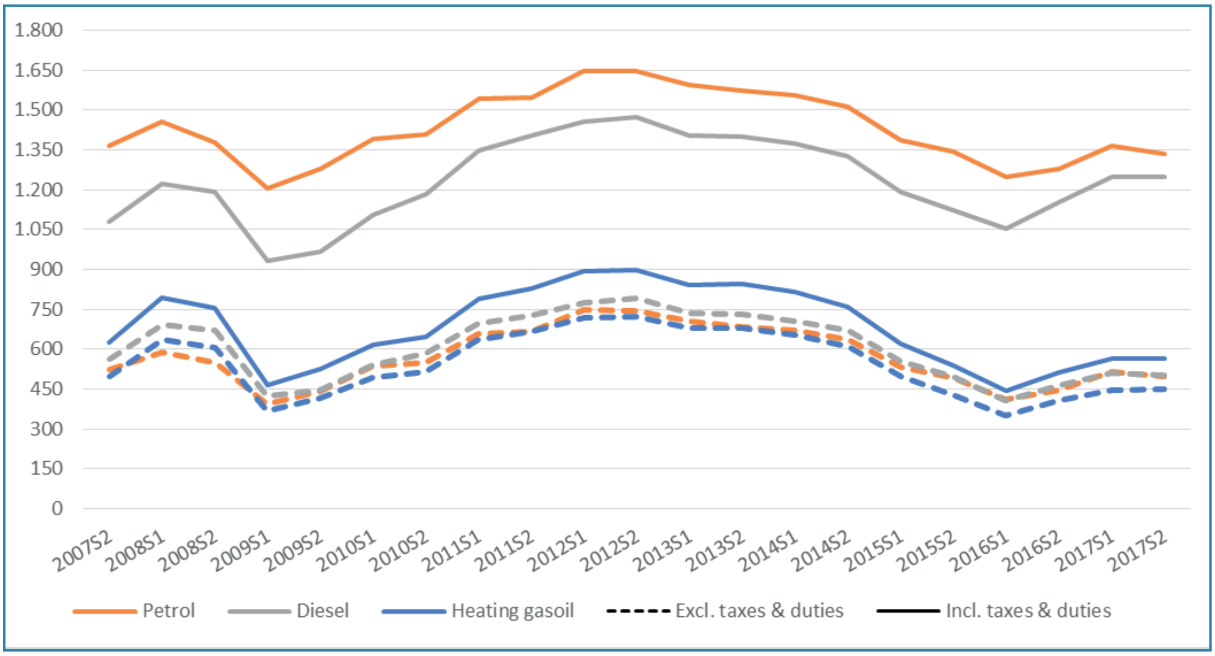
- petrol (Eurosuper 95 – in €/1000L),
- automotive diesel (in €/1000L),
- heating gasoil (in €/1000 L),
- natural gas for households consuming between 20 and 200 GJ/y (profile D2 – in €/MWh),
- natural gas for industrial companies consuming between 10 and 100 TJ/y (profile I3 – in €/MWh),
- electricity for households consuming between 2.500 and 5.000 kWh/y (profile DC– in €/MWh), and
- electricity for industrial companies consuming between 500 and 2.000 MWh/y (profile IC – in €/MWh).

A detailed analysis of and comparison between the prices applicable in Belgium and in its neighbouring countries can be found under each chapter dealing with a specific sector.

As can be seen in Figure 11, Figure 12 and Figure 13, prices for the above-mentioned energy products, both excl. and incl. taxes and levies, have in general evolved in a similar way in Belgium. Price fluctuations over time can therefore mainly be attributed to fluctuations of commodity prices, while taxes and levies have remained more or less stable throughout the years. A similar evolution can also be noticed in the neighbouring countries.

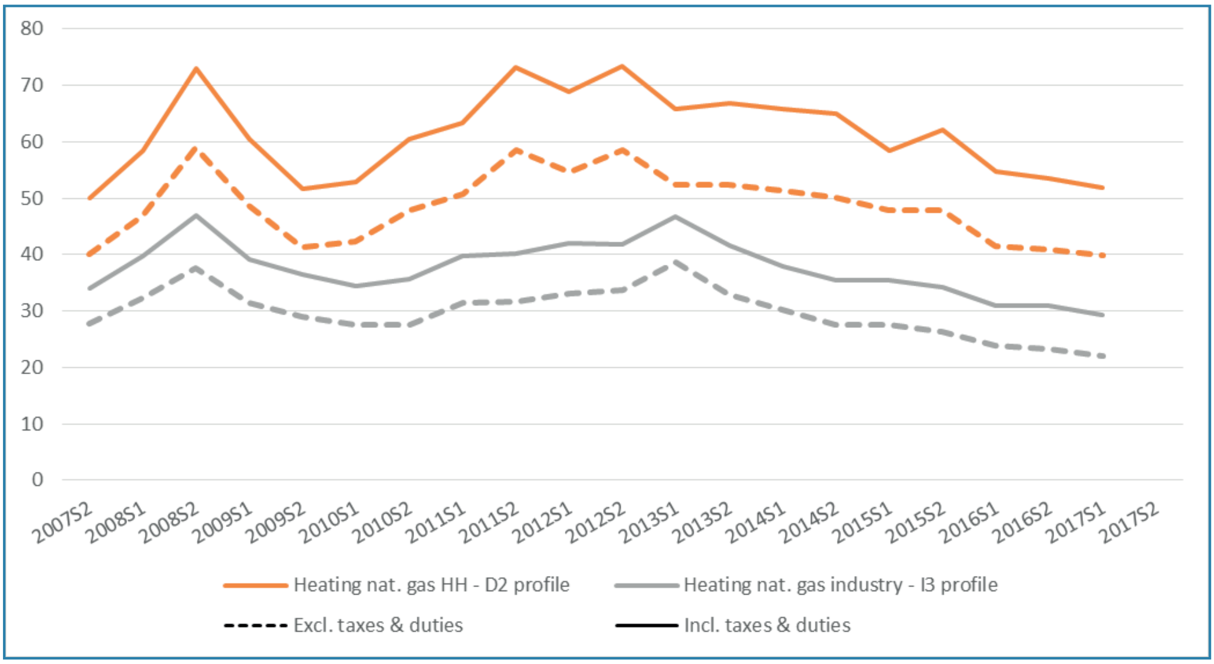
Regarding natural gas prices, we observe that both for households (profile D2) and for industrial companies (profile I3), the price evolution in Belgium is mainly the result of commodity price evolution. Prices for industrial companies are significantly lower than for households throughout the analyzed years.

Figure 11: Evolution of prices for a selected petroleum products in Belgium (in EUR/1000L)



Source: Weekly Oil Bulletin, European Commission

Figure 12: Evolution of prices for natural gas in Belgium (in EUR/MWh)



Source: Eurostat

When looking at heating gasoil and diesel used as motor fuel, we notice that the difference in price between both products is mainly due to a different taxation level throughout the years, while the difference in prices with or without taxes and duties has remained relatively stable over time.

Regarding petrol, we observe that this energy product has had the highest taxation level over time in Belgium.

The situation is somehow particular regarding electricity: for electricity consumed by households (profile D2), we observe a bigger difference between prices without and with taxes and levies since the beginning of 2015, meaning that the taxation level has increased for this consumer profile. The electricity price for industrial companies (profile I3) has experienced a relatively stable, but slightly upward evolution over time (although this price decreased in the first semester of 2017), but here as well, the taxation level has slightly increased these past few years, although not as much as for households.

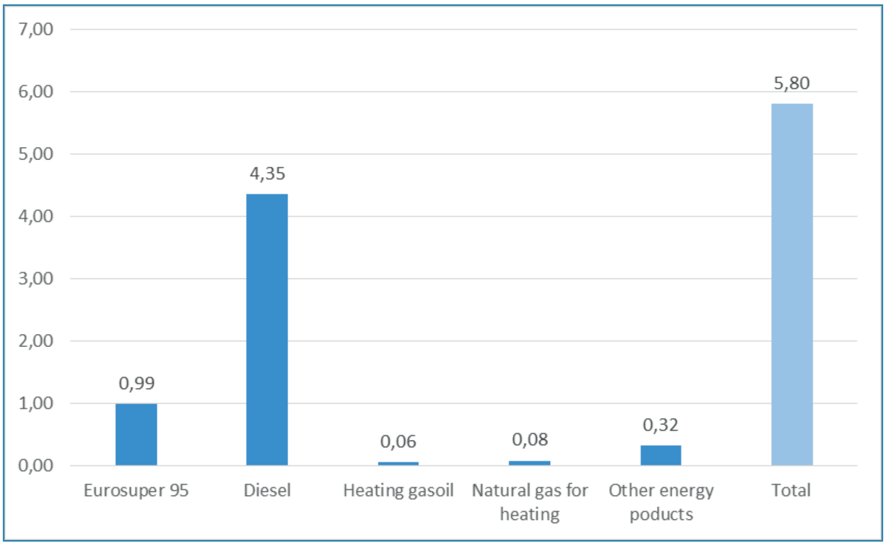
Figure 13: Evolution of prices for electricity in Belgium (in EUR/MWh)

Source: Eurostat

Fiscal revenues and expenditures related to energy products in Belgium

The following information regarding fiscal revenues (for the year 2017) and expenditures (for the years 2012-2016) through excise duties related to energy products in Belgium was gathered from the Federal Public Service (FPS) of Finance.

Figure 14: Public revenues (in billion €) from a selection of excise duties (2017)



Sources: Ministry of Finance, own calculations

Figure 14 presents the public revenues generated by excise duties for a selection of energy products in the year 2017. We observe that the main energy products have generated up to 5,47 billion € of revenues in 2016 and 5,80 billion € in 2017 through excise duties. Diesel used as motor fuel is the energy product generating most of these revenues.

Table 1 below presents the fiscal expenditures through reduced tariffs or exemptions of excise duties on energy products that have been estimated by the FPS of Finance.

Table 1: Fiscal expenditures related to excise duties on energy products, 2012-2016
(excise duties only – in million €)

Energy products	2012	2013	2014	2015	2016
Kerosene used as heating fuel	40,90	41,87	29,52	35,37	35,36
Kerosene used as motor fuel (industrial & commercial purposes)	3,92	2,94	3,37	3,82	3,16
Gasoil used as motor fuel (low sulphur - reimbursement of professional diesel)	119,21	192,04	180,97	184,30	254,22
Gasoil used as heating fuel (low sulphur)	231,03	279,11	274,34	441,08	867,07
Gasoil used as heating fuel (high sulphur)	1.430,53	1.496,24	1.162,36	1.262,03	937,73
Gasoil used as motor fuel (industrial & commercial purposes)	204,10	204,95	232,59	137,14	85,79
LPG used as heating fuel	3,27	3,19	2,82	3,19	3,36
TOTAL	**2.032,96**	**2.220,34**	**1.885,97**	**2.066,93**	**2.186,69**

Source: Ministry of Finance

These figures suggest that in the analyzed period 2012-2016, fiscal expenditures on energy products through reduced rates/exemptions of the excise duties amounted to around 2 billion € per year. The biggest part of these expenditures stem from gasoil used as heating fuel (low and high sulphur), which is determined by considering the rate of heating gasoil as being a reduced rate of the 'standard' rate of gasoil used as motor fuel.

The other important fiscal expenditure concerns the reimbursement of professional diesel, which amounted to 254 million € in 2016 (up from 184 million € in 2015).

3 Transversal issues and methodology

We have identified 3 overall principles that serve as a common framework for guiding our discussions on carbon pricing implementation modalities. These principles are outlined in the first subsection. We have then identified 4 key implementation issues that define the main modalities of implementation of any carbon price: the scope of carbon pricing, the price trajectory, the use of public carbon revenues and the alignment of carbon pricing with other policies and measures. The second subsection is devoted to an overview of these issues that will allow us to deepen the analyses at a sectoral level (Sections 4-8). Finally, the methodology used to analyse those implementation modalities in each sector is described in the third subsection.

3.1 OVERALL PRINCIPLES

KEY MESSAGES

3 overall principles for the design of the carbon pricing scheme have been identified: budget neutrality, long-term orientation and embeddedness in a package of policies and measures.

Several overall principles guiding the carbon pricing implementation modalities can be derived from previous debates on the same or on similar subjects, as well as from experiences abroad.

a) Budget neutrality

A first principle shared by all stakeholders relates to the use of the proceeds of carbon pricing. It is argued that carbon pricing should not be implemented with the view to raise additional public funds, but rather in the perspective of delivering a price signal, thereby internalizing (part of) the climate externality by encouraging low carbon investments and behaviours.

As a result, any proceeds from carbon pricing cannot simply feed the public budget. Without compromising the principle of budgetary universality, a corresponding amount of resources should be allocated to specific purposes in the form of reduced taxation or transfers to actors. Budget neutrality is, however, not necessarily guaranteed ex-post as changes in energy consumption and GHG emissions (the purpose of pricing) will affect the 'pricing base'[11].

Moreover, the notion of budget neutrality could be extended beyond the simple definition retained here. It could encompass, for instance, all related changes in energy taxation in general (which would include a loss of revenues from excise duties for instance)[12] or be even broader and include all indirect and potentially positive, macroeconomic effects on economic activity and thereby on public revenues[13].

[11] See also High Council on Finance (2009), Chapter 1, Section 5 for a discussion on the concept of budget neutrality.

[12] In this context, it should not be forgotten that the low carbon transition necessarily involves a progressive loss of public revenues from excise duties on fossil fuels, whose total revenues amounted to about 6 billion € in 2017, i.e. about 2,5% of general government revenues in Belgium (see above). Even though this is not directly linked to carbon pricing itself, the progressive decrease of such revenues will have to be accounted for in the mid and long term, together with the required evolution of the overall fiscal system and with the potentially positive impact on public finances of the macroeconomic stimulus generated by the transition.

[13] See Berger and Bossier (2016) for an assessment of such effects.

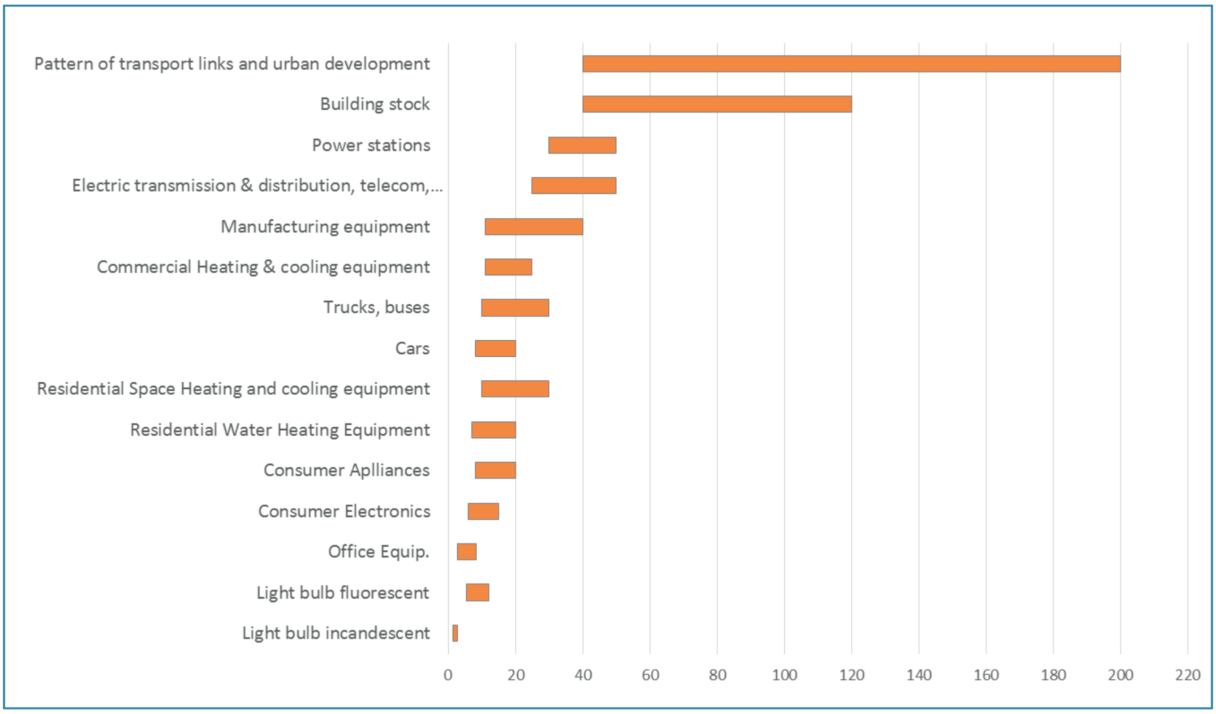
The specific use of revenues from carbon pricing is a matter of debate. We come back to this topic in the next Section as well as in the sectoral analyses.

b) Long term orientation

Setting a price on GHG emissions aims at supporting the low carbon transition, which will entail major changes in the energy system and beyond. All these changes require a shift in the level as well as in the type of investments.

Most of these investments are clearly long-lived assets, as illustrated in Figure 15: while road vehicles' lifespan does not exceed 10 to 30 years, manufacturing equipment or power stations are being installed with a perspective of up to 40 years or more. When it comes to buildings or transport infrastructure, investment lifespans can largely exceed a century. When designing any carbon pricing scheme, it is therefore crucial to account for two aspects. First, this additional price ideally needs to weigh on the entire lifespan of the investment. Second, the implementation modalities will need to account for the sunk cost/lock-in effects due to such long lifespan, meaning that investment cycles come into play for many actors and that anticipated capital replacement might come at some costs.

Figure 15: Average lifespan of energy-related capital stock (years)



Source: Philibert, IEA (2007)

c) Embeddedness in a package of policies and measures

Virtually all economists support that carbon pricing is a powerful instrument to drive changes in behaviour, consumption and investment patterns towards low carbon alternatives. Indeed, price instruments incentivize an efficient allocation of the abatement efforts (Eyckmans, 2017; Bréchet, 2017). The price signal allows to differentiate emission reduction efforts in such a way that those that can reduce emissions at lower cost do actually reduce their emissions to a larger extent. Beyond this 'static cost-efficiency' argument, carbon pricing has the advantage of providing a continuous incentive to innovate ('dynamic cost-efficiency'). Finally, cost-efficiency could be reached in this way at low information cost for the public authorities as opposed to standards and norms that require information on abatement costs.

However, carbon pricing is no magical solution and will not suffice by itself, for at least two reasons. Firstly, a long list of non-price-related barriers exists that needs to be tackled through appropriate instruments for the carbon price to be effective. These barriers include information failures, principal agent problems, etc. Moreover, the behavioral and technological choices of economic agents do not take place in a neutral vacuum, but are embedded in a certain, inherited infrastructure (physical (spatial planning, roads, availability of charging stations, …) as well as institutional (tax code, fossil fuel subsidies, cultural habits, …)), that inherently guides the decisions of these societal actors. Various existing policies and institutional choices are geared towards a reality in which fossil fuels were central and therefore distort the level playing field by hindering low carbon options. The physical and institutional infrastructure therefore must be aligned with the low-carbon objectives, in order to increase the effectiveness of a carbon price. Secondly, the implementation of a carbon price necessarily has distributive impacts. Although at least part of that issue can be dealt with through the allocation of the revenues stemming from carbon pricing (see below), complementary policies might be required to effectively address them, as we shall see further on.

Carbon pricing in the non-ETS sectors must therefore be introduced together with a whole set of other policies and measures at different levels, including the EU, the regional and the local level. At the international level, the Paris Agreement constitutes the central policy framework. In the EU, the Energy Union encompasses a long list of targets and policies with a direct impact on GHG emissions. At the national and regional levels, the preparation of the national climate and energy plans by each entity and the related strategies and measures is the natural framework within which carbon pricing must be analysed.

3.2 KEY IMPLEMENTATION ISSUES

Key identified overall implementation issues include the scope of carbon pricing, its price level and trajectory, the use of carbon revenues and the alignment of this policy measure with other existing or forthcoming policies. This Section gives an overview of each of these issues and further elaborates on transversal aspects of each of them.

3.2.1 Scope of carbon pricing

KEY MESSAGES

Although all non-ETS GHG emissions could potentially be priced, countries or regions that have implemented carbon taxes do not price emissions in all sectors.

The buildings and the transport sectors are almost always part of the scope of their carbon pricing schemes. Emissions from non-ETS industrial sectors, from combustion in the agriculture sector and of fluorinated gases are diversely covered. Non-CO_2 emissions in the agriculture sector are not covered.

Those countries or regions that started early with their pricing scheme tend to progressively broaden the scope or phase out reduced carbon tax rates.

Broadly speaking, the potential, maximum scope of the carbon pricing in the sectors that are not part of the EU ETS includes all sources of GHG emissions, as depicted in Figure 4 above. The aim of this Section is to discuss the scope of carbon pricing in a broad sense, encompassing the different non-ETS emission sectors that could be subject to pricing, by analyzing how countries and regions that have already introduced a carbon tax or are considering to do so in the near future have defined the scope of their carbon tax system. Thorough analysis of the scope of carbon pricing within each sector is performed in the sectoral analyses (Sections 4-8).

Table 2 below presents our main findings that can be summarized as follows:

- The **buildings sector** is covered by a carbon tax in almost all analyzed cases. The exemptions or reduced tax rates in this sector are very limited;

- The **transport sector** usually falls under the scope of the carbon tax as well. Exemptions or reduced tax rates occur more often in this sector when compared to the buildings sector, although in most cases there is no full exclusion of specific fuels from the scope of the carbon tax. Where exemptions or reduced tax rates exist, they mostly apply to domestic shipping and aviation, railway, freight road transport, agriculture (tractors), and/or fishing vessels.
- Regarding industries not covered by Emissions Trading Schemes (**non-ETS industry**), we notice that several exemptions or reduced tax rates have been applied in the selected group of countries/regions considered here. These mainly relate to fuels used as raw material or input for manufacturing, industrial processes, wood industry, energy-intensive industries with a risk of carbon leakage (if not covered by a ETS) and the fishing industry.
- As to the **agricultural sector**, we notice that **non-CO_2 emissions** are not covered by the carbon tax (even though a few countries have considered to include these emissions under the scope of the carbon tax). We also notice that some exemptions and reduced tax rates are foreseen for CO_2 emissions from combustion (greenhouse industry, etc.);
- With regard to **F gases**, a majority of the selected countries/regions does not tax these gases, but five countries do apply a tax on F gases (even though not through the carbon tax itself), while two countries are in the process of finalizing legislation to tax them.

We also observe that some countries, where exemptions or reduced tax rates are applied, gradually phase out the reduced tax rates (e.g. Sweden, Norway) or broaden the scope over time (e.g. Denmark). Such an approach is coherent with the recommendation of the High Council on Finance (2009, see p.31 and 34): when efficiency in the allocation of the resources is to be pursued, the scope of the pricing should be as broad as possible. Issues of competitiveness (companies) and of regressivity (households) are then best addressed, when possible, by compensating measures, rather than by the exclusion of greenhouse gases from the scope.

Finally, it is also worth noting that in some countries, the ETS sector is not automatically fully out of the scope of a carbon tax. Indeed, in Norway, Sweden and Estonia, some subsectors / activities / installations still fall under the scope of the carbon tax, although usually with reduced rates. It concerns petroleum activities and domestic aviation in Norway, and specific heat production installations in Sweden and Estonia.

Table 2: Scope of carbon taxes and of F gas taxes- selected group of countries / regions

EUROPE	SCOPE OF THE CARBON TAX OR F GAS TAX					
	Buildings	Transport	Non-ETS Industry	Agriculture (fuel combustion)	Agriculture (non-CO_2)	F-gases
Denmark						
	Only electricity is not covered by the CO_2 tax since 2014.	➤ Biofuels are exempted from the carbon tax. ➤ Fuels used by commercial ships and commercial flights are exempted.	➤ Reduced rates for businesses (light and heavy processes) abolished (since 2005 and 2010, respectively); ➤ Fuels used for extraction and production of oil and gas are exempted.	Fuels used by fishing vessels are exempted, no further indications of exemptions.		Tax on imports (and production) of CFC, HCFC and HFC.
Estonia						
	Carbon tax on the generation of thermal energy. Buildings sector partially covered given that district heating apparently covers more than half of the heat demand.	Carbon tax only for the generation of thermal energy.	Non-ETS Industry (as well as EU ETS companies, that also have to pay the tax) producing heat for their activities are covered.	Heat production for agricultural purposes is covered.		
Finland						
	Reduced rate for peat, that can also be used for domestic heating.	No indications that exemptions apply in this sector.	➤ Fuels used as input for manufacturing and energy production are exempted; ➤ There is a tax refund for the energy-intensive sectors (including the wood industry).	There is a tax refund in this sector, but it is included in the scope of the carbon tax.	No indication that non-CO_2 emissions are covered by the carbon tax.	

EUROPE	SCOPE OF THE CARBON TAX OR F GAS TAX					
	Buildings	Transport	Non-ETS Industry	Agriculture (fuel combustion)	Agriculture (non-CO_2)	F-gases
France						
	➤ Biomass is exempted. ➤ Industrial companies benefiting from the reduced rate, also benefit from this rate for the fuels purchased for heating their buildings (cf. non-ETS industry).	➤ Road passenger transport: in general no reduced rates or exemptions apply. However, there is a reimbursement scheme for diesel used by buses, and for diesel and petrol used by taxis. ➤ There is no impact of the carbon tax on road freight transport, since there is an equivalent decrease of the energy excise duty.	Reduced rates apply to energy-intensive companies that moreover have a significant risk of carbon leakage (level applied: 7€/tCO_2e within the current excise rates).	Falls under the scope of the carbon tax, although in practice, the sector does not pay it since it can get energy tax reimbursements up to a certain limit.		Law under preparation to tax imports and production of HFCs from 2019 onwards.
Iceland						
	Some reduced rates or exemptions (coal does not fall under the scope of the carbon tax) apply, the extent of which could not be assessed at this stage. Therefore, we conservatively assess a partial inclusion of the buildings sector under the scope of the carbon tax.	Exemption for offroad transport, the extent of which could not be assessed at this stage. Therefore, we conservatively assess a partial inclusion of the transport sector under the scope of the carbon tax.	➤ Cement and alluminium sectors exempted (under EU ETS), but other industry under the scope of the carbon tax; ➤ Coal not under the scope of the carbon tax. Its use in industry is significant. ➤ Therefore, we conservatively assess a partial inclusion of this sector under the scope of the carbon tax.	Some reduced rates apply, the extent of which is to be further assessed in order to correctly determine the scope.	No information found that non-CO_2 emissions are taxed.	

EUROPE	SCOPE OF THE CARBON TAX OR F GAS TAX					
	Buildings	Transport	Non-ETS Industry	Agriculture (fuel combustion)	Agriculture (non-CO_2)	F-gases
Ireland						
	In general, there are no reduced rates or exemptions of the carbon tax.	➤ In general, there are no reduced rates or exemptions of the carbon tax in the transport sector. ➤ One exemption: reduced rate of the carbon tax for 'vehicle gas' (mix of gas and biogas).	➤ No exemptions / reduced rates for the non-ETS industry; ➤ Still, there is a full reimbursement of the carbon charge on coal, peat and natural gas when used for CHP.	➤ CO_2 emissions are covered; ➤ Full tax also applies to farmers, but the 2013 tax increase from 15 to 20 EUR is compensated by a decrease in income tax within this sector.		
Norway						
	There are many different tax rates, including reduced rates for some sectors/consumers. However, we have no indications that exemptions are applied within this sector.	➤ Exemption on gas for freight and passenger transport within domestic shipping; ➤ Reduced rate for diesel fuel subject to road usage tax; ➤ Domestic aviation under the scope of EU ETS and CO_2 tax (but reduced rate).	➤ Reduced rate for mineral oil used by the pulp and paper industry; ➤ Reduced rates for natural gas and LPG for the manufacturing and mining industries; ➤ Petroleum activities fall under the scope of the carbon tax, even though they also fall under the EU ETS.	➤ Reduced rate for mineral oil and exemption for natural gas/LPG used for fishing and catching in inshore waters; ➤ Tax exemption for gas used for commercial greenhouses; ➤ We have no indications of other specific exemptions / tax reductions related to agricultural CO_2 emissions from fuel combustion.	➤ Non-CO_2 emissions not covered by the CO_2 tax.	➤ HFC & PFC
Portugal						
	No specific exemptions / tax reductions other than the ones that already exist in the context of the tax on petroleum and energy products.	No specific exemptions / tax reductions other than the ones that already exist in the context of the tax on petroleum and energy products.	No specific exemptions / tax reductions other than the ones that already exist in the context of the tax on petroleum and energy products.	No specific exemptions / tax reductions other than the ones that already exist in the context of the tax on petroleum and energy products.		

EUROPE	SCOPE OF THE CARBON TAX OR F GAS TAX					
	Buildings	Transport	Non-ETS Industry	Agriculture (fuel combustion)	Agriculture (non-CO_2)	F-gases
Slovenia						
	No information found that reduced rates are applied within this sector.	No information found that reduced rates are applied within this sector.	➤ Next to EU ETS compa-nies, some cogeneration facilities are exempted; ➤ No information on other exemptions/reduced rates.	No information found that reduced rates are applied within this sector.	According to our informa-tion, non-CO_2 emissions are not covered by the carbon tax.	No separate tax on F gases any-more since 01/04/2016.
Sweden						
	Biomass is exempted.	➤ In general, no reduced rates or exemptions from the carbon tax within this sector; ➤ Still, there is a reduced energy tax rate for die-sel, since it is the fuel most commonly used by the commercial transport sector.	➤ Reduced rates applied up till 2017, but these have almost completely been phased out by January 1st 2018; ➤ Reduced energy tax rates for industry as a compensation, but overall (energy/envi-ron-mental) taxation levels are still very high in Sweden.	➤ Reduced rates applied up till 2017, but these have almost completely been phased out by January 1st 2018; ➤ Reduced energy tax rates for industry as a compensation, but overall (energy/envi-ron-mental) taxation levels are still very high in Sweden.		
Switzerland						
	➤ Biomass is exempted from the carbon tax; ➤ Companies performing spe-cific activities and engaged in voluntary emission reduction agreements, are also exempted from the carbon tax on fuels used for heating their buildings.	Carbon tax is applied only on thermal fuels (so no tax on motor fuels).	Companies with signifi-cant CO_2 emissions can be exempted from the tax if they agree to voluntary reduction agreements (ETS companies are exempted).	Specific activities linked to agriculture can be exempted from the carbon tax, if the companies agree to voluntary agreements (cultivation of plants in greenhouses, processing of agricultural products, fat-tening of pigs and poultry).		
Poland						
Spain						

OTHER COUNTRIES	SCOPE OF THE CARBON TAX OR F GAS TAX					
	Buildings	Transport	Non-ETS Industry	Agriculture (fuel combustion)	Agriculture (non-CO_2)	F-gases
British Columbia						
	➤ The carbon tax is applied to emissions from fuel combustion; ➤ We have found no indications of exemptions or reduced rates within this sector.	➤ The carbon tax is applied on emissions from fuel combustion, so the transport sector is covered in that sense. ➤ We have found no indications of exemptions or reduced rates within this sector.	➤ The carbon tax is applied to emissions from fuel combustion; ➤ Industrial processes are not covered (non-combustion), the same is true for some fugitive emissions.	The carbon tax is applied to emissions from fuel combustion, so those emissions from the agricultural sector are covered.		
Chile						
	It concerns a tax on all stationary sources (boilers or turbines) with a thermal input capacity of 50 MWt or more, so the buildings sector is excluded.		Only exemption is biomass, and there is a special treatment for electricity companies.			
Japan						
		Exemptions apply to shipping, domestic aviation, and railway.	Exemptions / refund measures apply to petrochemical products production, electricity generation with coal.	An exemption applies to heavy fuel used in agriculture, exemptions / refund measures also apply to fishery, forestry.	No indication that non-CO_2 emissions are taxed.	
Mexico						
	➤ Tax on the sales and imports of fossil fuels by manufacturers, producers and importers; ➤ Natural gas exempted.	➤ Tax on the sales and imports of fossil fuels by manufacturers, producers and importers; ➤ Natural gas exempted.	➤ Tax on the sales and imports of fossil fuels by manufacturers, producers and importers; ➤ Natural gas exempted.	➤ Tax on the sales and imports of fossil fuels by manufacturers, producers and importers; ➤ Natural gas exempted.		

OTHER COUNTRIES	SCOPE OF THE CARBON TAX OR F GAS TAX					
	Buildings	Transport	Non-ETS Industry	Agriculture (fuel combustion)	Agriculture (non-CO_2)	F-gases
South Africa						
Provisional, law delayed (a new attempt to pass it in parliament will probably be launched soon)	During the first phase, 60% threshold under which the tax is not payable.	During the first phase, 60% threshold under which the tax is not payable.	➤ During the first phase, 60% threshold under which the tax is not payable; ➤ additional 10% for process emissions; ➤ additional max. 10% for trade-exposed sectors; ➤ additional max. 5% related to benchmarks; ➤ up to 5-10% through offsets possible, depending on the sector.			PFC, HFC, SF_6

Legend:

- Sector/gas fully or almost fully covered by carbon / F gas tax
- Sector/gas partially covered by carbon / F gas tax
- Sector/gas not covered by carbon / F gas tax
- Sector/gas fully or partially covered by a carbon / F gas tax under development (not yet formally approved)
- Insufficient information to assess the scope

3.2.2 Price trajectory

KEY MESSAGES

Currently observed carbon price levels are very diverse and tend to increase over time. A limited number of countries have set formal trajectories for the future evolution of their carbon price.

The High-Level Commission on Carbon Prices recommends the implementation of carbon prices in the order of at least 40-80 US$/t$CO_2$e in 2020 and 50-100 US$/tCO_2e in 2030.

We suggest to frame the debate with three possible carbon price trajectories in Belgium: from an initial level of 10 €/tCO_2e in 2020, the price would gradually evolve to, respectively, 40€/tCO_2e (option A), 70€/tCO_2e (option B) or 100€/tCO_2e in 2030 (option C). This corresponds to an increase of diesel price of 3 €cents/liter (about 2%) by 2020 and of 11 to 27 €cents/liter (about 8 to 19%) by 2030, and to an increase of the natural gas prices of 3% by 2020 and of 13 to 34% by 2030.

The second main implementation modality is the level of the carbon price. Efficiency arguments do support the introduction of a single carbon price across countries and across sectors. However, several methodologies can be used regarding the setting of an appropriate carbon price and none of them leads to a single price level. Moreover, institutional reality brings about that various price levels are observed across the world. Some countries have even introduced reduced price levels in some sectors (cf. Sections 4-8). So most countries have set their carbon price following a pragmatic approach.

An analysis of the carbon price trajectories adopted by those countries that have implemented a carbon tax is presented in the next subsection. It is complemented by a description of the findings of the High-Level Commission on Carbon Prices (Stiglitz and Stern, 2017) and by a proposal for implementation options in Belgium regarding a 'default' or maximum value, while the implications of defining lower levels for specific sectors is discussed further on in the sectoral analyses (Sections 4-8).

Observed price levels and trajectories

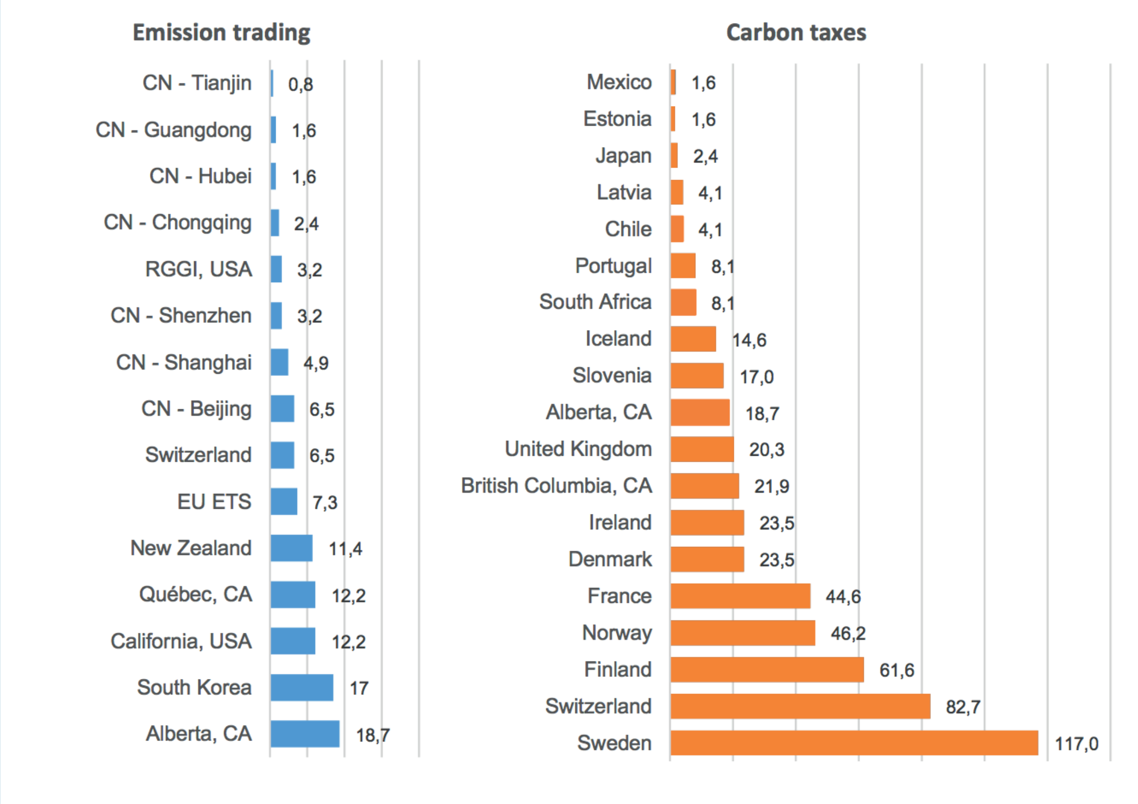
As mentioned earlier on, carbon pricing started in the early nineties in the form of carbon taxes adopted by Northern European countries: Finland (1990), Sweden and Norway (1991), and Denmark (1992). Since then and since the launch of the EU ETS in 2005, carbon pricing has been implemented in a large number of countries or regions. Figure 16 illustrates the various carbon prices observed in 2018.

The carbon price trajectory followed in these countries and regions is of particular interest. Figure 17 shows these pathways for a selection of countries.

We observe that most countries have launched their system with relatively moderate price levels before increasing them progressively. Northern Europe countries started with a carbon price ranging from close to zero to about 25 euros per tCO_2e and have raised it to 20 and more than 100 euros over 25 years. In some countries/regions, the increases in the price level occur very progressively (France, Ireland, …). In other cases, the rise occurs in a rather stepwise manner (Sweden, Switzerland, …).

Moreover, some countries have defined an explicit trajectory to be followed ex ante. This is the case in France and in Switzerland.

Figure 16: Carbon prices in 2018 (euros/tCO_2e)



Source: I4CE (2018)

In France, a thorough debate has taken place on the shadow price ("*valeur tutélaire*") of carbon (see the so-called 'Quinet report', 2008). Two possible methodologies have been defined to determine the appropriate price of carbon. The first one is based on the concept of the "social cost of carbon". This concept is currently being used by many governments in their cost-benefit analyses of infrastructure projects. The second one builds on the concept of cost-efficiency and consists of identifying the value of carbon required to reach a certain level of carbon emission reductions. However, given the many uncertainties linked to modelling, both methodologies lead to a broad range of possible values so that the Quinet report recommends values adopted on the basis of a consensus between experts.

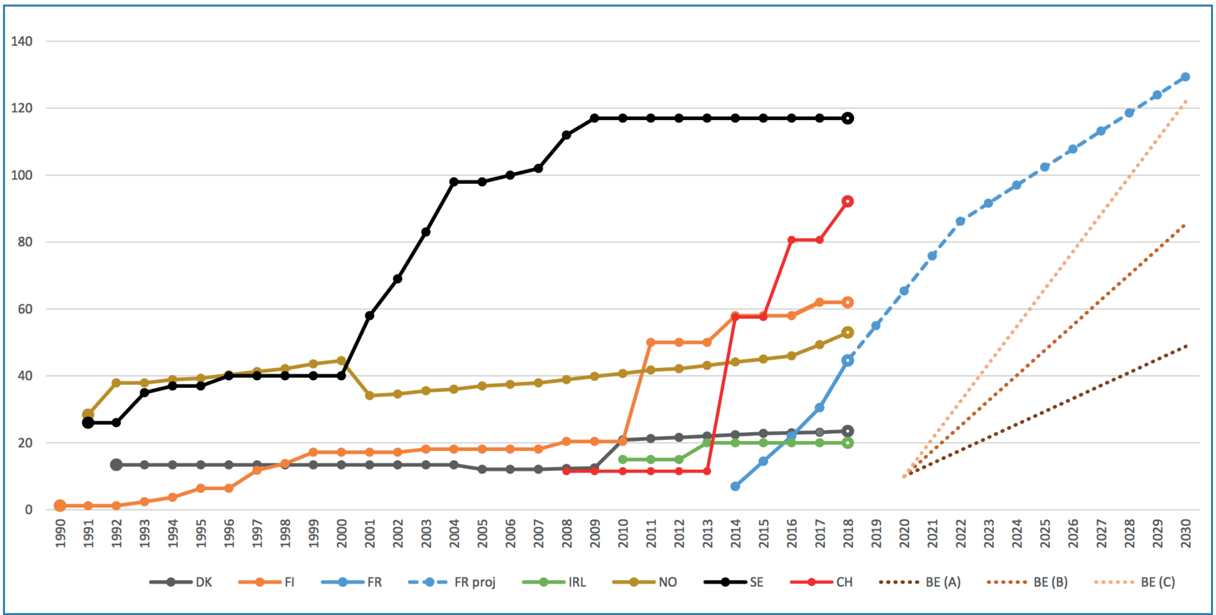
Table 3: The French « valeur tutélaire du carbone » ($euros_{2008}/tCO_2e$)

	2010	2020	2030	2050
Recommended value	32	56	100	200 (150-305)

Source: Centre d'Analyse Stratégique (2008)

As shown in Table 3, the recommended values increase gradually, from 32 euros in the first year (2010) up to 100 euros in 2030. Beyond 2030, the experts recommend to follow a specific rule (the so-called 'Hotelling rule') linked to the official public discount rate, namely 4%, leading to a level of about 200 euros by 2050.

Figure 17: Past, current and projected maximum nominal carbon tax rates (euros/tCO_2e), selection of countries and options for a carbon price path in Belgium



Source: Authors, Personal communications

In Switzerland, any rise in the level of the carbon levy is linked to the (non-)achievement of well-defined GHG emission targets (Art. 94 of the '*Ordonnance sur la reduction des émissions de* CO_2', 30 November 2012[14]):

"The levy shall be increased as follows:

a. from 1 January 2014:
at 60 francs per ton CO_2*, if the* CO_2 *emissions from thermal fuels in 2012 exceed 79% of 1990 emissions;*

b. from 1 January 2016:
1. at 72 francs per ton CO_2 *if the* CO_2 *emissions from thermal fuels in 2014 exceed 76% of 1990 emissions,*
2. at 84 francs per ton CO_2 *if the* CO_2 *emissions from thermal fuels in 2014 exceed 78% of 1990 emissions;*

c. from 1 January 2018:
1. at 96 francs per ton CO_2 *if the* CO_2 *emissions from thermal fuels in 2016 exceed 73% of 1990 emissions,*
2. at 120 francs per ton CO_2 *if the* CO_2 *emissions from thermal fuels in 2016 exceed 76% of 1990 emissions."*

We also observe that the EU 2030 climate and energy objectives, in particular the 2030 GHG emission reduction target in the non-ETS sectors, stimulate countries to adopt a long(er) term perspective at the level of the carbon price. In Ireland, for instance, the Ministry of Finance and the Economic and Social Research Institute (ESRI) are currently considering and analysing the extent to which a broader scope and (higher) carbon price could contribute to the achievement of their 2030 non-ETS target. Although the carbon price has been originally implemented with a view to generate public revenues to reduce the deficit, the country might thus consider redirecting the primary objective of its carbon tax policy towards an environmental goal.

Finally, as shown earlier in Section 2, energy prices tend to fluctuate significantly. The impact of carbon prices, with a level within the range of those already adopted in several countries and regions, could be partially, if not totally, offset by such fluctuations. On the other hand, carbon prices in the form of a carbon tax do not smooth any energy price increase. Still, we have not found any system in which the carbon tax would be explicitly linked to energy price fluctuations. In France, the Quinet report alludes to this specific issue, but concludes that it would not, for the time being, be relevant to explicitly establish such a link.

[14] See https://www.admin.ch/opc/fr/classified-compilation/20091310/index.html.

Recommendations from the High-Level Commission on Carbon Prices

In 2016, the Carbon Pricing Leadership Coalition (CPLC)[15] has conveyed a group of leading economists, and climate change and energy specialists chaired by J. Stiglitz and N. Stern in order to define indicative corridors of carbon prices to be used in climate policies to deliver on the ambition of the Paris Agreement.

Two methodologies can theoretically be used to assess such an appropriate carbon price level. The first one is based on the "social cost of carbon" concept. It represents the damage caused by the emission of one additional unit of GHG into the atmosphere. Computable integrated assessment models can then be used to provide estimations of such a price level. However, the range of values computed under this approach is extremely large and is of limited help to policy purposes. Such a modelling approach faces indeed severe limits because it is intrinsically based on valuation of climate damages, thus involving large uncertainties, issues of non-market impacts valuation and ethical dimensions.

The second approach rests on the concept of cost-effectiveness and aims at finding the level of the carbon price that is required to reach a given constraint on GHG emissions, such as the reduction required to comply with the Paris Agreement objectives. The results of the modelling exercises following this approach depend on a number of assumptions such as technological progress, the policy package, the level of energy prices, assumptions on economic growth or the possible behavioural responses. Although the range of carbon price levels is usually smaller than under the first approach, it cannot be used as such either.

Therefore, these methodologies based on computable models provide useful insights that need to be complemented by further analyses and expert judgments.

The conclusions of the Commission are (p. 50):

> *"Based on industry and policy experience, and the literature reviewed, duly considering the respective strengths and limitations of these information sources, this Commission concludes that the explicit carbon-price level consistent with achieving the Paris temperature target is at least US$40–80/t$CO_2$ by 2020 and US$50–100/t$CO_2$ by 2030."*

The Commission also points out that the objective of the Paris Agreement is also achievable with lower near-term carbon prices than indicated above. However (p. 51):

> *" (…) doing so would require stronger action through other policies and instruments and/or higher carbon prices later, and may increase the aggregate cost of the transition."*

Finally, the Commission highlights the necessity for the carbon price trajectory to be not only clear, but also credible. Such a credibility proves to be essential for investors to effectively move towards low carbon alternatives.

Options in Belgium

On the basis of the lessons learned from other countries and the recommendations of the High-Level Commission on Carbon Prices, we suggest three different options for a 'default' carbon price trajectory in Belgium on which we will base our analyses.

Under each option, the initial carbon price would be set at a relatively low level. Still, such a level must be noticeable. It is suggested to start in 2020 with a (nominal) level of 10€/tCO_2e.

The first option would consist in adopting, by 2030, a carbon price level that roughly corresponds to the high-end of the range recommended by the High-Level Commission on Carbon Prices and that is similar to the price level adopted by the countries with the highest level, namely around 100 €/tCO_2e. Let us assume that carbon pricing is introduced in 2020 and that, consequently, this value in 2030 would be expressed in prices of the year 2020 (thus 100 $€_{2020}$/tCO_2e in 2030)[16].

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15 The CPLC is a voluntary partnership of national and sub-national governments, businesses, and civil society organizations that agree to advance the carbon pricing agenda. Its secretariat is administered by The World Bank.

16 Assuming an inflation rate of 2% per year, this would correspond to 122 euros in nominal terms in the year 2030, as illustrated in Figure 17 above.

Under a second option, the price level by 2030 would correspond to the carbon value defined in the impact assessment of the European Commission (E.C., 2014), i.e. about 40 €/tCO_2e, which would be in line with the price of the EU allowances in the EU ETS as forecasted by some analysts (see Section 2.1). A last option would consist in adopting an intermediate value, 70€/tCO_2e, at the same horizon. Again, both values would be expressed in prices of the year 2020.

In terms of trajectory, the simplest option consists in adopting a linear trajectory between 2020 and 2030. Such trajectories are depicted in Figure 17 above.

Given the long term perspective, indicative carbon prices are also suggested for the period after 2030, based on the French experience. Adopting the same annual carbon price increase for the period 2031 to 2050 as the annual increase over the period 2020 to 2030, leads to carbon prices of 100, 190 and 280 €/tCO_2e by 2050. These options are summarized in Table 4 below.

Table 4: Suggested carbon price trajectory options (in $€_{2020}$/tCO_2e)

	2020	2030	2050
A	10	40	*100*
B	10	70	*190*
C	10	100	*280*

The impact of the carbon price on the price of energy depends on the CO_2 content of the different energy vectors. Table 5 illustrates the rise in the price of diesel, petrol, heating oil and natural gas for different carbon prices, on the basis of 2006 IPCC default emission factors.[17] The impact is shown in absolute terms (euros per unit) and as a percentage of a given price level. The increase in the price level should, however, not be confused with any change in the energy bill, as we shall see later on.

Table 5: Indicative impact of different carbon price levels on a selection of energy prices

	Diesel		Petrol		Heating oil		Natural gas	
CO_2e Emission Factor	2,71 kg/l		2,24 kg/l		2,63 kg/l		0,202 kg/kWh	
Consumer price	1,4 €/l		1,4 €/l		0,7 €/l		0,06 €/kWh	
Carbon price	**€/l**	**% of price**	**€/l**	**% of price**	**€/l**	**% of price**	**€/kWh**	**% of price**
10 €/tCO_2e	0,03	2%	0,02	2%	0,03	4%	0,00	3%
40 €/tCO_2e	0,11	8%	0,09	6%	0,11	15%	0,01	13%
70 €/tCO_2e	0,19	14%	0,16	11%	0,18	26%	0,01	24%
100 €/tCO_2e	0,27	19%	0,22	16%	0,26	38%	0,02	34%
200 €/tCO_2e	0,54	39%	0,45	32%	0,53	75%	0,04	67%

Sources: Authors, 2006 IPCC default emission factors, European Commission Weekly Oil Bulletin, FPS Economy

[17] 2006 IPCC default emission factors (that do not take biofuels into account), May 2018 average prices from the European Commission Weekly Oil Bulletin for diesel, petrol and heating oil, 1st trimester of 2018 average price for natural gas (household with a yearly consumption of 23.260 kWh) from Prijzenobservatorium - INR, FPS Economy.

3.2.3 Use of public carbon revenues

KEY MESSAGE

Three different ways to spend the revenues from carbon pricing can be identified from the theory and from case studies: direct redistribution or compensation for households or companies, tax shift and support of the transition in specific domains.

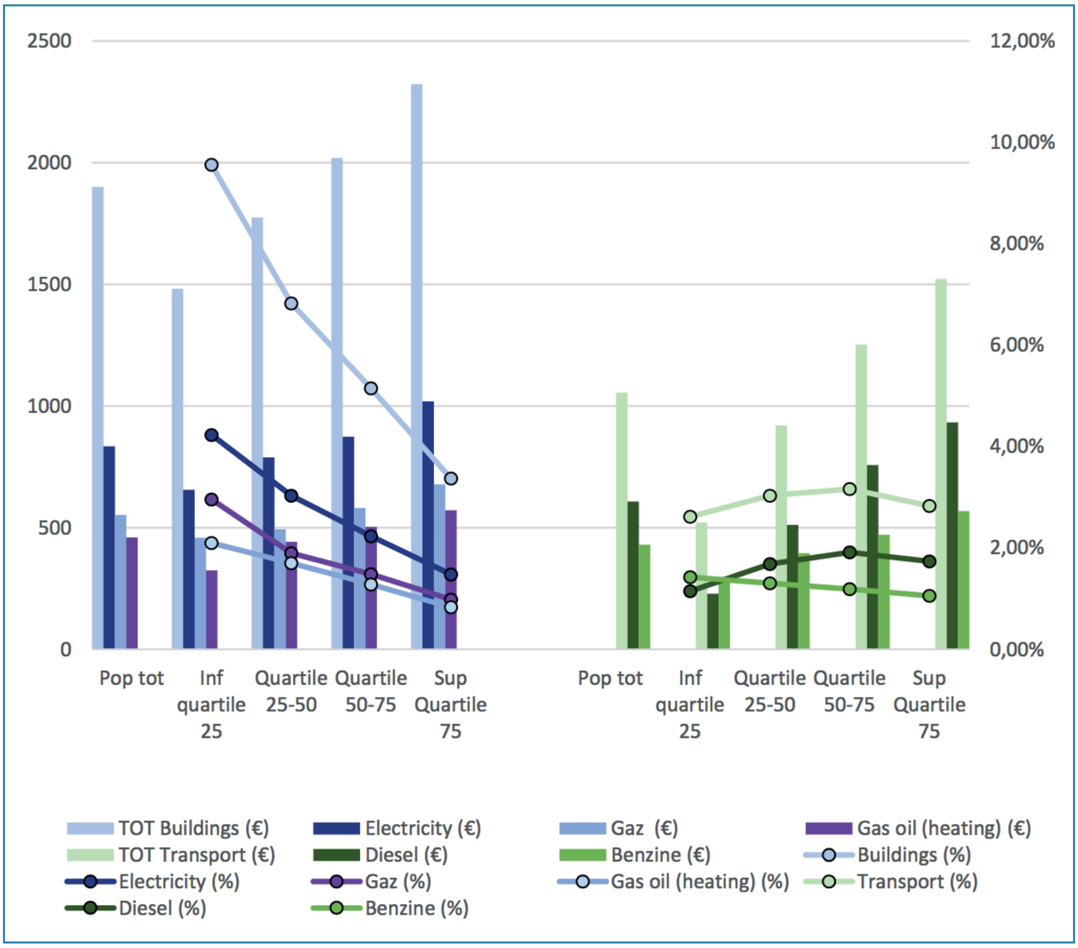
Almost all countries that have implemented a carbon tax have chosen specific uses for the collected public revenues, which can be regarded as a form of 'budget neutrality'. One noticeable exception is Ireland that allocated the proceeds of the carbon tax to its general budget with a view to reduce the public debt.

Three main channels for recycling the revenues can be distinguished. Each of them is further analysed in the sectoral analyses (Sections 4-8).

Redistribution/compensation

Firstly, the carbon revenues can be used for direct redistribution or compensation purposes to households or to companies. Regarding the impact of a carbon price on household spendings, energy expenditures in the buildings sector vary significantly across Belgian households (see Figure 18). As also observed in most other OECD countries (see for instance OECD, 2015a), the share of energy expenditures in total expenditures decreases strongly with the level of income, showing the potentially regressive effect of carbon pricing in that sector.

Figure 18: Distribution of households' energy expenditures in the buildings and transport sectors in 2014: in euros (left scale) and as a percentage of total expenditures (right scale)



Source: Survey on households' budget (2016)

As pointed out by Eyckmans (2017), other instruments than carbon pricing are also potentially regressive, such as imposing insulation norms that increase the cost of renting or building, for instance. In the transport sector, the share of fuel expenditures remains relatively stable across income levels, implying that the distributive aspects might be less of a concern in that sector. Still, as we will see in the sectoral analyses, these data might hide a significant level of heterogeneity within the income classes so that further insights are required to fully understand potential distributive concerns.

Regarding distributive impacts on companies, competitiveness aspects must be accounted for and need to be analysed on a sectoral basis. In the same spirit as under the EU ETS, where companies at risk of carbon leakage benefit from freely allocated emission quotas, some form of compensation for companies facing a carbon price in the non-ETS sector could be financed by the proceeds from the carbon price.

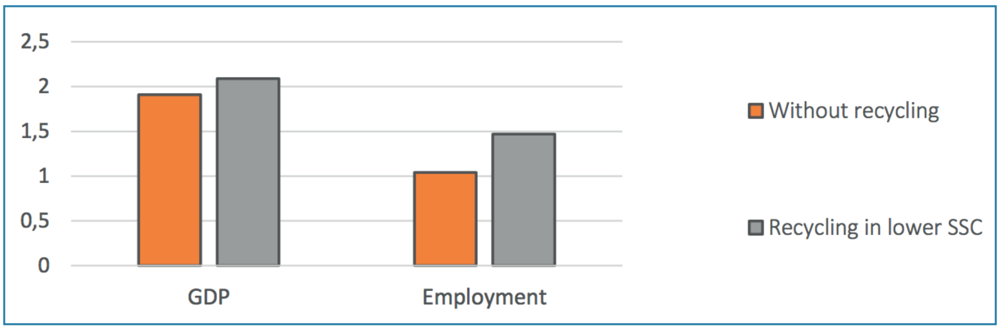
Tax-shift

Secondly, the recycling could consist of implementing a tax shift from existing fiscal bases towards fossil fuels and other GHG emission sources. This could lead to an improvement of the efficiency of the overall tax system by reducing the marginal cost of public funds, i.e., a reduction of distortionary taxation.

Labour

As we shall see later on, countries such as Sweden and France have allocated most of the revenues stemming from their carbon tax to the reduction of charges on labour. In Belgium, taxes on labour are a particularly good candidate for reducing distortionary taxation, in particular if less qualified workers are targeted. In this context, although social security contributions are a straightforward option, other options can also be considered. Bernheim (2017) for instance highlights the large potential to capture a double dividend in Belgium given, amongst others, the relatively high cost of raising public revenues on labour and the low level of energy taxation with respect to other EU Member States. Indeed, macroeconomic analyses have empirically shown that such a double dividend can be captured, leading to a significant rise in employment levels. In Bossier et al. (2016), it has been found that low carbon investments can trigger growth and employment (see Section 2.3 and Appendix 2). In particular, low carbon investment scenarios have been analysed together with the introduction of a carbon price in the non-ETS sectors, under two variants: in the first variant, all the proceeds from the carbon price are used to reduce the public debt (which does not lead to any macroeconomic feedback in the model); in the second variant, the carbon price revenues are used to lower social security contributions. As illustrated in Figure 19, the modelling exercise clearly shows that recycling carbon revenues in labour tax cuts can lead to a significant positive impact on GDP and employment, with an additional rise of about 0,5 percentage points of the employment level in the scenario analysed w.r.t. the baseline.

Figure 19: Illustration of the potential impact on GDP and employment of recycling carbon tax revenues in lower taxes on labour in the context of a low carbon transition (in % w.r.t. baseline, in 2030)



Source: Berger et al. (2016)

However, these modelling exercises necessarily face inherent limits of such approaches and concerns have been raised on two aspects. First, the extent to which lower social security contributions do lead to actual reductions of labour costs is challenged by some observers.

Second, the financing of such tax cuts would not be permanent since the purpose of the carbon price –as the low carbon transition- is to gradually phase out carbon emissions. We will show, however, that, if the carbon price rises gradually, a large and relatively stable amount of revenues can be collected for at least two decennia.

Electricity

In the same vein, some actors argue that electricity is disproportionately taxed with respect to other energy vectors, at least in comparison with other Member States (especially our neighbouring countries). Sectoral analyses highlight in detail the extent of the gap by type of fuel (see Sections 4 to 8) and show that such a gap does indeed occur in all sectors. At the same time, the low carbon transition requires electrification of the energy demand sectors (buildings, transport and industry), as shown in Section 2.3. Although energy efficiency arguments do not necessarily plead for a reduction in the level of energy prices (and thereby of electricity prices), a reduction of the electricity-fossil fuels price gap is likely to foster the switch (see again the sectoral analyses for more details). In this context, some actors argue that (part of the) carbon price proceeds should be devoted to the reduction of electricity prices.

Such a reduction could take place through a cut of taxes or levies on electricity. These taxes and levies apply in different forms and at different levels. The impact of a given amount of public revenues devoted to such tax cuts on the final electricity prices will then depend on the precise tax or levy being cut (e.g. VAT, offshore levy, federal contribution, regional levies for public service obligations, etc.). In particular, some actors benefit from degressive rates for some electricity taxes and levies. Hence, for any given budget, the reduction of the electricity price for a given consumer profile will depend on which taxes and levies are under consideration.

Although a comprehensive and thorough estimation of such impacts is currently beyond the scope of the present analysis, back of the envelope calculations highlight some orders of magnitude. For instance, let us first assume a fictive, conservative case where no degressivity would apply and use a level of yearly electricity consumption of 80 000 GWh and a price of 27,44c€/kWh[18] while assuming a price elasticity of zero[19]. In this case, a budget of 200 M€ would allow for an electricity price reduction of 0,25 c€/kWh (amounting to almost 1% of households' price). A budget of 1000 M€ would be required to reduce it by 1,25 c€/kWh (a bit less than 5% of households' price). Another example, with degressivity this time, is the offshore levy. Using 2016 data[20], we observe that abolishing the offshore levy would then lead to a reduction equivalent to 1,6% of the households' electricity price and require a budget of 217,527 M€ to finance it.

Bearing in mind the limits of such rough calculations, these amounts can be compared with the total (all sectors) expected carbon price revenues, which we estimate to be at maximum 607 M€ by 2020 and 2737 M€ by 2030 for price trajectory B, that is 10 €/tCO_2e and 70 €/tCO_2e in 2020 and 2030, respectively. They must also be put into perspective with respect to other potential uses of these revenues, as well as other means to reduce the different components of the electricity price.

Fostering the transition

Thirdly, the carbon revenues can be directed towards policies aimed at fostering the energy/low carbon transition. The financing of research or innovative projects is one such example.

In all cases, the evolution of these revenues over the long run must be looked at carefully as the objective is to gradually phase out carbon emissions: for any given scope and price level, revenues necessarily decline over time. However, two elements might ensure a relatively stable level of carbon pricing revenues, at least for two or three decades: the carbon price could have an upward trajectory and the scope could be progressively enlarged. Again, further details are provided in the sectoral analyses.

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18 Households' average price related to a yearly consumption between 2.500 and 5.000 kWh, 2nd semester 2016.

19 This is obviously a strong working assumption which, nevertheless, does not impact the assessed order of magnitude, a fortiori in the short/medium term. Moreover, changes (i.e. increases) in the level of electricity consumption would then increase the revenues from the other (not reduced) electricity taxes and levies.

20 More precisely: Offshore levy: 0,38261 c€/kWh; electricity price: 27,44 c€/kWh (*); electricity consumption: 77 665,6 GWh; degressivity reimbursements offshore levy: 79,629 M€.

3.2.4 Policy alignment

KEY MESSAGE

Following the third overall principle, carbon pricing must be developed together with a large set of measures that complement each other. Moreover, existing measures might have to be accounted for and possibly reformed for them to be aligned with carbon pricing. This particularly applies to environmentally harmful subsidies.

Any carbon pricing policy must be carefully aligned with a multitude of other policies and objectives at different levels (see for instance OECD, 2015b).

By increasing the price of fossil fuels, carbon pricing can reinforce the impact of energy efficiency measures and foster the competitiveness of alternative, renewable sources of energy. In that sense, the interplay between policies aimed at supporting energy efficiency or renewable energy investments must be analysed and possibly reformed. Obviously, environmentally harmful subsidies are not aligned with the low carbon transition as they direct behaviour and investments towards high carbon options.

In the transport sector, policies aimed at internalizing different external costs are in place or planned at regional and at EU levels (e.g. road pricing, eurovignette). Carbon pricing must be designed in such a way that it suits these developments. As part of the environmentally harmful subsidies, the favourable tax treatment of company cars must be further evaluated.

In the buildings sector, several strategies are currently being developed to address the renovation of public and private buildings with a comprehensive set of objectives, policies and measures. Carbon pricing would need to fit into this policy framework and reinforce it. The potential increase of air pollution due to the use biomass in this sector (as in other sectors) must also be addressed.

In both the transport and the buildings sectors, the strong interlinkages between climate policies, such as carbon pricing, and other policies aimed at controlling air pollution need to be addressed. Moreover, the alignment of carbon pricing with biomass and biofuel strategies must be carefully considered.

Many, if not most of the energy intensive industries that do not take part to the EU ETS have signed voluntary agreements with regional authorities. These agreements aim at fostering energy efficiency and GHG emission reductions by providing a financial incentive in the form of reduced tax payments or other contributions.

Several of the above-mentioned policies, measures or issues will be touched upon in the sector-specific analyses (Sections 4 to 8).

3.3 METHODOLOGY FOR THE SECTORAL APPROACH

KEY MESSAGES

In each sector, the context is described and a benchmark analysis on energy prices is performed together with an analysis of lessons learned from other countries. Different impacts of carbon pricing are analysed, depending on the sectors. In each sector, key implementation issues and options are presented.

Carbon pricing impacts are analysed from the perspective of a low carbon trajectory.

Identifying the precise impact of carbon pricing on energy consumption and GHG emissions is particularly challenging; assumptions on carbon price responsiveness need to be used cautiously.

In each sector, the context is first described in terms of GHG emissions and key characteristics are presented together with the corresponding CORE low carbon trajectory, when available. Then, energy prices, including taxes, in the sector are analysed and compared with their levels in other, most often neighbouring countries[21]. Lessons learned from the concrete implementation of carbon taxes abroad are detailed as well.

A series of impacts are also analysed at the sectoral level. In the buildings and the transport sectors, these include analyses performed on the energy bill[22], on expected public carbon revenues, as well as on the profitability of low carbon investments at both micro and sectoral levels. In the other sectors, the impact analyses focus mostly on expected carbon revenues.

Finally, specific, sectoral policy alignment issues are presented which, together with the above-mentioned elements, underpin the key implementation options.

Before turning to the sectoral analyses, some methodological aspects need further clarifications. They relate to the fact that the impact of carbon pricing is analysed along a low carbon scenario and that it is, in this context, particularly challenging to quantitatively assess the contribution of carbon pricing to the reduction of energy consumption. Further clarifications on energy price assumptions are also provided below.

3.3.1 Analysing the impact from the perspective of a low carbon scenario

Tax incidence analyses are often performed in a static or short-term framework. In its most simple form, the analysis consists in raising the price of the energy vector being taxed and to account for reduced consumption from current or projected business-as-usual levels through a given, direct, price elasticity of demand.[23] However, such an approach faces severe limitations, in particular in the context of the low carbon transition.

As outlined in Section 3.1, we work under the assumption that carbon pricing (in the non-ETS sectors) would (i) take place in the context of our commitments to decarbonise our economies and reach our long-term climate mitigation goals, and (ii) fit into a package of policies and measures that will need to be implemented at different levels, including the local, regional and EU levels. As suggested by the projec-

21 Next to the neighbouring countries, Ireland and Sweden have been included to the benchmark analyses in order to compare tax and price levels with additional countries (next to France) having already introduced a carbon tax. For these countries, it was possible to collect sufficient information in order to include them to the analysis.

22 By energy bill, we mean the payments made by different economic actors to purchase energy. Energy efficiency investments (e.g. insulation of houses, purchase of electric car, etc.) are therefore not included; it is the result of the average energy consumption by energy uses, the energy prices and the carbon price.

23 For instance, a consumption of 100 units at the price of 10 euros per unit leads to a bill of 1000 euros. Under a tax of 2 euros per unit and assuming a price elasticity of -0,5, the bill raises to 1080 euros and the public revenues amount to 180 euros.

tions of the non-ETS emissions under current policies (see Section 2.2), these new policies and measures will be critical to reach significant reductions in the non-ETS sectors.

Hence, the analysis of any middle to long-term impacts on prices and expenditures should best take this context into account and should therefore start from a low carbon scenario instead of a business-as-usual scenario. Concretely, the impact analysis will be based on the "CORE" low carbon scenario developed in the context of the study "Scenarios for a low carbon Belgium by 2050" (see Section 2.3).

These scenarios have been slightly updated to account for the recent evolution of GHG emissions in the sectors:

- The new REFERENCE scenario (here referred to as Business-as-usual, BaU) is coherent with the most recent official projections, the « With existing measures » scenario (WEM)[24];
- The new CORE scenario (here referred to as Low-Carbon scenario) follows a different trajectory as the BaU from 2020 onwards and reaches similar GHG reductions by 2050 w.r.t the initial CORE scenario (80% GHG reduction vs 1990).

3.3.2 On the difficulty of disentangling the impact of carbon pricing from the impact of other actions or policies and measures on emissions and energy consumption

This being said, it is particularly challenging to disentangle the impact of carbon pricing from the impact of other policies and measures that would together lead to a low carbon scenario.

Limits of the price elasticity concept

First, understanding the interplay between carbon pricing and other potential policies and measures which, together, would 'fill the gap' between a business-as-usual and a low-carbon scenario is far from being obvious. Although carbon pricing and the other policies and measures would tend to reinforce each other, the question of the attribution of emission or energy consumption reductions often remains an open question, a fortiori when these measures are not yet precisely defined.

Second, the low-carbon transition is not about short-term and marginal changes, but rather about structural, profound and long-term changes in (energy) systems wherein substitution possibilities as well as long-term behavioural and cultural changes are essential elements.

The usual methodology for estimating the effect of a price instrument on related quantities is based on the concept of price elasticity of demand and has severe limits in this context (see e.g. DeCanio, 2003). Estimations of elasticities are based on past observations of energy price changes. These observations therefore relate to price changes that occurred in systems and circumstances that are fundamentally different from those envisaged in the middle and in the long term and as such, their validity can be questioned.

Moreover, recent research points to the potential underestimation of the effect of a carbon tax on GHG emissions when the usual price elasticities of demand are used (see e.g. J. Andersson, 2017, p.33):

> *"[…] consumers respond more strongly to changes to the carbon tax rate than equivalent market-driven gasoline price changes. If carbon tax elasticities are indeed larger than price elasticities of demand for some goods, this has implications for climate change policies as well as economic theory. In the policy arena, carbon taxes would be more effective in reducing GHG emissions and air pollution than previous simulation studies using available price elasticities suggests."*

Indeed, it is suggested that carbon taxes are more stable and foreseeable than changes in (volatile) energy prices because they implicitly or even explicitly convey the message that we need to decarbonize our energy systems, thereby leading to a greater demand shift than a change in prices of the same magnitude caused by other, less explicit factors, such as oil price fluctuations.

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[24] See National Climate Commission, March 2017.

Energy-demand price elasticities from the literature

Despite such strong limitations, elasticities are used in many impact analyses. Table 6 shows a number of such elasticities for the buildings and the transport sectors. Again, these must be considered as indicative given the methodological limits, as well as being on the conservative side given the potentially larger impact of carbon prices compared to changes in energy prices stemming from other origins as explained above.

Table 6: Assumptions on the responsiveness of energy demand to rises in energy prices due to the introduction of a carbon price: energy demand-price elasticities in the buildings and transport sectors

Sector	2020	2025	2030	2035	2040	2045	2050
Buildings - Residential	-0.20	-0.35	-0.50	-0.50	-0.50	-0.50	-0.50
Buildings - Commercial	-0.20	-0.35	-0.50	-0.50	-0.50	-0.50	-0.50
Transport - Passengers	-0.20	-0.28	-0.35	-0.35	-0.35	-0.35	-0.35
Transport - Freight	-0.15	-0.28	-0.40	-0.40	-0.40	-0.40	-0.40

Sources: multiple sources as described below

As can be seen in the table above, elasticity level assumptions were defined for the different sectors in the short-, mid- and long-term, as expressed respectively in the years 2020[25], 2025 and 2030 through 2050. As the literature shows, elasticity levels are difficult to evaluate, especially in the longer term. The present approach has taken short-term elasticity values based on empirical estimations from different publications – those are explained hereafter. For the mid- and long-term elasticity values, the evolution of elasticities was estimated starting from the short-term values, based on a qualitative review of the literature.

Regarding the residential buildings sector, the short-term price elasticity corresponds to the assumption taken by the French Ministry of the Environment in 2017 to evaluate the impact of a carbon price on households (2017 French Report for MMR[26]). Precisely, a value of -0.2 is used, which reflects a low sensitivity to energy prices in the short-term. In the longer term, the price elasticity is increased to -0.5 as suggested by the analysis of the European University Institute (2016)[27], reflecting higher sensitivity to energy prices. This higher elasticity value is also confirmed by the bibliography review by Lipow (2007). The elasticity trajectory taken for the commercial buildings sector follows the assumption that the responsiveness of the sector's energy demand will grossly be the same as in the residential buildings sector in view of price increases.

The short- and long-term elasticities of the passenger transport sector are taken from the analysis of the European University Institute. The short-term elasticity value is considered lower for freight transport to reflect that fewer lower-carbon alternatives are available today. The long-term elasticity is considered higher for freight transport to reflect that long-term elasticities are higher for businesses as suggested by the above-referred results by the European University Institute (2016) and Lipow (2007). The -0.4 elasticity value corresponds to the one assumed by the French Ministry of the Environment in its MMR reporting exercise.

Our approach

Given the methodological difficulty to properly work with price elasticities, we adopt an intermediate, pragmatic approach.

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25 The year 2020 is taken as a baseline where the first, short-term effects of the implementation of a carbon price will occur

26 Rapport de la France en application de l'article 13.1 du règlement n° 525/2013 relatif à un mécanisme pour la surveillance et la déclaration des émissions de gaz à effet de serre, Actualisation 2017.

27 The paper quantitatively summarizes recent empirical evidences, using meta-analysis to identify the main factors affecting the elasticity results, both short and long term, for energy in general as well as for specific products: electricity, natural gas, gasoline, diesel and heating oil.

We consider that it is not possible to precisely assess the expected impact of a given carbon price level on energy consumption and that, besides cultural aspects, such an impact depends mostly on the set of other policies and measures that will be adopted at different levels. In a way, one can consider that the lower the carbon price, the more ambitious the other complementary policies and measures need to be in order to set the economy on a low carbon pathway. In other words, different carbon price levels could lead to the same levels of energy consumption depending on the mix of complementary policies and measures.

Nevertheless, we want to highlight the fact that *ceteris paribus*, thus in any given policy context, different carbon prices lead to different energy consumption levels and thereby different impacts, in particular on (i) the energy bill and (ii) expected public revenues. Therefore, despite its limits, we follow, for the assessment of those two impacts in the buildings and the transport sector, the methodology adopted for the analysis of the macroeconomic impacts of the low carbon scenarios (Berger et al., 2016): we assume that the introduction of a carbon price will lead to an additional energy consumption reduction, beyond the reductions already assumed in the low-carbon CORE scenario, according to the above-mentioned price-elasticities. Given the levels of the carbon price and of the elasticities assumed, this additional reduction remains limited as we will see.

Given its limits, we will use the approach cautiously, in a conservative manner and highlight the role of the assumed price-elasticities on the results. In order to elaborate further on the extent to which the carbon price could have an impact on energy consumption, micro analyses have been performed on its impact for the profitability of low carbon investments in the buildings and the transport sectors.

3.3.3 Assumptions on energy prices

The levels of energy prices, in particular their relative evolutions, play an important role in the assessment of the above-mentioned impact analyses. The energy vectors to be considered here do include electricity. Indeed, although it is suggested not to apply any additional carbon price to electricity production as it already falls under the EU ETS, assumptions on its price evolution are nevertheless required as they may play an important role in the analysis of substitution possibilities, in particular because of the electrification of important segments of the demand sectors.

For clarity purposes, analyses are performed on the basis of constant energy prices assumption and the sensitivity of the results to different energy price evolutions is analysed. Constant energy prices considered in the analyses are the price levels observed in 2016. Results provided under this assumption should be interpreted having in mind a context of historically increasing energy prices on average[28]. Sensitivity analyses are therefore performed to test the robustness of the results, considering possible energy price evolutions suggested by modelling work by the International Energy Agency. These energy price trajectories are provided in Figures A.2.3 and A.2.4 of Appendix 2.

[28] E.g. +3%/year on average since 2000 for diesel, +6%/year since 2010 on average for electricity prices for households. Note that 2016 fossil-fuel energy prices were, however, lower than the ones observed in the period 2010-2015. Source: Statista.

4 Buildings

The implications of setting a carbon price on GHG emitted in the buildings sector are discussed in this Section. The context of the sector is first described, in terms of emissions, key characteristics and long term low carbon perspectives. Second, current levels of energy prices and taxes in the sector are analysed together with experiences in pricing carbon emissions from buildings abroad. In the third subsection, impact analyses are provided on the average energy bill, on expected public revenues, on the profitability of low carbon investments and on the total costs at sectoral level. The main policy alignment issues are analysed in a fourth subsection. Finally, key implementation options are described on the basis of all these analyses and the discussions held with key actors.

4.1 CONTEXT

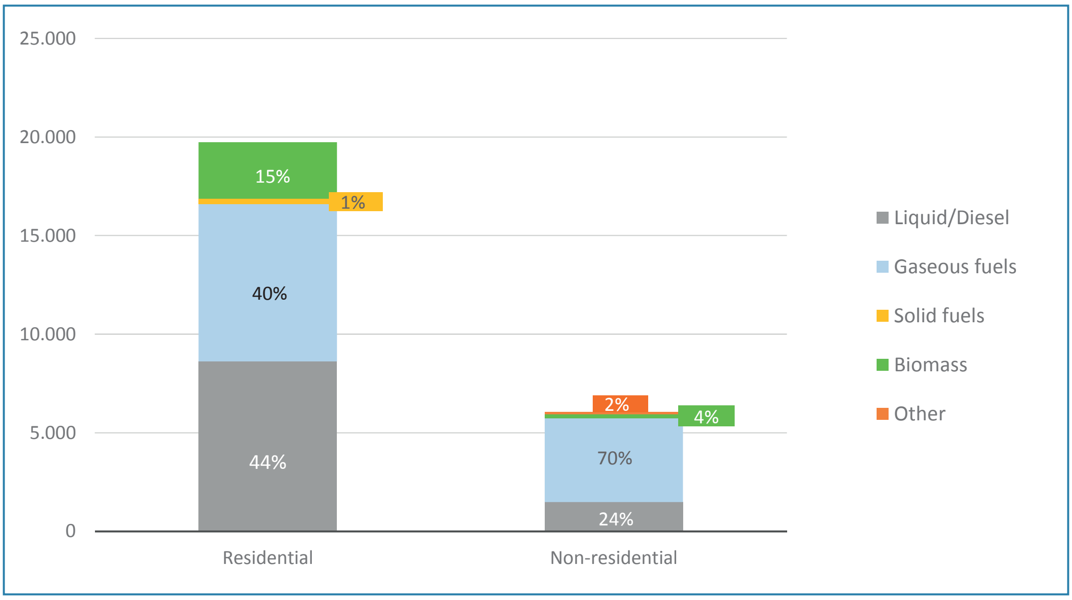
This section provides an overview of the status of the buildings sector and the main stakes for its low-carbon transformation. It successively describes the main characteristics of the Belgian buildings stock, the resulting GHG emissions and their evolution in the low-carbon scenario.

4.1.1 Emissions

KEY MESSAGES

GHG emissions in the buildings sector represented 31% of total Belgian non-ETS emissions in 2016. Emissions in this sector have been reduced by 0,3% per year on average between 1990 and 2016, well below the estimated 2,9% required to reach zero emissions in 2050.

Figure 20: 2016 GHG emissions in the Buildings sector



Source: NIR 2018

GHG emissions in the buildings sector amounted to 31% of non-ETS emissions in 2016, with 23% for residential buildings and 8% for non-residential buildings. GHG emissions in the buildings sector have been reduced by 8,2% between 1990 and 2016 i.e., 0,3% per year on average vs 2,9% per year on average required between 2016 and 2050 to reach zero GHG emissions in 2050 as in the initial CORE scenario.

Gas is the first source of GHG emissions in buildings: it represents 40% of total GHG emissions in residential and 70% in non-residential buildings. Its share is moreover increasing since 1990. Heating oil comes second with 44% and 24%, respectively. Its share is decreasing since 1996. Biomass accounts for 15% of GHG emissions in residential buildings and 4% in non-residential buildings (2016, see Figure 20, and Figures A.3.1 and A.3.2 of Appendix 3).

4.1.2 Key characteristics

KEY MESSAGES

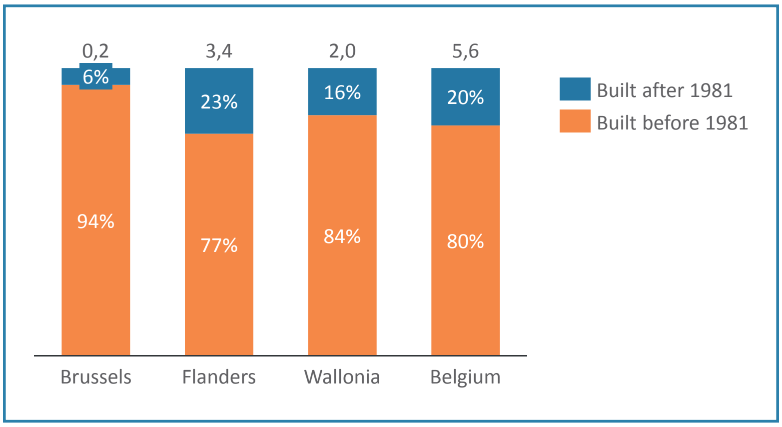
The buildings stock in Belgium is old. A large part has been built before the implementation of energy norms.

The share of apartments, while still low, is increasing. One third of the residential buildings is not occupied by their owner(s).

Offices, administration and commercial buildings are responsible for half of the fossil fuel consumption of non-residential buildings in Belgium.

The residential buildings stock is old as 80% of these buildings have been built before 1981[29], i.e., before the implementation of energy norms, as illustrated in Figure 21. The situation is even worse in Brussels. At EU level, the residential building block is younger, with 79% of residential buildings dating from before 1990[30].

Figure 21: Distribution of residential buildings by region according to their construction year (in % and million dwellings)



Source: SPF Economie 2016, Aperçu statistique de la Belgique

The share of apartments is about 20% in Flanders and in Wallonia (~80% of single family homes -SFH- in Wallonia and Flanders) and about 70% in the Brussels-Capital Region (see Figure A.3.3 in Appendix 3). On average in Belgium, 22% of the population lives in apartments, while this share rises to 42% at the EU level[31]. The increasing share of apartments in new buildings leads to a decreasing average living area (see Figure A.3.4 in Appendix 3).

29 SPF Economie 2016, Aperçu statistique de la Belgique.
30 BPIE, 2011. European buildings under the microscope.
31 Eurostat online database.

The tenure status also differs across regions: one third of the residential buildings is not occupied by their owner[32], thereby raising a moral issue (split incentive). This situation is similar to the EU average: 69% of dwellings are occupied by their owner[33]. It differs in Brussels where 2/3 of dwellings are occupied by tenants[34]. The situation could evolve with a trend towards more private business groups investing in dwellings[35].

The energy consumption of the different types of non-residential buildings in Belgium is illustrated in Figure A.3.5 of Appendix 3. Availability of robust energy data for the various types of non-residential buildings in Belgium is limited[36].

4.1.3 Low-carbon scenarios

KEY MESSAGES

The renovation rate and the renovation depth must both increase drastically to reach significant GHG reductions.

Heating must shift towards environmentally friendly heating technologies in order to achieve significant GHG reductions in 2050.

GHG emissions of the residential sector are reduced by 31% in 2030 and by 88% in 2050 In the low-carbon scenario. These reductions amount to 26% and 80% in the non-residential buildings sector in 2030 and 2050, respectively (Figure 22). This will only be possible with fastened and deepened energy renovation (see Figures A.3.6 and A.3.7 of Appendix 3), for which vast investments will be required.

Figure 22: Updated 2050 scenario for residential and non-residential buildings

Source: Own calculations

32 SPF Economie 2014, Aperçu statistique de la Belgique.
33 Eurostat online database.
34 SPF Economie 2014, Aperçu statistique de la Belgique. Regarding non-residential buildings, this is also an issue for SMEs in particular.
35 FEDERIA, 2018. Presentation at CAP2020 event "Crise du logement".
36 There is a lack of information that prevents from having a precise evaluation of the situation of the building stock in Belgium.

4.2 PRICES AND TAXES

4.2.1 Current levels and comparison with neighbouring countries

KEY MESSAGES

In general, there are limited tax exemptions or reduced rates (except for business use) that apply to energy products used for heating buildings. Standard rates in Belgium are usually lower than even the reduced rates in its neighbouring countries, with the exception of Luxembourg.

Due to relatively low tax levels, prices for natural gas in Belgium are significantly lower than in its neighbouring countries (with the exception of Luxembourg). The difference with the average price in the four and in two (the Netherlands and France) neighbouring countries corresponds to a price of around 44 €/tCO_2e and 90 €/tCO_2e, respectively.

Prices for heating gasoil in Belgium are also significantly lower than in its neighbouring countries, with the exception of Luxembourg. The difference with the average price in the four and in two (the Netherlands and France) neighbouring countries corresponds to a price of around 59 €/tCO_2e and 117 €/tCO_2e, respectively.

Current taxes and tax levels

Table 7 below provides an overview of excise tariffs[37] applicable in 2017 to the main energy products used in the buildings sector in Belgium and its neighbouring countries.

Rates for business use are provided next to the standard rates, since companies that can benefit from the business use rates for their heating fuels purchased specifically for their business activities, in general also tend to benefit from these (often reduced) rates for heating their buildings as well.

The main conclusions that can be formulated regarding taxes and tax levels, are the following:

- In general, there are limited tax exemptions or reduced rates (except for business use) that apply to energy products used for heating buildings. In Belgium, there are virtually no exemptions besides one for the use of coal by households. Biomass also benefits from a special treatment in Belgium and its neighbouring countries, since no excise duties are due on wood and wood pellets and a reduced VAT rate generally applies as well (with the exception of the Netherlands regarding a reduced VAT rate);
- The standard rates in Belgium are usually lower than even the reduced rates in its neighbouring countries, with the exception of Luxembourg.

[37] The excise tariffs presented here include excises, exceptional excises and the energy contribution. Sources: PwC, EU Commission excise tables

Table 7: Overview of 2017 excise tariffs on main energy products in Belgium and neighbouring countries – Buildings sector

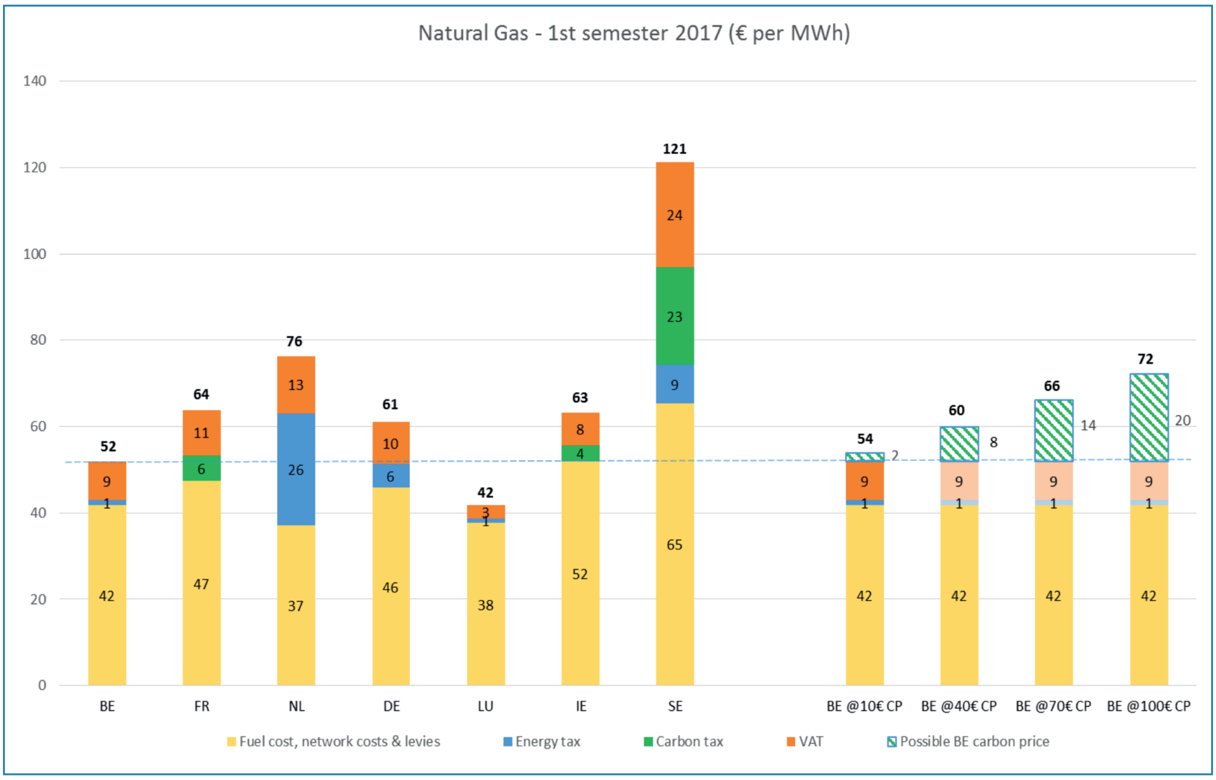
	Product / Applicable excise tariff	Heating gas oil (1000 L)	Natural gas (MWh)	Electricity (MWh)	LPG (1000 kg)	Coal, cokes, lignite (MWh)	Heavy fuel oil (1000 kg)
BE	Standard rate	18,6521	0,9978	1,9261	18,63 (B) 18,90 (P)	0	16,34
	Rate for business use	18,6521	0,9978 (1)	1,9261 (1)	18,63 (B) 18,90 (P)	1,44	16,34
	Difference	0	0,4578	0 (2)	0	0	0
FR (3)	Standard rate	118,9	5,88	22,5	116,9	9,99	95,4
	Rate for business use	118,9	1,52 - 1,60	22,5	116,9	1,19 – 2,29	95,4
	Difference	0	4,36 – 4,28	0	0	8,80 – 7,70	0
NL	Standard rate	485,92	1,216 - 25,244	1,07 - 101,3	336,34	1,836	36,44
	Rate for business use	485,92	1,216 - 25,244	0,53 - 101,3	336,34	1,836	36,44
	Difference	0	0	0,54 (4)	0	0	0
DE	Standard rate	61,35	5,5	20,5	60,6	1,188	25
	Rate for business use	46,01	4,12	15,37	45,45	0,612	25
	Difference	15,34	1,38	5,13	15,15	0,576	0
LU	Standard rate	10	1,08	1	10	1,08	15
	Rate for business use	10	0,05 / 0,3 / 0,54	0,5	10	18	15
	Difference	0	0,54 - 1,03	0,5	0	-16,92	0

(1) The 'normal' rate for business use is the same as for non-business use. There is only one possible reduced rate (i.e. 0,54 €/MWh, leading to a reduction of 0,4578 €/MWh) for companies engaged in energy policy agreements.
(2) A zero-rate applies to those businesses (end users) that are connected to the transport or distribution network of which the nominal voltage is more than 1kV.
(3) Reduced rates on natural gas and coal apply to companies under the EU ETS and/or energy-intensive companies that are moreover at risk of carbon leakage (zero-rate on electricity can apply to the last category) – link with the carbon tax.
(4) Only applies to the highest tranche of electricity consumption.

Prices – comparison with neighbouring countries

Figure 23 and Figure 24 below provide a comparison of final prices in 2017 for natural gas and heating gasoil in Belgium and its neighbouring countries, these two energy products being the ones mainly used in the buildings sector in Belgium.

Figure 23: Comparison of final prices of natural gas and impact of carbon price in Belgium[38]

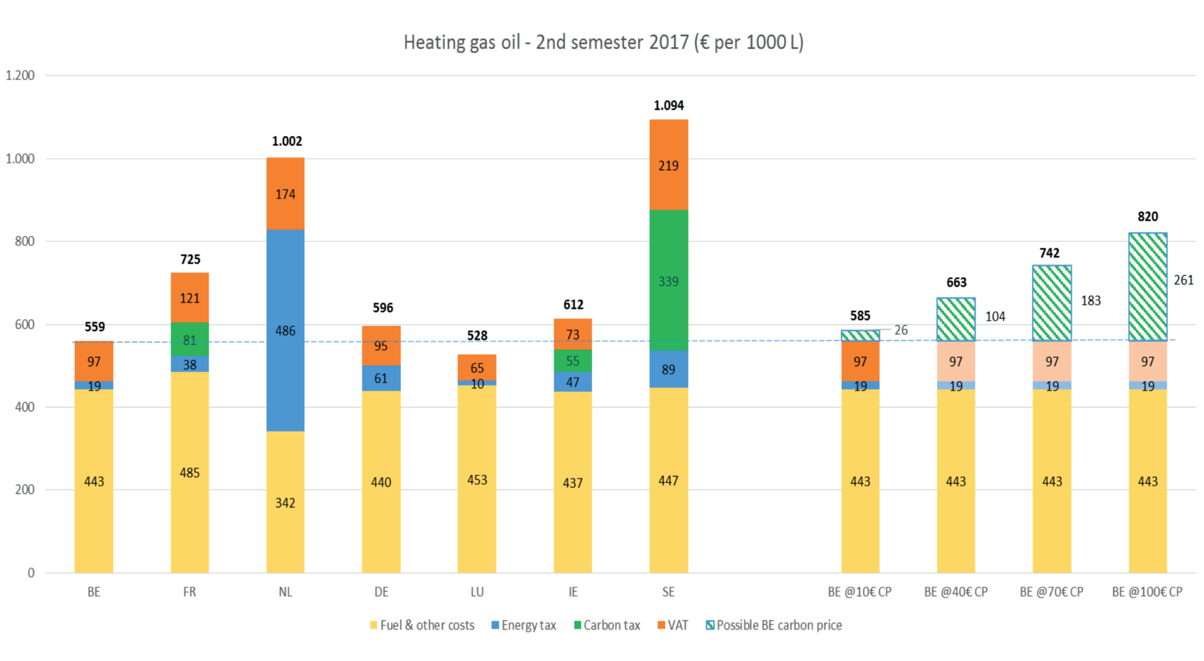


Sources: Eurostat data on gas prices (S1 2017 averages for domestic consumers D2 – 20 GJ < consumption < 200 GJ), EU Commission excise duty tables on energy products and electricity (excise rates on 01/01/2017), information on carbon taxes from colleagues of the respective countries, own calculations.

Regarding natural gas, we can observe that currently, due to relatively low tax levels, prices in Belgium are significantly lower than in its neighbouring countries (with the exception of Luxembourg). The Belgian prices are about 15% lower than the average price of the four neighbouring countries and about 26% lower than the average price of France and the Netherlands together. Implementing a carbon price up to 40 €/tCO_2e in Belgium now would not change this situation. The difference with the average price in the four and in two (France and the Netherlands) neighbouring countries corresponds to a price of around 44 €/tCO_2e and 90 €/tCO_2e, respectively. For more details, see Table A.3.8 of Appendix 3.

38 Methodology: use of the average S1 2017 final prices as a basis, deduct the VAT from those prices, then the energy (and carbon) taxes to obtain the category 'fuel cost, network costs & levies'.

Figure 24: Comparison of final prices of heating gas oil and impact of carbon price in Belgium[39]



Sources: European Commission Weekly Oil Bulletin for final prices (S2 2017 averages), European Commission excise duty tables on energy products and electricity (excise rates on 01/01/2017), information on carbon taxes from IE, FR and SE colleagues, own calculations.

Regarding heating gasoil, we also observe that prices in Belgium are significantly lower than in its neighbouring countries (with the exception of Luxembourg), Ireland and Sweden. The Belgian prices are about 22% lower than the average price of the four neighbouring countries and about 35% lower than the average price of France and the Netherlands together. The difference with the average price in the four and in two (France and the Netherlands) neighbouring countries corresponds to a price of around 59 €/tCO_2e and 117 €/tCO_2e, respectively. For more details, see Table A.3.9 of Appendix 3.

4.2.2 Lessons learned from existing carbon taxes

KEY MESSAGES

GHG emissions stemming from the heating of residential and non-residential buildings usually fully fall under the scope of the carbon tax in the countries that were analyzed in detail. There are very limited to no reduced rates or exemptions of the carbon tax that apply on fuels used for heating buildings (with the exception of biomass).

Several different redistributive schemes have been implemented or reinforced following the introduction of a carbon tax in the analyzed countries.

An initial analysis of countries and/or regions/provinces having already implemented a carbon tax or where the final decision is pending and to be taken in the near future was presented in Table 2 above. Based on the publicly available information gathered, further information collected through contacts in the respective administrations, and available time and resources, it was possible to analyze in more detail the carbon tax features of the following countries: France, Ireland, Sweden and Switzerland. The focus lied on the scope of the tax within the buildings sector (incl. whether any reduced rates / exemptions apply for some energy products / consumers) and on the mechanisms used to address potential distributive issues.

39 Methodology: use the average S2 2017 final prices as a basis, deduct the VAT from those prices, then the energy (and carbon) taxes to obtain the fuel & other costs.

France

The carbon tax within the buildings sector is mainly applied through the taxes on energy products ("Taxe Intérieure de Consommation sur les Produits Energétiques" or TICPE) and the taxes on natural gas ("Taxe Intérieure de Consommation sur le Gaz Naturel" or TICGN). No specific exemptions or reduced tariffs of the carbon tax have been foreseen for heating buildings, except for LPG (but its use as heating fuel is marginal in France) and biomass (that is exempted from the carbon tax for obvious reasons).

However, it should be noted, as can be seen under Section 6.2.2 regarding the non-ETS industry, that energy-intensive companies that are exposed to a significant risk of carbon leakage and that as a result are exempted for paying the carbon tax for their industrial activities, also do not pay the carbon tax on energy products used for heating their buildings.

The following mechanisms/instruments were implemented in France in order to support specific consumer groups or more generally the transition towards more energy-efficient buildings:

1) The so-called "chèque énergie" (energy check) for modest households – this check (of which the average value to date is of 150 € per year per household) can either be used to pay (part of) the energy bill or to finance a part of energy renovation expenses if performed by a certified professional. It is meant to progressively replace the system of social tariffs and is financed, through the state budget, by the carbon tax revenues.
2) Reduced VAT rates for energy renovation works;
3) Tax credit for energy transition (« Crédit d'Impôt Transition Energétique » or CITE): support to individuals for insulating their houses and/or for improving the source of heating their homes.

Ireland

In Ireland, the carbon tax has been introduced as a component of excise duties on energy products. No specific exemptions or reduced rates apply in the buildings sector, with the exception of solid fuels that have a minimum biomass content of 30% (30% relief of the carbon tax if biomass content is min. 30% and lower than 50%, and 50% relief if the biomass content is over 50%).

Two energy renovation schemes that support homeowners and that are indirectly (i.e. through the general budget) financed through the carbon tax revenues, were identified:

1) "Better energy homes" scheme – targets roof and wall insulation, as well as heating system upgrades, performed by certified professionals for homeowners, covering up to 30% of average retrofitting costs;
2) "Better energy warmer homes" scheme – designed to support vulnerable people in or at risk of energy poverty, for works related to roof and cavity wall insulation, draught proofing and installing low-energy light bulbs, fully covering the costs of retrofitting.

Sweden

In Sweden, the carbon tax has also been introduced as a component of excise duties on energy products. There are no specific exemptions or reduced rates of the carbon tax on energy products used for heating buildings, other than biomass that is not taxed for obvious reasons.

When introducing the carbon tax, however, the government took the necessary steps in order to limit the initial increase of heating gas oil prices, while no such measures were taken for coal that was immediately fully taxed (which lead to an instant and significant price increase of coal). The main achievement of the carbon tax in the buildings sector is considered to be the very important fuel-switch from coal to biomass mainly through district heating, thanks to the already existing infrastructure.

Finally, there is no direct link between the carbon tax revenues and specific support mechanisms or programs in Sweden. In general, carbon tax increases have been compensated by tax cuts elsewhere, and any potential distributive issues have been taken into account through this way and through the welfare system of Sweden.

Switzerland

The carbon tax in Switzerland only applies to fuels (excluding biomass) used in thermal installations or as input for CHP installations. Companies performing specific activities and engaging in voluntary agreements, can be exempted from the carbon tax upon request (cf. Section 6.2.2 on non-ETS industry – the exemption mainly relates to the use of fuels for the specific activities listed in legislation, but fuels used for heating buildings then also benefit from the exemption, since it would otherwise be administratively cumbersome to implement). The carbon tax follows a stepwise approach, as its level is periodically reviewed in function of the gap between actual GHG emissions and a set emission reduction target.

Around two thirds of the carbon revenues are redistributed to the public and to companies by means of a lump sum through health and social insurance, respectively. Around one third of these revenues are directed to an energy efficiency renovation fund that runs up to 2019 (it might be extended), and that finances energy-efficient renovations of buildings and investments in renewable energy, waste heat recovery and optimization of building utilities.

Conclusions

In general, GHG emissions stemming from the heating of residential and non-residential buildings usually fully fall under the scope of the carbon tax in the countries that were analyzed in detail. There are very limited to no reduced rates or exemptions of the carbon tax that apply on fuels used for heating buildings (with the exception of biomass).

Finally, several different redistributive schemes have been implemented or reinforced following the introduction of a carbon tax in the analyzed countries, including: (i) (energy efficiency) renovation programs/funds (Switzerland, France, Ireland), (ii) energy vouchers (France) and (iii) lump sum transfers (Switzerland).

4.3 EVALUATION OF IMPACTS

In this section, the impacts of carbon pricing in the buildings sector are quantified. It first looks at the impacts for individuals: the impacts of carbon pricing on the average energy bill are discussed, and the profitability of investments for buildings' energy renovation and heat decarbonization investments are analyzed. This allows to identify how carbon pricing can trigger the profitability of the investments. The analysis then considers the impacts at the sectoral level, complementing the microeconomic analysis with an update of the costs of the transformation of the buildings sector analyzed in the 'Scenarios for a low-carbon Belgium by 2050' and quantifying the public revenues that carbon pricing in buildings would generate.

4.3.1 On the average energy bill

KEY MESSAGES

In the short-term (2020), a carbon price of 10€/tCO_2 would increase households' annual energy bill on average by 32 €. Depending on the final prices used, heating oil and gas prices would increase by between 3% to 5%.

In the long-term (2030 and 2050), a carbon price of 190€/tCO_2 (trajectory « B ») would lead to an average carbon payment of 51 € per household per year. By 2030, heating oil and gas prices would increase by around 25%.

The average energy bill would be reduced w.r.t. 2020 even with a higher carbon price.

The impact of a 10€/tCO_2e carbon price on the energy prices ranges between +3% and +5%[40] in function of the fuel used. This increase depends on the final energy price used, that results from the commodity price, other distribution costs and levies, and on the GHG emission intensity of the fuel. By 2030, energy prices would increase by around 25% under carbon price trajectory « B ».

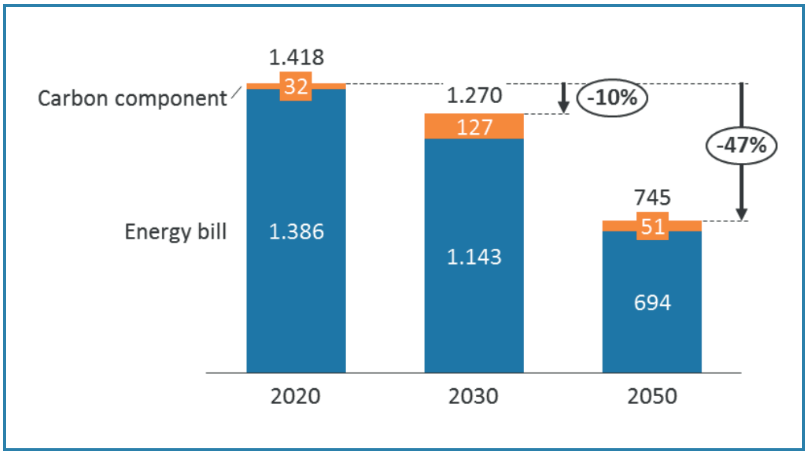
This increase is the result of the combination of a higher carbon price partly compensated by the decrease in energy consumption. Under constant energy prices, the average energy bill would be divided by two by 2050 as important energy savings supported, at least partly, by the carbon price largely outweigh (i) the carbon payment and (ii) the impact of the switch from fossil fuels towards electricity. Average impacts mask potentially important differences among households; these differences and options to overcome them are further analysed in Section 4.4.1 devoted to the distributive issues. Sensitivity analyses confirm these messages with different price assumptions even if energy prices are a key factor of the energy bill.

The average energy bill for heating residential buildings would be reduced in the low-carbon scenario by 10% in 2030 and by 47% in 2050 vs 2020, under the carbon price trajectory « B », including 70€/tCO_2 in 2030 and 190€/tCO_2 in 2050, respectively (see Figure 25). This is the result of a reduced energy demand for heating.

The carbon payment per household first increases between 2020 and 2030, from 32€ to 127€ on average per household, even if the total energy bill is reduced. It then drops to 51€ on average by 2050 as the reduction in the share of fossil fuels used for heating more than compensates the carbon price increase.

These figures derive from the average energy consumption by fuel and do not represent individual situations[41]. To look at individual situations of households, specific household profiles will be considered in Section 4.4.1.

Figure 25: Evolution of the average annual energy bill for heating residential buildings, in the low-carbon scenario under Option B (in €/household/year)



Source: Own calculations

Figure 26 and Figure 27 show the main drivers of the lowered energy bill compared to the BaU: reduced energy consumption more than compensates the higher energy price in 2030 (Figure 26) and 2050 (Figure 27).

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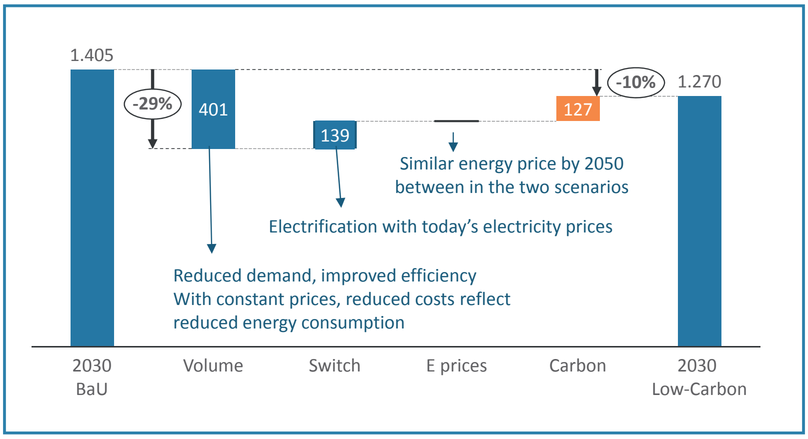
40 Note: the possible increase in VAT due to implementation of carbon price is not included (e.g. in case the carbon price is implemented via increase in excise duties)

41 The average energy consumptions are derived from the low-carbon scenario (the total energy consumption divided by the number of households or the total added value in non-residential buildings divided by the number of buildings). The split of the energy into energy vectors results from the average technology mix of the buildings stock. To exemplify, a situation with gas-firing boilers for half of the population and heat pumps for the other half will result in a heat demand covered in average by half gas and half heat pumps while none of the households has a mix of the two.

These figures should be read as follows:

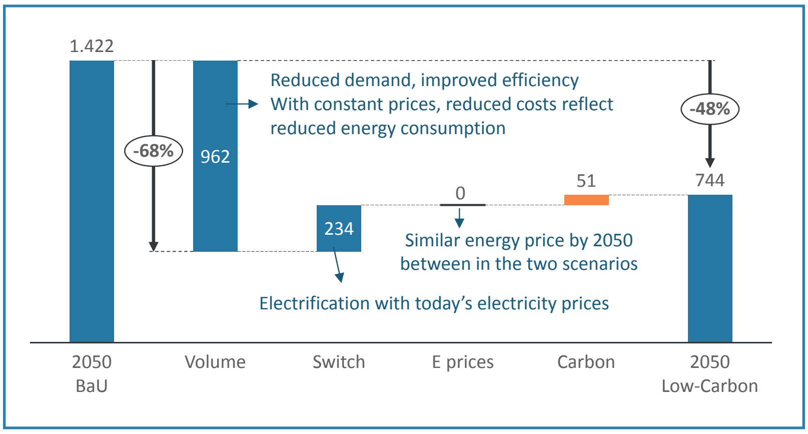
- BaU: this corresponds to the average energy bill in the business as usual scenario for the specified year;
- Volume: this is the impact on the average energy bill of a reduced demand in the low-carbon scenario w.r.t. the BaU. At this stage, fuel mix and energy prices assumptions are the same in the two scenarios[42];
- Switch: this is the impact on the average energy bill of a fuel switch, keeping the same energy prices assumptions[43];
- E prices: this is the impact on the average energy bill of different assumptions on energy prices between the low-carbon scenario and the BaU. It equals zero since energy prices are kept constant and equal to 2016 energy prices in both scenarios. The sensitivity of considering different assumptions on energy prices between the two scenarios is tested in Figures A.3.15 and A.3.16 of Appendix 3;
- Carbon: this is the contribution of the carbon price to the energy bill. It results from the energy consumption (volume and fuel mix), the emission intensity of fuels and the carbon price level;
- Low-Carbon: this finally represents the average energy bill in the low-carbon scenario for the specified year.

Figure 26: Average annual energy bill for heating residential buildings by 2030 in the BaU and the low-carbon scenario; Waterfall highlighting the drivers of the difference (in €/household/year)



Source: Own calculations

Figure 27: Average annual energy bill for heating residential buildings by 2050 in the BaU and the low-carbon scenario; Waterfall highlighting the drivers of the difference (in €/household/year)



Source: Own calculations

42 The impact of the carbon price is modelled through classical price-demand elasticities in addition to the demand reduction considered in the low-carbon scenario (the elasticity values considered are given in the section "Methodology for the sectoral approach").

43 In particular the use of electricity that, at least with a 2016 energy price, is more expensive than fossil fuels.

The conclusions stated above are robust to different carbon price trajectories and to evolutions of the energy prices (see the sensitivity analysis given in Figures A.3.15 and A.3.16 of Appendix 3 and Figure A.3.13 in the same Appendix).

For non-residential buildings, the average energy bill is expressed below in € of energy by million € of added value. The value added is indeed the main context driver of energy consumptions in the non-residential sector. This indicator does not reflect the differences of the respective sub-sectors. Expressing energy bills based on sector-specific indicators such as the number of beds for hospitals or hostels or the number of employees for offices would be more appropriate, but this detailed information is not available. The analysis is therefore completed by lever-defined ambition on the heating and cooling intensities by unit of added value.

In the non-residential buildings sector, the average energy bill would be reduced by 4% in 2030 and 43% in 2050 with respect to 2020 under option B (see Figure A.3.10 of the Appendix 3 – see also Figure A.3.14 for the evolution under different carbon price trajectories). Compared to the BaU, the average energy bill would be 6% higher in 2030 in the low-carbon scenario (see Figure A.3.11 of the Appendix 3), and 27% lower in 2050 (see Figure A.3.12 of the Appendix 3). A sensitivity analysis based on different energy price assumptions can be found in Figures A.3.17 and A.3.18 of the Appendix 3.

4.3.2 On public carbon revenues

KEY MESSAGE

Revenues from carbon pricing in both residential and non-residential sectors would amount to 219 M€ in 2020 and 939 M€ in 2030.

The revenues from carbon pricing in both residential and non-residential sectors would amount to 219 M€ in 2020, 939 M€ in 2030 and 468 M€ in 2050, representing a cumulated budget of 23,5 billion € under the carbon price trajectory « B » (prices of 10, 70 and 190€/tCO_2 in 2020, 2030 and 2050, respectively) as illustrated in Figure 28. These annual public carbon revenues can be compared with estimated annual investment needs on top of the BaU of around 7 billion € for the buildings sector. Such a comparison shows that, under realistic leverage effects, carbon pricing revenues are sufficiently large to foster the financing of the required investments in this sector. Further details are provided in Table A.3.19 of Appendix 3 for the three carbon price trajectories.

Figure 28: Annual carbon revenues for the buildings sector under option B (in M€/year)

	2020	2025	2030	2035	2040	2045	2050
Non-residential	60	199	270	302	293	250	182
Residential	159	494	668	705	639	491	286

Source : Own calculations

4.3.3 On the profitability of investments

KEY MESSAGES

Carbon pricing can trigger the profitability of investments in buildings' energy renovation. The business case can already be positive when the renovation is done for motives other than energy efficiency.

Carbon pricing can contribute to accelerate heat pump penetration by improving the cost efficiency. The annual energy bill of heating with the most efficient heat pumps is already lower than the ones obtained with gas or liquid fuel boilers. A 100€/tCO_2 carbon price would make investing in all kinds of heat pumps a profitable investment.

While energy renovation can be undertaken for many reasons like for savings, comfort, maintenance, environmental motivations, etc., this Section focuses on the economics of investments for energy renovation.

The key transformations of buildings in the low-carbon transition are the reduction of heating needs through improved insulation and the decarbonization of the remaining heat. This explains why these two different types of investments have been further analyzed below. First, buildings' energy renovation is considered with a focus on building envelope insulation. Second, investments in decarbonized electrification through heat pumps are analyzed.

4.3.3.1 Buildings' energy renovation

An investment is considered profitable if the savings from the lowered energy bill compensate for the investments. In other words, renovation investments are profitable if the cost to save one kWh is lower than the price to consume that kWh[44].

The cost of saved energy is illustrated in Figure 29 based on the following base case example and a selection of sensitivity analysis cases described below.

Let us consider an investment of 50.000€ that allows to reduce the energy consumption of a 125m² house from 300kWh/m²/year to 100kWh/m²/year through an investment cost of 400€/m². Annual energy savings amount to 25 000kWh/year. Considering a 20-year investment lifetime, the yearly undiscounted amortization of the investment is 2500€. This corresponds to a cost of 10c€/kWh saved annually (see the base case figures of Figure 29). With an energy price around 5c€/kWh, energy savings will therefore compensate only 50% of the investments.

The sensitivity of the proposed assumptions is illustrated in Figure 29, with different variants:

- Ideal timing: the ideal timing for an energy renovation is when a renovation has to be done anyway ("anyway investments"), for instance when there is a change in urban planning or when building components require maintenance;
- Higher investment cost: energy renovation costs reported in the literature vary significantly and were debated in the Buildings workshop. 600€/m² seemed to better reflect participants' estimates of current market cost for ambitious energy renovation[45];
- Longer lifetime: the base case example considers a 20-year lifetime. A lifetime of 30 years could be considered more market conform for some investments, for instance in the building envelope.

Lower energy savings: the real energy savings might differ from the theoretically-estimated savings: energy consumption for heating depends on a buildings' efficiency and occupants' behaviour[46]. The dotted bars of Figure 29 show that energy renovation at 400€/m² is not profitable with today's energy prices

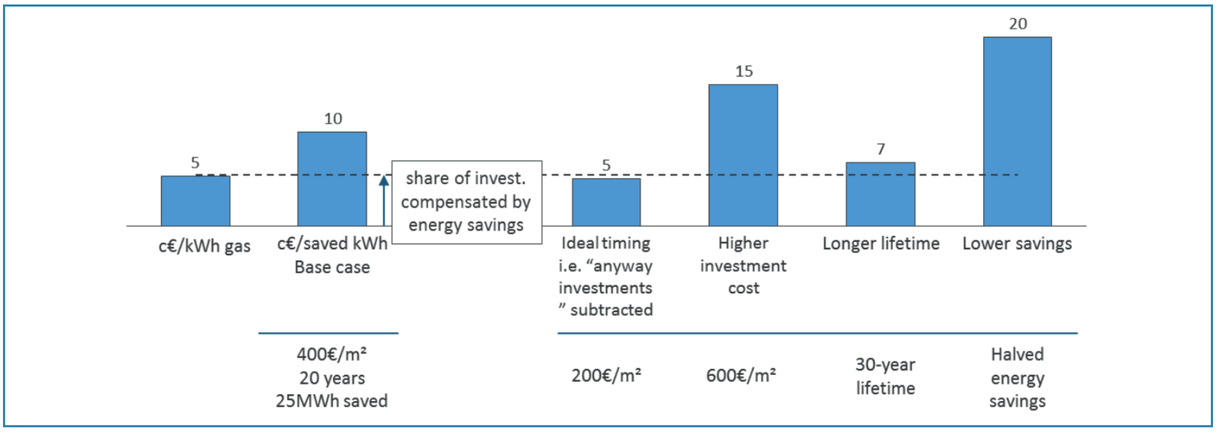
[44] The price to consume that kWh is slightly higher than 5c€/kWh for fossil fuels without carbon price.

[45] The cost per saved energy unit is directly proportional to the investment since no co-benefits are modeled here.

[46] The effective business case will depend on the real heating behaviour of the occupants. Before the renovation, if the occupants have a lower actual consumption than the theoretical one because they cannot afford a higher consumption, the renovation savings will be lower, which in turn translates into higher costs per saved kWh.

of about 5c€/kWh. Considering the share of the investments purely related to energy efficiency ("anyway investments" subtracted) leads to costs of the saved energy slightly lower than the cost of energy. Also, considering a longer lifetime for the investments (i.e. 30 years instead of 20 years) proportionally improves the profitability of the investment. Not surprisingly, the profitability degrades when occupants behave differently, resulting in lower savings than expected.

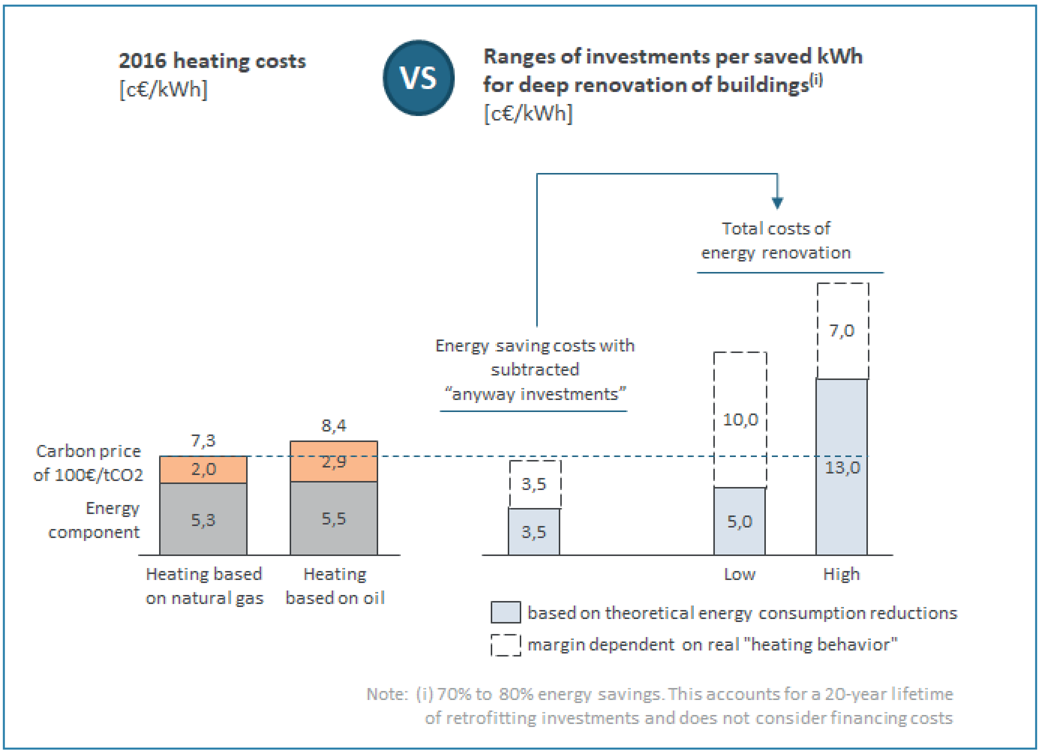
Figure 29: Profitability of buildings energy renovation, sensitivity analyses, in c€/kWh



Source: Own calculations

The comparison of the renovation costs reported in the literature (assessed from renovation investment costs and the related energy savings, see Figures A.3.20 and A.3.21 of the Appendix 3) with the cost of heating with fossil fuels (Figure 30) shows that carbon pricing can trigger the profitability of the investments in a number of cases. It also demonstrates that energy-only related investment costs ("anyway investments" subtracted) are already lower than heating costs in most cases. It also shows that the business case can still be positive with low energy renovation costs not synchronized with buildings maintenance needs, this with current energy prices.

Figure 30: Ranges of investment per saved kWh for deep renovation of buildings and heating costs with a 100€/tCO_2 carbon price (in c€/kWh)



Source: Own calculations

Sensitivity analysis on energy prices

Looking at the cost of energy renovation in terms of euros per saved energy unit shows how sensitive these investments are to energy prices. This is also demonstrated in neighbouring countries:

- In the Netherlands (see Figure 23 and Figure 24) the higher fossil-fuel energy costs make more expensive investments profitable: compared to the situation in Belgium, profitability is improved with +46% w.r.t. heat obtained from gas, and with +79% w.r.t. oil-firing boilers;
- In France, energy prices observed make energy renovation investments more profitable up to +23% (gas) and +30% (oil) than in Belgium. Complementary data from the French BBC Observatory show that the return on energy renovation investments is well above 5% in more than half of one-step deep energy renovation projects[47]. This demonstrates that deep energy renovation is already profitable in several situations.

As demonstrated by these two examples, the impact of the different energy price (as discussed in the previous paragraph) must be considered before translating such results to the Belgian renovation market. In other words, higher carbon prices would be required in Belgium w.r.t. to France and the Netherlands to trigger the profitability of renovation projects with similar investment costs.

Sensitivity analysis on investment costs

As discussed with the illustrative example of Figure 29, the cost of renovation (in terms of cost of saved energy) is directly proportional to the investment costs. The literature review shows that deep energy renovation can be achieved with investment costs ranging from less than 200€/m² (when renovation is synchronized with other maintenance needs) to 400€/m².

A recent analysis of the data on energy renovation costs provided by the French Observatory for Low Energy Buildings[48] suggests that a deep energy renovation is achieved in France at an average renovation cost of €316/m² for dwellings in multi-family buildings and €374/m² for detached single-family homes.[49]

Sensitivity analysis on other dimensions

Our analyses focus on financial flows resulting from energy savings. Other financial flows such as operation and maintenance costs and the evolution of real estate value should be taken into account to complete the analysis: the quality of buildings deteriorates in the absence of regular servicing, resulting in an increase of maintenance costs and a decrease of the real estate value. Taking these other financial flows into account would reinforce the business case for energy renovation, making additional investments profitable.

4.3.3.2 Heat pumps

After improvements of buildings' energy efficiency, decarbonization of heat is key to reaching GHG emission reduction targets. The low-carbon scenario relies on the penetration of heat pumps. Carbon pricing can contribute to accelerate heat pump penetration by improving the cost efficiency of these solutions[50].

The analysis starts by comparing the annual energy bills for heat pumps and conventional fossil-fuel boilers. While this helps to make sense to which extent solutions compete, this does not fully demonstrate the profitability of the investment. To this end, cumulated expenses of both solutions are assessed to discuss

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47 OpenExp (2018) Deep Energy Renovation -Trapped in overestimated costs and staged approach

48 OpenExp (2018) Deep Energy Renovation -Trapped in overestimated costs and staged approach

49 As highlighted in that study, this contrasts with costs reported in EU funded projects exploring deep energy renovation. For example, the CITYNVEST project suggests costs over 1200€/m² for deep renovation of non-residential buildings and the ZEBRA project reports costs between 330€/m² in Poland to 2.500€/m² in Denmark for nearly-zero energy renovation.

50 Policy alignment between regional and federal entities, including with regard to support measures, will be required in order to secure the necessary level of heat pump penetration.

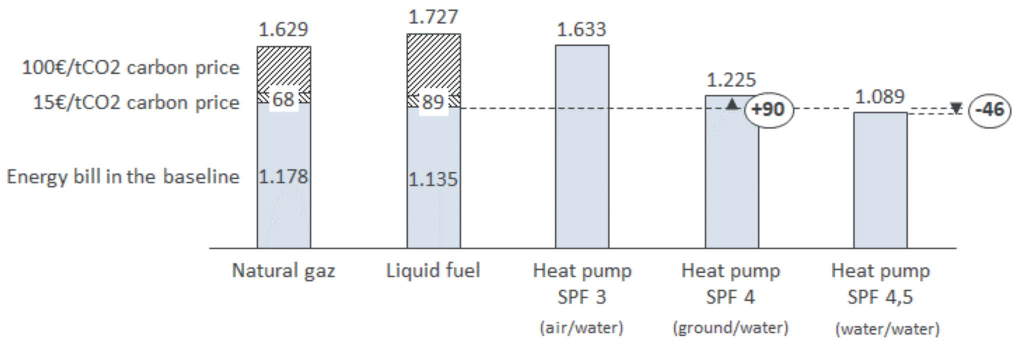
the cost-parity time between technologies. Investing in heat pumps is considered as profitable if the cost-parity time (w.r.t. fossil-fuel boilers) is lower than the lifetime of the investments[51].

The energy bill for heating depends on the heat demand, the efficiency of the heating system and the energy price.

Considering the heat demand of an average household of 20 000kWh/year, Figure 31 shows that the annual energy bill of heating with the most efficient heat pumps (ground water heat pumps) is already lower than the ones obtained with gas or liquid fuel boilers. Considering geothermal (ground-coupled) and aerothermal heat pumps, carbon prices of 15€/tCO_2 and 100€/tCO_2, respectively, are required for the annual energy bills to be equal.

The assessment is based on 2016 energy prices.

Figure 31: Comparison of the energy bill for selected heating systems (in €/year)



Source: Own calculations

The analysis illustrates two key drivers for the deployment of heat pumps to decarbonize heat in buildings: their efficiency and the price differential between fossil fuels and electricity[52]. Cumulated expenses better inform on the profitability of investing in heat pumps compared to fossil-fuel boilers. Considering a lifetime of 15 to 20 years for heat pumps[53], heat pumps would constitute a profitable investment if their cost-parity time with fossil-fuel boilers is lower than this time range.

Figure 32 shows that a 100€/tCO_2e carbon price would make the investment economically profitable since it brings cost-parity time between heat pumps and gas-fired boilers to 18 to 20 years, and to 13 and 15 years compared to oil-fired boilers. To illustrate the sensitivity of the result to the electricity price, Figure 33 shows that a decrease of the electricity price to end-users by 10% would shorten the parity time by 1 to 2 years[54].

[51] A 90% system efficiency is considered for fossil-fuel boilers and the EN 15450 norm is used for the seasonal performance factors of heat pumps. Seasonal performance factors (SPF) are used instead of coefficients of performance (COP). The SPF is a yearly averaged COP taking into account that the COP is typically lower when the heat demand is high. It better reflects real performance since COP is measured in controlled lab-conditions and is thus not a good measure for the real performance of a heat pump system installed in a building (KUL, 2015. Heat pumps fact sheet).

[52] An additional illustration is provided in A.3.22 of Appendix 3.

[53] JRC's report on best available technologies for heating technologies suggests lifetime ranging between 7 and 30 years (JRC, 2012. Best available technologies for the heat and cooling market in the European Union).

[54] The result is sensitive to the coefficient of performance (COP) of the heat pump.

Figure 32: Cumulated expenses (investment, O&M, fuels) for a heating demand of 20.000 kWh/year (in undiscounted €), carbon price of 100€

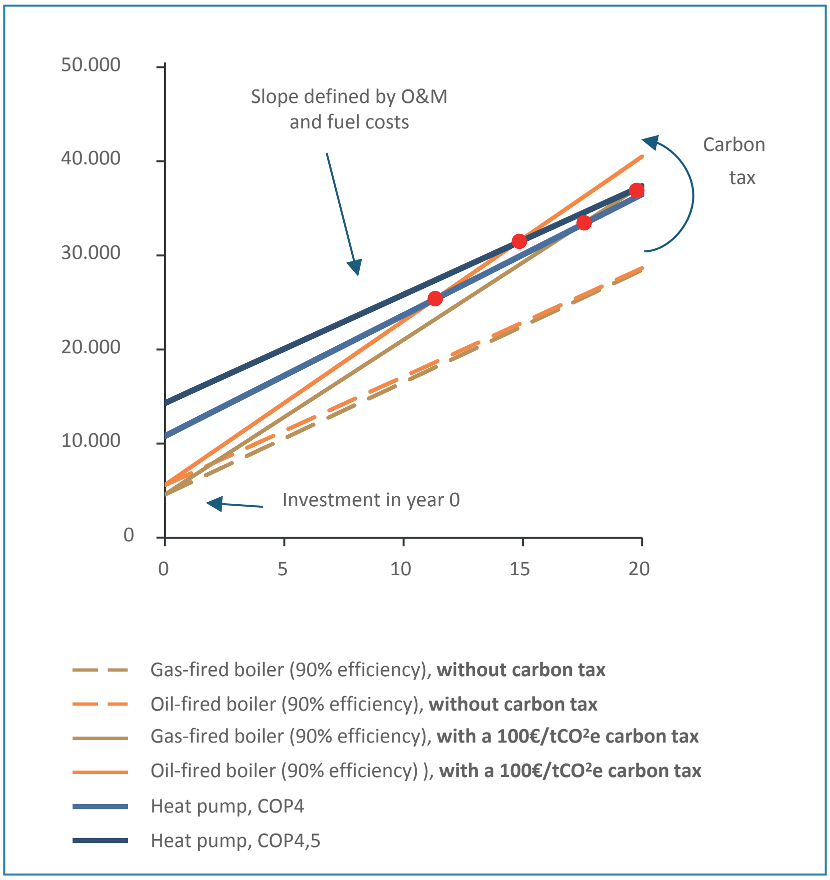
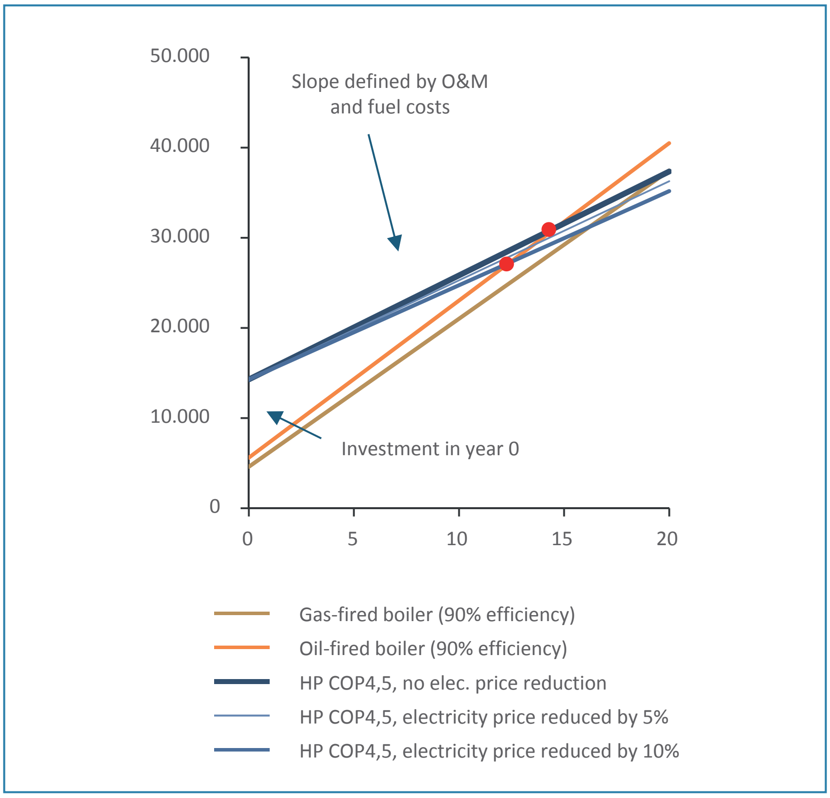


Figure 33: Cumulated expenses (investment, O&M, fuels) for a heating demand of 20.000 kWh/year with a 100€/tCO_2e carbon price and an electricity price reduction ranging from 0% to 10% (in undiscounted €)



4.3.4 Impacts at sectoral level

KEY MESSAGE

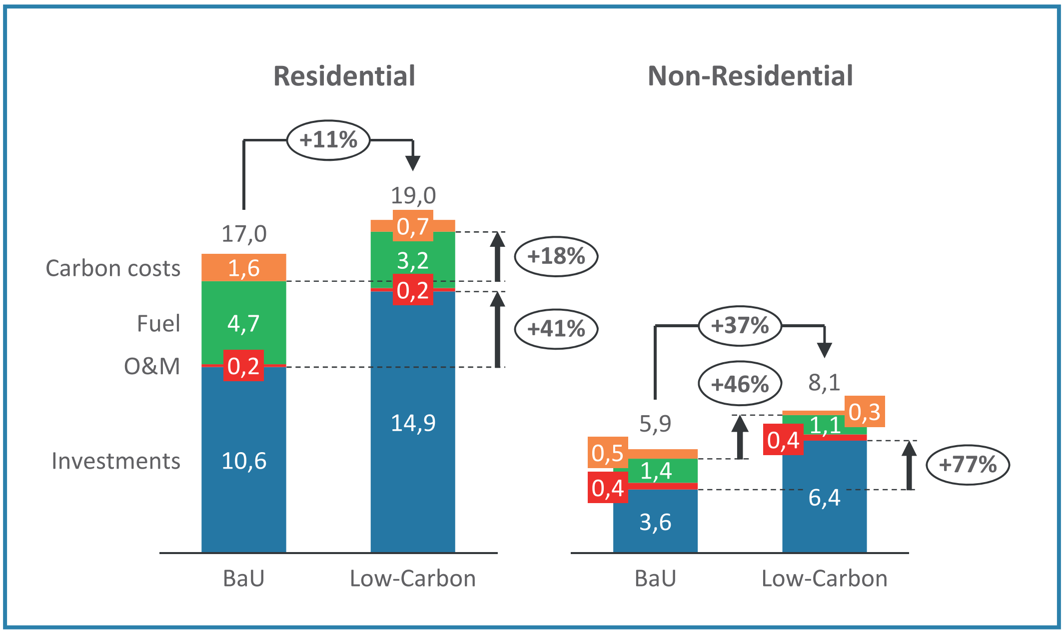
Carbon pricing significantly increases the profitability of the required investments in buildings.

An update of the costs analyzed in the 'Scenarios for a low-carbon Belgium by 2050' complements the microeconomic analysis above. Figure 34 illustrates the evolution of the costs components (investments, O&M, fuels and carbon costs) in the low-carbon scenario w.r.t. the BaU for residential and non-residential buildings.

With energy prices kept constant and equal to 2016 prices, higher investments in buildings are partially compensated by lower energy bills. W.r.t. the BaU, the total costs excluding carbon payments are +18% in the low-carbon scenario whereas the required investments are 41% higher. Carbon pricing[55] further improves the profitability of the investments, reducing the gap between the costs of the two scenarios to +11% (instead of +18%).

The comparison between the two scenarios is impacted by the price evolutions for the different energy vectors. As illustrated in Figure 35, carbon pricing further helps to trigger the profitability of the investments for residential buildings when considering energy price evolutions like the ones suggested in the IEA World Energy Outlook 2016 (see Figures A.2.3 and A.2.4 of Appendix 2).

Figure 34: Average annual costs in buildings with energy prices kept constant and equal to 2016 prices, 2020-2050 (in b€/year)[56]

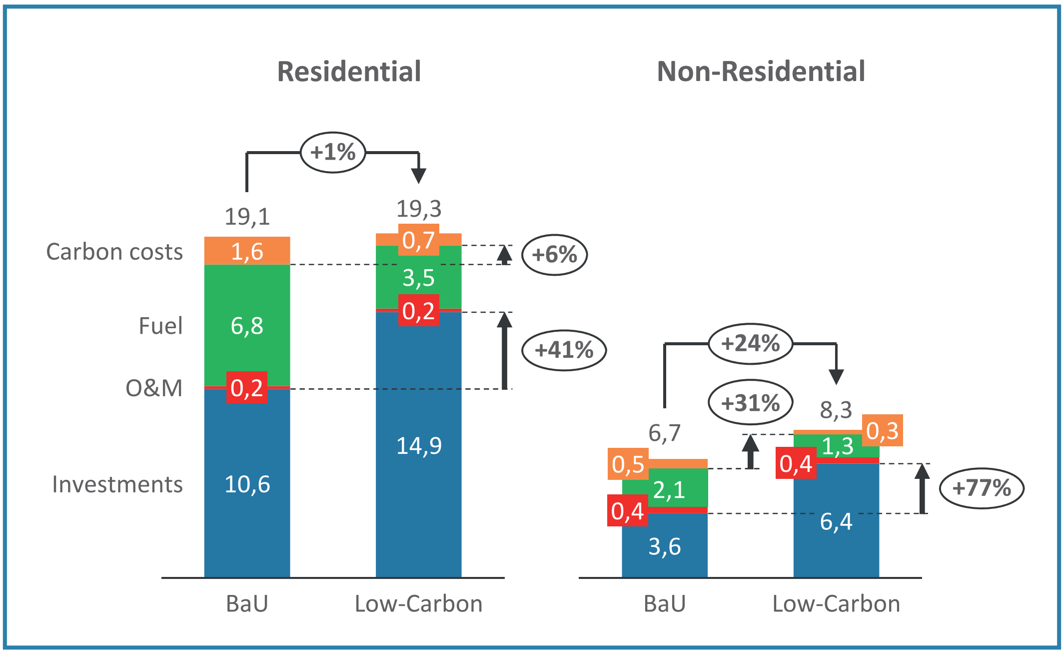


Source: Own calculations

[55] The carbon price trajectory B is considered in this analysis

[56] Note: although investments take place at a constant pace over the whole period, energy savings after 2050 are not accounted for

Figure 35: Average annual costs in buildings with energy price evolutions as described in the Appendix 2, 2020-2050 (in b€/year)



Source: Own calculations

4.4 POLICY ALIGNMENT

4.4.1 Distributive issues

KEY MESSAGES

Distributive issues, in particular the impact of the rise of fossil fuel energy prices following the implementation of the carbon price, on households facing energy poverty, are key elements to account for in the design of the pricing scheme.

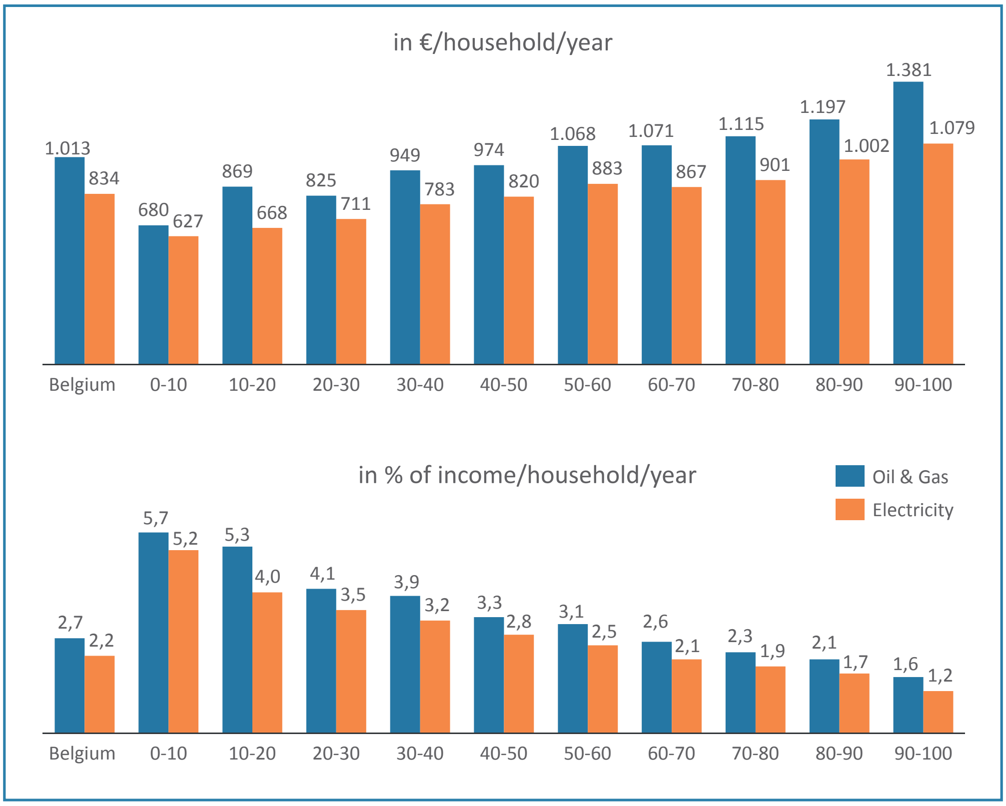
Lump-sum transfers of (part of) the carbon revenues can to some extent alleviate the problem and avoid the regressivity of the scheme. Such transfers do not suffice because energy consumption may vary significantly across income classes. Moreover, energy poverty is multi-faceted. This requires specific policies targeting people at risk of energy poverty.

In Section 4.3.1, we have shown that, in the short-term (2020), a carbon price of 10€/tCO_2 would increase households' annual energy bill on average by 32 € and, in the long-term (2030 and 2050), a carbon price of 190€/tCO_2 (trajectory « B ») would lead to an average carbon payment of 51 € per household per year. These are, however, average impacts that may prove to be significantly different from one household to the other.

a) **A potentially regressive measure that may require lump-sum transfers**

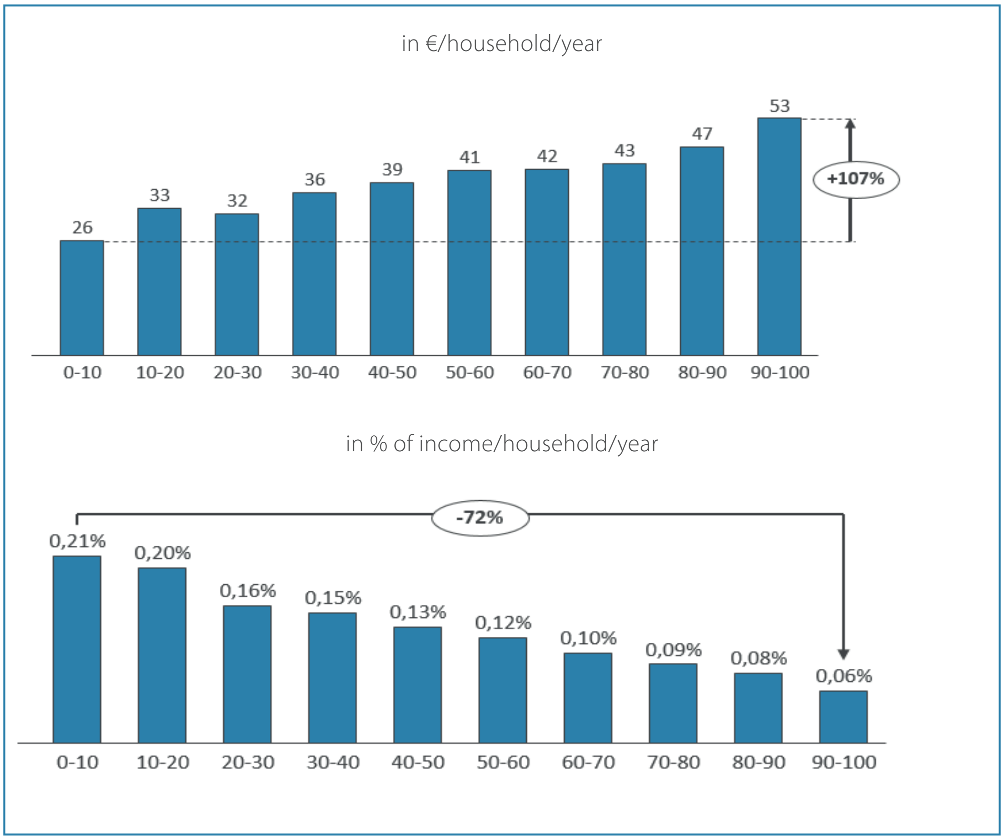
The latest survey on Belgian households' budget shows that, on average, households spend 1000 € per year on oil and gas and more than 800€ on electricity. Although the absolute amounts do rise with the level of income, the share of the income dedicated to heating decreases with income and ranges from 11% for the lowest incomes to 3% for the highest ones as illustrated in Figure 36.

Figure 36: Energy expenses in residential buildings in 2014 by decile of income



Sources: Survey on Belgian households' budget, 2016; own calculations

Figure 37: Average carbon contribution for heating by decile of income with a 10€/tCO_2 carbon price



Sources: Survey on Belgian households' budget, 2016; own calculations

A carbon price on energy for heating therefore impacts more the lowest incomes. Figure 37 illustrates the impact of a price of 10€/tCO_2 across deciles under no changes in energy consumption. Although the carbon payments are two times higher for the last decile compared with the first decile, the impact relatively to income is much larger.

This figure also allows to better apprehend the impact of a lump-sum redistribution of the carbon payments. As households would pay on average 39€ annually for the carbon tax[57], a complete redistribution of the proceeds on an equal basis across households would lead the first deciles to be strictly better off with respect to a situation without carbon tax: the first two deciles would benefit from 13€ and 6€, respectively (for a carbon price of 10€/tCO_2). The last two deciles would be worse off, with a net contribution of 8€ and 14€.

Of course, only part of the total revenues could be redistributed and the redistribution could also be targeted to the lowest income deciles. Moreover, the compensation need not necessarily be complete. Still, the above reasoning shows that redistributing carbon revenues can alleviate the regressive impact identified above.

b) **Energy poverty is multi-faceted and carbon pricing impacts also vary within income classes so that targeted measures are required**

The analyses presented just above do not fully capture the energy poverty issue, at least because energy poverty has many dimensions and because there exists an heterogeneity within income classes.

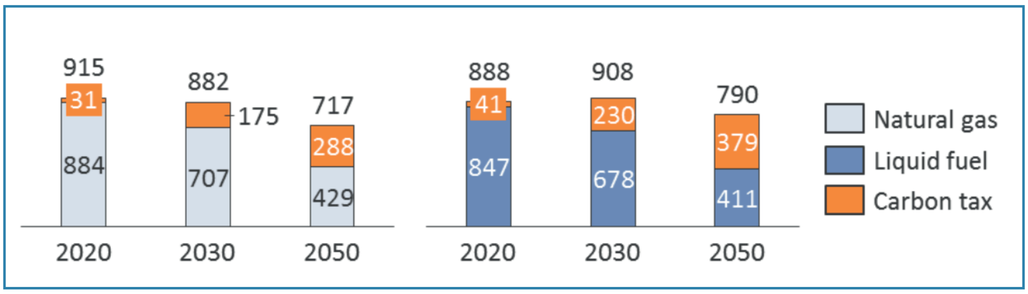
Indeed, has shown by Meyer (2017), one must make a distinction at least between measured energy poverty, hidden energy poverty and perceived energy poverty. The Belgian energy poverty barometer, which includes those three dimensions, indicated that globally 21% of the households were affected in 2015 by at least one form of energy poverty. In particular, low income households, single-person households and single-parent families, aged people (especially single ones) and tenants are among the most vulnerable profiles.

Given the important share of rented buildings, especially among vulnerable households, the split-incentive issue is of particular importance (Meyer, 2017). Also, rented dwellings have globally lower quality and energy performance, meaning that the impact is potentially higher on tenants and that investments in energy efficiency, the realisation of which depend on landlords' willingness, has an important potential. Addressing energy poverty thus also requires tacking such a split-incentive issue.

Then, regarding measured energy poverty, heterogeneity in energy expenditures within income classes is potentially important as shown by Valenduc (2017). A good understanding of the explanatory variables of such a spread is then useful to (i) assess whether any lump-sum redistribution (cf. energy vouchers option above) should be differentiated across households and, if so, based on which criteria (e.g. type of heating source (gas vs heating oil) in the short term), and (ii) determine an appropriate set of measures targeting specific household profiles at risk.

Indeed, the average energy bill for heating will for instance differ according to the type of fossil fuel used. Figure 38 shows an estimation of such an impact under the carbon price trajectory B. Carbon payments would be about 30% higher for households using heating oil than for households using natural gas.

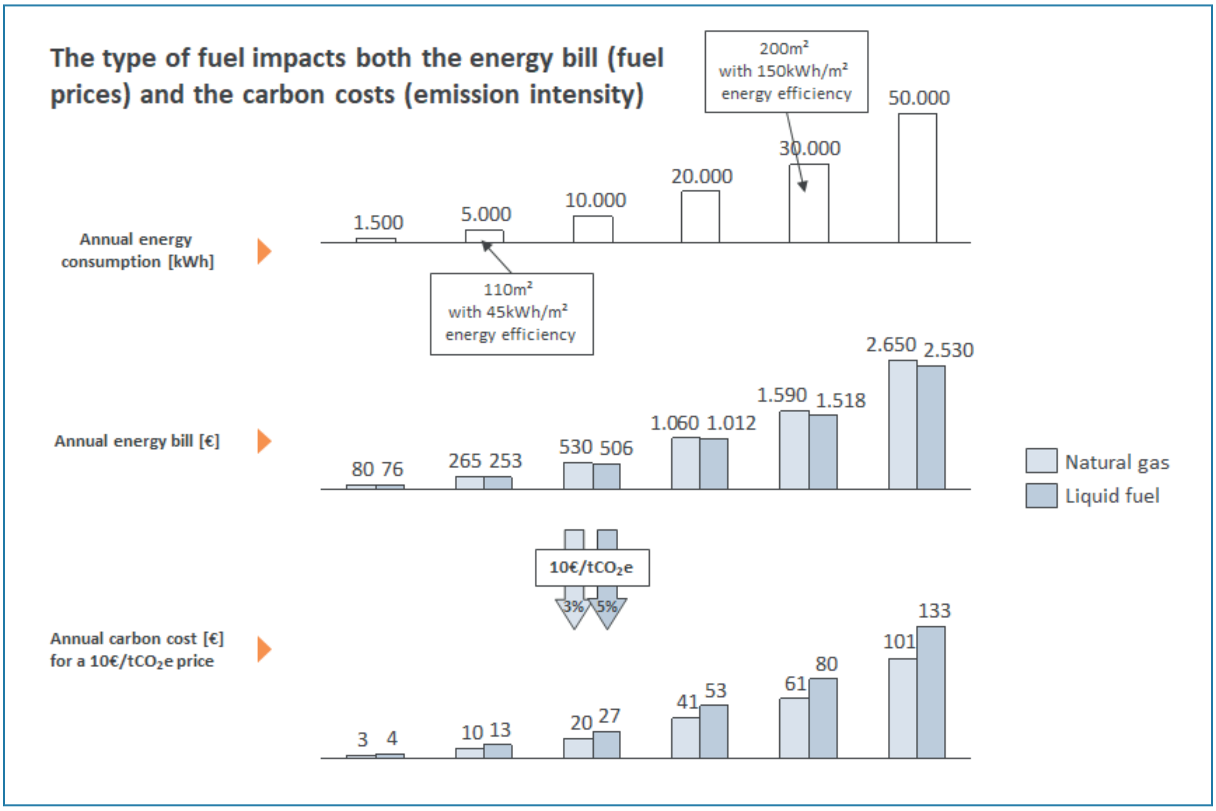
Figure 38: Evolution of the average energy bill for heating with fossil fuels under price trajectory B (€/year)



Source: Own analyses

[57] This figure, 39€, is a little higher than the 32€ average payment estimated in Section 4.4.1. This is mainly due to the fact that the former relates to energy consumptions in the year 2014 instead of 2020.

Figure 39: Annual energy bill and annual carbon payments for different energy consumption levels



Source: Own analyses

Also, the type of dwelling will drastically influence the level of energy consumption and, thereby, the carbon payment. Figure 39 shows the annual energy bill and the carbon payment (for a carbon price of 10€/ tCO_2) for different levels of energy consumption. Typically, the carbon payment for an apartment with a high degree of thermal insulation (110m^2 – 45kWh/m^2) would be 6 times lower than for a house with a low degree of thermal insulation (200m^2 – 150kWh/m^2).

Beyond any lump-sum redistribution mechanism, measures targeting households at risk of energy poverty are thus required to complement any carbon pricing scheme. Further investigations on the most appropriate set of measures are required, building on the schemes currently in place or under development at regional and local levels. As we shall see in Section 4.5, an option is to finance such complementary measures by at least part of the carbon pricing revenues.

4.4.2 Renovation strategies

KEY MESSAGES

The renovation strategies of the three Regions aim to reduce energy demand while taking into account the dimension of energy poverty.

The implementation of a carbon price in the buildings sector could contribute to reaching the objectives of these strategies.

The three Regions are currently working on/implementing ambitious renovation strategies in the buildings sector. These strategies aim to reduce energy demand, while taking into account energy poverty dimensions. They are based on a broad range of instruments (standards, fiscal incentives and subsidies, communication tools, …). Experts agree that the implementation of a carbon price in the buildings sector could contribute to reaching the objectives of these strategies. Indeed, they stress that a carbon price should be part of a broad package of measures that also include norms, standards, etc., and that increased cooperation between the Belgian political entities is necessary in this respect. It was also observed that in all three Regions, the issue of split incentives is a real obstacle for energy renovations that should be addressed. Finally, it was clear that leveraging sufficient finance to renovate the Belgian building stock remains a challenge that has to be addressed and discussed within and between all political levels.

In what follows, we provide a brief overview of the main elements of the regional renovation strategies.

Brussels-Capital Region

For the Brussels-Capital Region, a renovation strategy for buildings is crucial for reaching its GHG emission reduction objectives, given that 74% (in 2015) of its energy consumption stems from this sector. Indeed, 91% of its building stock dates from before 1970 and is thus very energy-intensive. The main areas of the Brussels-Capital Region's current strategy are the following, where energy poverty considerations are to be taken into account continuously, given the importance of this issue in the region:

- Stimulate the demand for sustainable buildings. This is among others done through the introduction of legal obligations related to energetic performance of buildings, providing financial support (energy subsidies, green loans, etc.), a call for exemplary projects, the promotion of the public authorities as role model (use of a passive administration building, etc.), raising public awareness and providing advice, studying options like for instance the possibility of taking into account the energetic performance of buildings in the context of the 'précompte immobilier / onroerende voorheffing', etc.
- Improve the offer of sustainable buildings, a.o. through the provision of support on the construction site or through a helpdesk, the creation of a network to exchange best practices, etc.
- Improve knowledge and know-how in general: guidebooks have been drafted for professionals, formations are provided to energy experts, construction workers/supervisors, etc.
- Adapt the legal framework accordingly.

Walloon Region

The main, broad objectives of the Walloon Region's renovation strategy are to improve the comfort and quality of the occupiers, to reduce the environmental impact of the buildings stock occupation and infrastructure, and to reduce the energy dependence of the Walloon Region.

Based on these broader objectives, the following specific objectives have been formulated:

- Regarding residential buildings, achieve on average an Energy Performance of Buildings (EPB) label A by 2050 for the whole residential buildings stock, whereby priority must be given to deep renovations of the least performing buildings;
- Regarding commercial buildings, achieve an energy-neutral commercial buildings stock by 2050 at the level of heating, production of sanitary hot water, air conditioning and lighting.

Finally, the renovation strategy itself is built on the following axes, and should result in the increase of the renovation rate from 1 to 3%:

- Creating a transparent framework that facilitates energy efficient investments;
- Structuring and reinforcing the market of supplies and services related to the renovation of buildings;
- Reinforcing the demand for energy-performant buildings.

Flemish Region

Generally, the renovation strategy of the Flemish Region is based on sensibilization, stimulation and obligations in order to reach its fixed objectives.

Firstly, the objective for the non-residential sector is to reach 100% emission reductions by 2050, so that fossil fuels are no longer used for heating/cooling, lighting and hot water.

Regarding the residential sector, the Region's strategy is implemented through the Renovation Pact: the Government will facilitate and support the renovation of the building stock, but the engagement of all stakeholders is needed, which is why 34 parties have signed an engagement declaration at the end of 2014. The main objectives of the Renovation Pact are to improve the energy performance of the whole building stock by 75% and to reduce emissions in the buildings sector by more than 80% by 2050. Concretely, this means that the renovation rate needs to increase from currently 0,7% to over 2,5% per year. The strategy must include all dwellings in order to ensure that energy poverty is also dealt with, which is why an energy poverty program was also developed. Renovation advice is also provided and a building passport should be available over time for all dwellings.

4.4.3 Other

KEY MESSAGES

Several other fiscal and non-fiscal measures that might have a negative impact on the objectives of a carbon price in the buildings sector, such as the "Kadastraal Inkomen (KI) / Revenu Cadastral (RC)" and its related tax "Onroerende Voorheffing (OV / Précompte Immobilier (PI)", VAT and registration rights, have been identified throughout the national debate. These should be carefully looked at when considering to implement a carbon price in the buildings sector.

Several other fiscal and non-fiscal measures that might not necessarily be related to energy consumption of buildings exist, which may somehow have an impact on decisions to be taken in relation to buildings (choice of a building, decision to renovate it or not, etc.). We will briefly highlight these measures identified throughout our national debate in this section, since these are linked to the objectives of a carbon price. Anyway, it was pointed out that measures aiming to promote energy efficiency in the buildings sector should target the key moments in the life-cycle of a building (construction, rental, sale, heirloom).

Regarding the **"Kadastraal Inkomen (KI) / Revenu Cadastral (RC)"** and its related tax **"Onroerende Voorheffing (OV) / Précompte Immobilier (PI)"**, it was observed that the current system could have the following consequences or could be improved as follows:

- Performing renovation works on a building would result in an upward revaluation of the building, which in turn would result in higher taxes to be paid. This issue is particularly relevant for landlords;
- For similar buildings, there can be significant differences in RC/KI, which influences the taxes to be paid through the OV/PI. This in turn might lead to the distortion of the choice (w.r.t. energy efficiency) for a particular building;
- It would be interesting to link the tax OV/PI to the energy performance of a building or renovation works, for instance by giving a deduction (limited in time) whenever the energy performance of a building has been improved or following renovation works.

Regarding **Value Added Tax (VAT)**, the following was observed:

- A VAT rate of 21% for newly built (with better energy efficiency standards), as opposed to existing buildings;
- A VAT rate of 6% only for demolition and rebuilding in certain towns.

It is worth exploring whether for instance the reduced VAT rate for demolition and rebuilding could be extended, whether a reduced rate for renovation works linked to the energy/climate performance of a building could be implemented, etc.

Regarding **registration rights**, it was observed that it might be worthwhile examining whether the current regional systems have an impact on the mobility of people, in particular on the incentive to moving in order to live closer to the workplace.

Finally, the following **additional measures that might have a positive impact on the energy performance of buildings** were identified throughout the discussions held: reducing inheritance rights in case of major building renovation, forbidding the sale/rent of energy inefficient buildings, and sharply increasing the renovation rate in social housing.

4.5 KEY IMPLEMENTATION ISSUES AND OPTIONS

Different options for each of the four identified implementation modalities emerge from all previous analyses and from discussions with key actors. These options are summarized at the end of the Section.

Scope

The benchmark analysis has shown that the price of fossil fuels used for heating is significantly lower in Belgium than in the neighbouring countries due to lower levels of excise duties. Such low levels neither foster energy efficiency nor the switch to low carbon heating technologies.

It is proposed that **all fossil fuel emissions**, namely those from heating oil, gas and coal in both the residential and the non-residential sectors, be subject to the carbon price through increased energy taxes on the basis of their carbon content.

CO_2 emissions from biomass, which are not accounted for in national inventories, would not be subject to the carbon price. Indeed, the concrete implementation of a carbon price on wood and wood products is far from being obvious (e.g. self-producing consumers). Although the use of biomass for heating is responsible for air pollution (see below), the control of air pollution stemming from biomass would thus best be addressed by specific measures other than carbon pricing.

Price trajectory

The impact analyses have shown that carbon pricing can contribute to making low carbon investments in buildings profitable, but that is depends to some extent on the motive for renovation: profitability increases if the renovation is done for motives other than energy efficiency. This pleads for the implementation of a price trajectory starting at a low level and gradually increasing towards significant levels in the long term. Such a trajectory would not penalise those who are not able to anticipate a deep renovation and, at the same time, would provide them with a clear signal in favour of low carbon investments.

It is proposed that the carbon price follows the default trajectory A, B or C as described in Section 3.2.2.

Use of public carbon revenues

General purposes

A first possibility is to allocate part or all of the revenues to already identified general purposes, i.e. to reduce either labour taxes (cf. France or Sweden) or taxes and levies on electricity. See Section 3.2.3 for more details.

Distributive issues – energy poverty

A second possible use of the revenues relates to the distributive impacts of carbon pricing. Such impacts have been analysed in Section 4.4.1. Since its purpose is to increase the price of fossil fuels with respect to alternatives, carbon pricing also raises concerns regarding energy poverty. This concern applies to the low carbon transition in general, as behaviours have to change and investments have to be made whatever the policy instrument. Moreover, the purpose of carbon pricing is to drive the low carbon transition, which will reduce the average energy bill in the mid-term due to energy efficiency and, thereby, can contribute to reducing energy poverty. In the near term, however, even slightly increasing energy prices could deepen energy poverty. This concern being shared by almost all actors, it is proposed that a share of the revenues from carbon pricing is used to tackle this issue, along two lines: (i) a system of energy vouchers and (ii) financing specific policies targeting energy poverty.

A first way to deal with (potentially increasing) energy poverty is to redistribute a share of the revenues directly to households at risk of energy poverty in order to cover the additional carbon payments. A key feature that should characterise such transfers as much as possible is their 'lump-sum' nature: for the carbon price to fully play its role in guiding behaviours and investments towards low carbon alternatives, the amount transferred to the households should be independent of their energy consumption/carbon emissions (CSF, 2009, Bréchet, 2017, Eyckmans, 2017, Valenduc, 2017).

A system of energy vouchers is the main option identified in a.o. the analysis of lessons learnt from the implementation of carbon pricing in other countries. Such an option has also been highlighted by the High Council on Finance (2009).

- **Energy vouchers option**. The vouchers would be allocated only to households facing energy poverty. A possibility is to limit its allocation to households currently benefiting from social tariffs, although this scope could be broadened if analysis shows that an important part of households facing energy poverty is not covered by the system of social tariffs. The vouchers could be used for paying both energy and energy efficiency expenditures. Their value would be set with the view to compensate, on average, for the payments of the carbon tax. This value could also be differentiated across benefiting households based on criteria still to be defined, such as the size of the household, the heating energy vector, etc …

  Which share of the revenues would be required to finance such a measure? A back-of-the-envelope calculation shows that about 5 to 10% of the yearly revenues from pricing carbon in the buildings sector would be required to cover the payment of vouchers amounting to the average carbon payment per household (e.g. 32€ in 2020 for a price of 10€/tCO_2, see Section 4.3.1) for 500 000 households, i.e. approximately the number of households that currently benefit from social tariffs. Table 8 below illustrates the budget required for energy vouchers in 2020 and in 2030 under different carbon price levels. The budget raises from about 0,2 billion € in 2020 to 1 billion € in 2030 under price trajectory B, i.e. about 6 to 7% of the carbon revenues in the sector being needed to finance energy vouchers.

  Table 8: Illustration of the budget required to finance energy vouchers

Carbon price (€/tCO_2)	Year	Average carbon payment (€)	Budget required (M€)	Carbon revenues*(M€)	Share budget-revenues
10	2020	32	16	221	7%
40	2030	57	29	435	7%
70	2030	127	64	1.016	6%
100	2030	176	88	1.451	6%

  As to the implementation of the system, a possibility is to rely on a 'energy desk' (cf. High Council on Finance, 2009) that would not only be responsible for the allocation and the management of the vouchers but that could also foster the deployment of energy efficiency measures in the buildings sector through, a.o., providing consumers with information on supporting measures and other related policies and measures.

- **Reinforcement of social tariffs and gradual evolution towards energy vouchers option**. Another, complementary, option is to reinforce the current social tariffs (at least those related to gas and heating oil)[58] in proportion to the additional carbon payments and make the system gradually evolve towards energy vouchers. France has just implemented such a reform in the context of its carbon tax scheme (cf. Section 4.2.2).

  Beneficiaries of the system would still be the same as those under the current social tariffs (including the heating oil fund) and vouchers could also be used for the payment of both the energy bill and

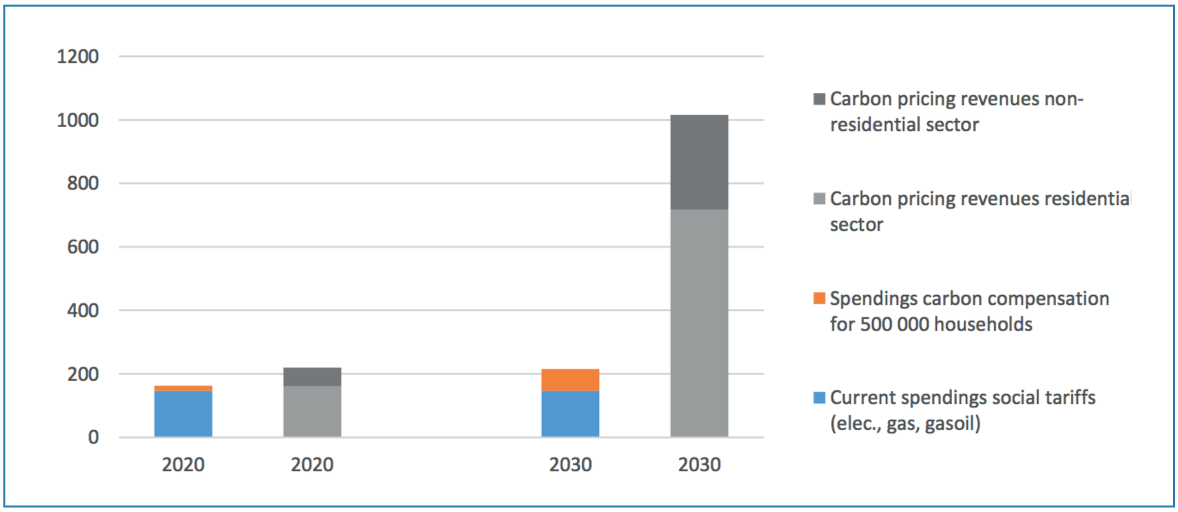
[58] Or broaden them, if analysis shows that an important part of households facing energy poverty is not covered by this system.

for energy efficiency expenditures. The reform would have the advantages to (i) progressively move towards a lump-sum compensation instead of a compensation currently based on actual energy consumption, (ii) rationalize the compensation schemes, and (iii) identify a clear source of financing, i.e. carbon emissions, thereby removing related current charges and levies not only on oil and gas, but also on electricity.

In 2017, there were about 500 000 beneficiaries of the reduced tariffs on electricity, about 300 000 beneficiaries of the reduced gas tariffs and about 90 000 (2016) beneficiaries of the gasoil social fund in Belgium.[59] Annual spending corresponding to these tariffs amounted to about respectively 70 M€, 59 M€ and 18 M€ on average over the years 2014-2016, that is 147 M€ per year in total. The sources of finance of those social tariffs and measures are the federal levy for 'protected consumers' (1,6956 €/MWh on electricity and 0,3961 €/MWh on gas in 2017) and the levy on gasoil[60] (1,6 €/1000L).

Would carbon pricing revenues suffice to finance such a reform? Again, back-of-the-envelope calculations show that estimated revenues from carbon pricing in the buildings sector would, in 2020, slightly outweigh current spending for social tariffs (including for electricity) and the budget required to finance a transfer to 500 000 households corresponding to the average carbon payment of the same year (32€ in 2020 for a price of 10€/tCO_2, see above). From then on, as illustrated in Figure 40, carbon pricing revenues become much larger than the amounts required to finance the reform as the carbon price increases.

Figure 40: Spendings on social tariffs/measures and on carbon payment compensation vs. carbon pricing revenues – carbon price trajectory "B" (M€)



Sources: Own analyses, CREG, FPS Economy, Sociaal Verwarmingsfonds

Notes: Working assumptions: total spendings on social tariffs and measures are constant at 147 M€/year, i.e., average over years 2014-2016 of repayments CREG protected consumers (electricity and gas) and heating oil fund payments; carbon compensation would correspond to the total average carbon payment in the given year and would be allocated to 500 000 households, cf. above.

A second, complementary way to address energy poverty issues is to finance **specific policies targeting energy poverty.** Indeed, as shown in Section 4.4.1, energy poverty has a number of different dimensions and it is obviously difficult to target people at risk. In particular, because they are based on lump-sum redistribution, the compensations under the options described just above will hardly perfectly match the needs. Therefore, reinforcing policies that target people in the field is required and could be financed by part of the revenues from carbon pricing. These include renovation funds or programmes for people facing or at risk of energy poverty that would be developed or reinforced at local or regional levels.

[59] Sources: CREG, FPS Economy, Sociaal Verwarmingsfonds, own calculations.
[60] The revenues from this levy are complemented by a federal public subsidy through the FPS Economy.

Facilitating the transition in the buildings sector

Three other options have been identified.

- **Lump-sum transfer** to each citizen. This option is similar to the way Switzerland redistributes all revenues from carbon pricing in the buildings sector. The 'Conservative case for carbon dividends' proposal in the USA is similar, with the exception that revenues from not only the buildings sector but also the other sectors would be redistributed equally to citizens. Such a lump-sum transfer could take different forms, including energy vouchers, tax credits, etc…
- **Renovation programme** for both residential and non-residential sectors. The low carbon transition requires a massive renovation of the buildings, meaning that the renovation rate has to double from current levels. Programs developed in Ireland, namely 'better energy homes' and 'better energy warmer homes' can be inspiring[61]. As shown in Section 4.4.2, the three regions are implementing renovation strategies and policies. Part of the revenues could then be used to support those renovation programmes.
- **Support to SMEs**. Part of the non-residential buildings are used by small and medium enterprises (SMEs). As for residential buildings, barriers also exist that could limit the role of carbon pricing in reducing energy demand and driving low carbon investment. Part of the revenues could be used to accompany those SMEs in the transition. The support could take different forms, from the provision of information, financing of audits, etc. to a direct participation to financing part of the investments and could build on existing programmes[62].

Policy alignment

Finally, for carbon pricing to play its signalling role, it must be aligned with other relevant policies at federal, regional and local level. Information problems and moral hazard issues, such as the owner-landlord incentive problem (with one third of the residential buildings not occupied by their owner), as well as any distributive issues (cf. Section 4.4.1) and air pollution aspects (cf. Section 9.1) resulting from the implementation of a carbon price, must be carefully taken into account in this context. The most relevant policies identified throughout the national debate for which an alignment must be ensured, include the renovation strategies under development/implementation in each of the regions (cf. Section 4.4.2), since a carbon price can contribute to reaching their objectives, as well as other fiscal and non-fiscal measures (such as the KI / RC and its related tax OV / PI", VAT and registration rights – cf. Section 4.4.3), since these might have an impact on the objectives of a carbon price in the buildings sector.

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61 "Better energy homes" scheme – targets roof and wall insulation, as well as heating system upgrades, performed by certified professionals for homeowners, covering up to 30% of average retrofitting costs; "Better energy warmer homes" scheme – designed to support vulnerable people in or at risk of energy poverty, for works related to roof and cavity wall insulation, draught proofing and installing low-energy light bulbs, fully covering the costs of retrofitting.

62 See for instance the "4ECO" program developed by UCM for instance.

Summary

Emissions in 2016	23,0 $MtCO_2e$ 31% total non-ETS
Scope	All fossil fuel emissions (oil, gas, coal), biomass excluded Via component of energy taxes
Price	Trajectory A, B or C (*)
Public carbon revenues (uses)	General tax shift away from labour and/or electricity Lump-sum transfers to and financing of targeted policies for people at risk of energy poverty Lump-sum transfers to all citizens Renovation programmes Support to SMEs
Max. expected annual revenues (trajectory B)	2020: 220 M€ 2030: 939 M€
Policy alignment	Renovation strategies, incl. policies targeting people at risk of energy poverty Air pollution policies (incl. biomass) Specific fiscal reforms, including: ➤ removing exemptions/reduced rates on fossil fuels ➤ reforming the Revenu Cadastral/Kadastraal Inkomen and the Onroerende voorheffing/Précompte Immobilier ➤ reform of VAT level (new built, renovation) ➤ reform of Registratierechten/droits d'enregistrement

(*) From 10€/tCO_2e in 2020 to 40, 70 or 100 €/tCO_2e in 2030.

5 Transport

The implications of setting a carbon price on GHG emitted in the transport sector are discussed in this Section. The context of the sector is first described, in terms of emissions, key characteristics and long term low carbon perspectives. Second, current levels of energy prices and taxes in the sector are analysed together with experiences in pricing carbon emissions from transport abroad. In the third subsection, impact analyses are provided on the average energy bill, on expected public carbon revenues, on the profitability of low carbon investments and on the total costs at sectoral level. The main policy alignment issues are analysed in a fourth subsection. Finally, key implementation options are described on the basis of all these analyses and the discussions held with key actors.

5.1 CONTEXT

5.1.1 Emissions

KEY MESSAGES

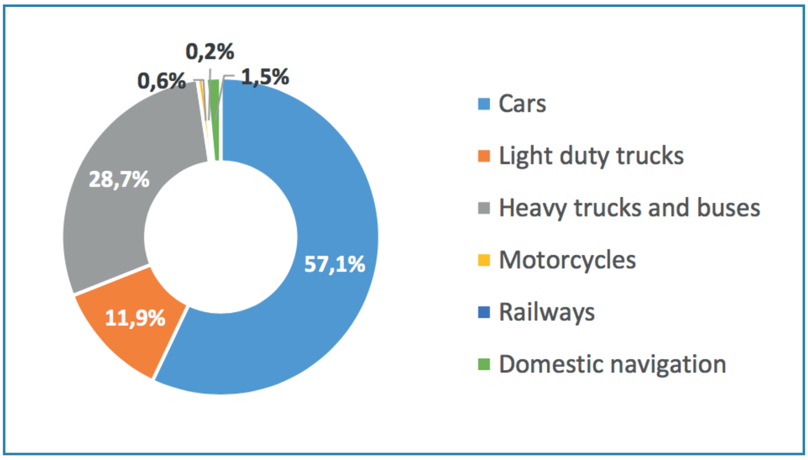
GHG emissions in the transport sector represented 35% of total Belgian non-ETS emissions in 2016. Emissions in this sector have increased by 1,1% per year on average between 1990 and 2016, compared to the estimated 2,9% decrease required to reach full decarbonisation by 2050.

In 2016, CO_2 emissions in the transport sector amounted to 35% of non-ETS emissions, with 20% for cars and 14% for light and heavy-duty vehicles and buses. Between 1990 and 2016, CO_2 emissions in the transport sector have risen by 28%, i.e., +1,1% per year on average vs -2,9% per year on average required between 2016 and 2050 to reach zero emissions (see figures A.4.1 and A.4.2 in Appendix 4).

As illustrated in Figure 41, cars represented 57,1% of CO_2 emissions in the transport sector in 2016, followed by heavy trucks and buses (28,7%), light duty trucks (11,9%), domestic navigation (1,5%), motor-cycles (0,6%) and railways (0,2%). Emissions from international civil aviation and maritime transport are not included here, since they are not accounted for in the specific GHG inventory for the transport sector under the UNFCCC and since these emissions are covered by other multilateral agreements. Even though pricing those emissions remains an issue, they are not analysed in the context of the present debate.

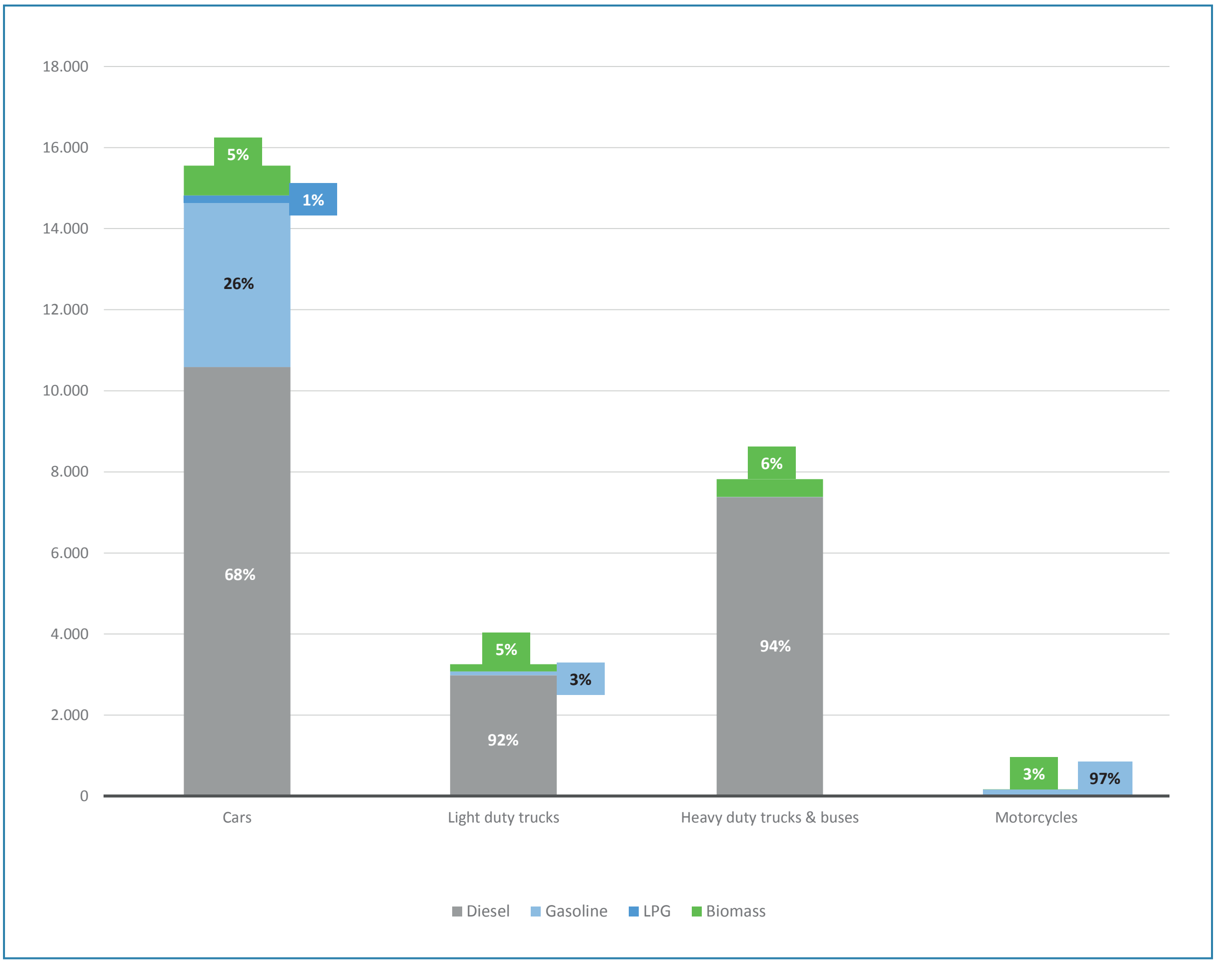
Diesel is the first source of CO_2 emissions in the road transport sector (see Figure 42): 68% for cars, 94% for heavy duty vehicles and buses and 92% for light duty vehicles in 2016.

Figure 41: Distribution of 2016 CO_2 emissions in transport (in percentage per category).



Source: NIR 2018

Figure 42: 2016 CO_2 emissions in road transport per energy source (in ktCO_2 and in percentage per category)



Source: NIR 2018

5.1.2 Key characteristics

> **KEY MESSAGES**
>
> Within the last ten years, the density of vehicles increased by around 10% in Belgium. On average today, Belgian households have one car for two persons.
>
> 75% of freight activity is ensured by trucks, of which the half for national transportation. Trucks that are subject to the kilometric levy ensure 70% of freight transport and are responsible for 30% of road GHG emissions. Light-duty vehicles, that are not subject to the kilometric levy, ensure 4% of freight transport and are responsible for 12% of road GHG emissions.

The transport activity in Belgium is mainly covered by cars and trucks: 76% of personal transport is ensured by cars[63] and 75% of freight activity is ensured by trucks, of which half for national transportation (see Figure A.4.5 in Appendix 4). Within the last 10 years, the density of vehicles increased by ~10% (see Figure A.4.3 in Appendix 4) leading to, on average, one car for two persons. The car fleet mostly consists of diesel cars (62%), followed by gasoline cars (36%). However, registrations of new cars in Belgium show that gasoline cars are catching up with diesel cars (see Figure A.4.4 in Appendix 4). Electric cars only represent 0,02% of the Belgian fleet. Finally, company cars amount to 15% of the cars in Belgium.

As for freight transport, most of it (70%) is covered by vehicles with MMA higher than 3,5t, which are responsible for 30% of the total road GHG emissions. These vehicles are subject to the kilometric levy. Light-duty vehicles are not subject to the kilometric levy. They ensure 4% of freight transport and are responsible for 12% of road GHG emissions.

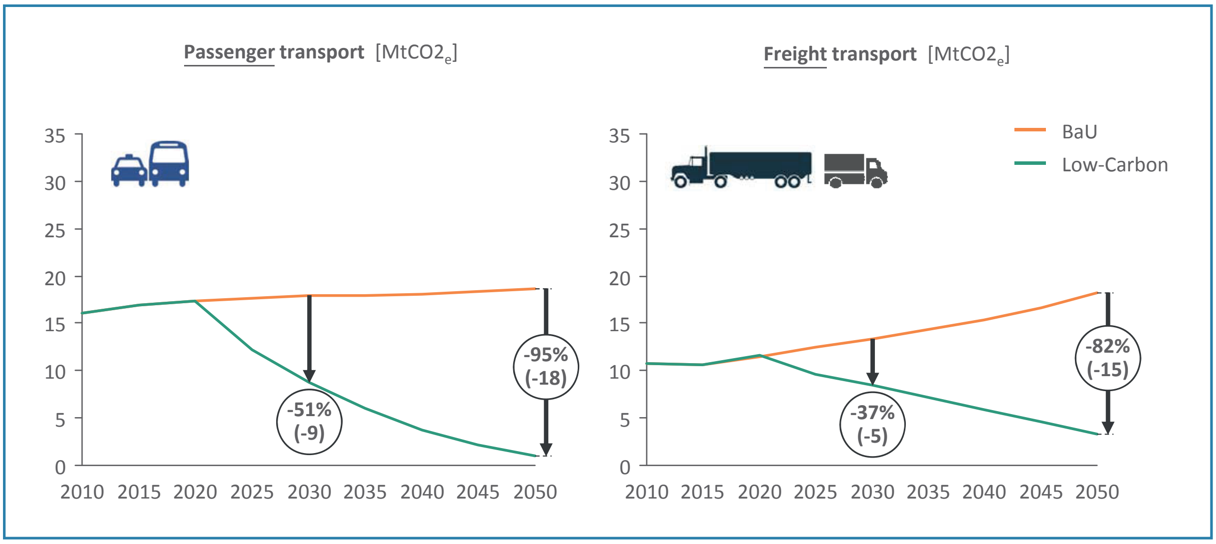
5.1.3 Low-carbon scenarios

> **KEY MESSAGES**
>
> For passenger transport, the low-carbon scenario relies on a reduced demand, a shift to alternatives to the car like public transport, bicycle and walking, and a switch to electric cars.
>
> For freight transport, the low-carbon scenario relies on a limited increase of the demand and an important shift to alternatives to road.

In the low-carbon scenario, GHG emissions of the transport sector are reduced by 45% in 2030 and by 88% in 2050 with respect to the BaU scenario (51% and 95% for passenger transport and 37% and 82% for freight transport, see Figure 43).

[63] Source: Federal Planning Bureau.

Figure 43: Updated 2050 scenarios for passenger and freight transport



For passenger transport, the evolution of the travel demand per person and of the share of cars play an important role in the low-carbon scenario, with almost a complete shift to electric mobility. The low-carbon scenario relies on a reduced demand (-10% passenger transport in 2050 w.r.t. 2010), a shift to alternatives to car (transport by car is reduced from 81% of the passengers.km in 2015 to 65% in 2050, see Figure A.4.6 in Appendix 4) and a switch to mainly electric cars (76% EVs by 2050) but also to other cars fueled on e.g. hydrogen and biogas (see Figure A.4.7 in Appendix 4). Public transport and 'soft modes' like walking and the use of the bicycle will play a crucial role in the shift to alternatives to the car.

For freight transport, the low-carbon scenario relies on a limited increase of the demand (+34% in 2050 w.r.t. 2010) and an important shift to alternatives to road (road is reduced from 73% of transport in 2015 down to 58% by 2050 – see Figures A.4.8, A.4.9 and A.4.11 in Appendix 4).

The low-carbon scenario also relies on an increasing use of bioenergy. Bioenergy contributes to reducing GHG emissions by 0,9MtCO_2e in 2015 up to 4,6MtCO_2e in 2050[64]. This is illustrated in Figure A.4.10 in Appendix 4.

[64] Biomass is considered as zero emission in these assessments. Indirect emissions related to land-use change are not accounted for.

5.2 PRICES AND TAXES

5.2.1 Current levels and comparison with neighbouring countries

KEY MESSAGES

There are limited reduced excise rates or exemptions on motor fuels used for road passenger transport in Belgium and its neighbouring countries. Regarding road freight transport, a reimbursement scheme for 'professional' diesel is only in place in Belgium and in France. Fuels for commercial navigation and aviation are exempted from excise duties, while rail transport tends to benefit from exemptions or reduced rates.

Regarding professional diesel, when reimbursement schemes are taken into account, final prices in Belgium (incl. VAT) are lower than in its neighbouring countries (with the exception of Luxembourg). The difference with the average in the four and in two (the Netherlands and France) neighbouring countries corresponds to a price of around 19 €/tCO_2e and 36 €/tCO_2e, respectively.

Regarding non-professional diesel, given the alignment of excise duties on diesel and petrol in Belgium, final prices tend to be higher than in its neighbouring countries. Implementing a carbon price in Belgium of 10 €/tCO_2e above the current excise duty rates would rise the differential by about 2 percentage points.

Regarding petrol, final prices in Belgium (incl. VAT) are lower than in its neighbouring countries (with the exception of Luxembourg). The difference with the average in the four and in two (the Netherlands and France) neighbouring countries corresponds to a price of around 10 €/tCO_2e and 54 €/tCO_2e, respectively.

Current taxes and tax levels

Table 9 and Table 10 below provide an overview of excise tariffs[65] applicable in 2017 to the main energy products used in the road transport and other transport sectors in Belgium and its neighbouring countries.

In Belgium, a partial refund of excises on diesel is granted only to professional users when the diesel is used for (i) paid transport of persons (e.g. taxis), (ii) paid transport of disabled or injured persons (e.g. ambulances), (iii) carriage of goods by road (vehicles with a max. load capacity of > 7,5 ton), and (iv) transport of persons, whether regular or occasional, with a vehicle of category M2 or M3 (vehicles with more than 8 seats, excl. the one for the driver). The Belgian reimbursement scheme is linked to the so-called 'cliquet' system that partially offsets declines in international oil prices by an increase in excise duties levied on diesel fuel, given that it neutralizes the price increase for professional users. The last refund amount applicable in 2017 was of 177,4298 €/1000L.

In France, a partial refund of energy taxes on diesel may be obtained when used for motorized road vehicles for the transport of goods with a max. load capacity > 7,5 ton and/or road transport vehicles with a total rolling weight of more than 7,5 ton, for buses and for taxis. Taxis may also benefit from a partial refund for petrol. The refund amount is the difference between the applicable energy tax rate and a minimum tax level, and amounted on average in 2017 to 114,2 €/1000L for diesel used for road freight transport, 154,2 €/1000L for diesel used by buses, 242,2 €/1000L for diesel used by taxis and 299 €/1000L for petrol used by taxis.

Both in Belgium and in France, the respective governments have decided to phase-out the current difference in taxes between diesel and petrol. In Belgium, this is also done through the 'cliquet' system and it is expected that excise duties on diesel will have caught up with excise duties on petrol by the end of 2018.

65 The excise tariffs presented here include excises, exceptional excises and the energy contribution. Sources: PwC, EU Commission excise tables

Table 9: Overview of 2017 excise tariffs in Belgium and neighbouring countries – Road transport

	Product/ Applicable excise tariff	**Gas oil (1000 L)**	**Petrol (1000 L)**	**LPG (1000 kg)**	**Methanol (1000 L)**	**Biodiesel (1000 L)**	**Electricity (MWh)**
BE	Standard rate	529,9726	605,0731	0	529,9726 or 620,5354	529,9726 or 605,0723	1,9261
	Reduced rate / exemption	352,5428	-	-	-	-	0
	Difference	177,4298 (1)	NA	NA	NA	NA	1,9261
FR	Standard rate	530,7	683,4	165	94,1	No fixed rate	22,5
	Reduced rate / exemption	416,50	-	-	-	-	0,5 (2)
	Difference	114,2 (1)	NA	NA	NA	NA	22 or 22,5
NL	Standard rate	485,92	772,21	337,35	772,21	485,92	1,07 - 101,3
	Reduced rate / exemption	-	-	-	-	-	0,53 - 101,3 (3)
	Difference	NA	NA	NA	NA	NA	0,54 (3)
DE	Standard rate	470,4	654,5	180,32	0	21,4	20,5
	Reduced rate / exemption	416,38 (6)	600,48 (6)	166,95 (6)	-	-	15,37 or 11,42 (4)
	Difference	54,02	54,02	13,37	NA	NA	5,13 or 9,08 (4)
LU	Standard rate	335	462	101,64	101,64	335	1
	Reduced rate / exemption	-	-	-	-	-	0,5 (5)
	Difference	NA	NA	NA	NA	NA	0,5 (5)

(1) This corresponds to the reimbursements made for professional diesel in Belgium and in France, respectively.
(2) 0,5 €/MWh rate applies to metro, tram and trolley buses.
(3) Only applies to the highest tranche of electricity consumption.
(4) 15,37 €/MWh for business use and 11,42 €/MWh for metro, tram and trolley bus.
(5) 0,5 €/MWh for business use.
(6) Reduced rates through reliefs for local public passenger transport (bus, tram).

Table 10: Overview of 2017 excise tariffs in Belgium and neighbouring countries – Other transport

	Product/ Applicable excise tariff	**Gas oil (navigation – 1000 L)**	**Kerosene (aviation – 1000 L)**	**Electricity (railway - MWh)**
BE	Standard rate	529,9726	657,3179	1,9261
	Reduced rate / exemption	0 (1)	0 (2)	0
	Difference	529,9726	657,3179	1,9261
FR	Standard rate	530,7	476,8	22,5
	Reduced rate / exemption	0 (1)	0 (2)	0,5
	Difference	530,7	476,8	22
NL	Standard rate	485,92	485,92	0,54 - 101,3
	Reduced rate / exemption	0 (1)	0 (2)	0,53 - 101,3 (3)
	Difference	485,92	485,92	0,54
DE	Standard rate	470,4	654,5	15,37 (4)
	Reduced rate / exemption	0 (1)	0 (2)	11,42
	Difference	470,4	654,5	3,95
LU	Standard rate	335	330	0,5 (4)
	Reduced rate / exemption	0 (1)	0 (2)	0
	Difference	335	330	0,5

(1) Exemption for commercial navigation within community waters (includes inland waterways).
(2) Exemption for commercial aviation.
(3) Only applies to the highest tranche of electricity consumption.
(4) Rate for business use.

In France, this catching up is expected to be finalized by 2021. Figures A.4.12 and A.4.13 of Appendix 4 present an analysis of expected final prices of diesel and petrol in Belgium once this catching up is finalized.

The main conclusions that can be formulated regarding taxes and tax levels, are the following:

- Regarding road transport, there are, overall, limited reduced rates or exemptions on motor fuels used for road passenger transport, the main ones being (i) a zero rate on LPG only in Belgium, (ii) a reduced rate on electricity when used by trams, metro and trolley buses in France, and (iii) the same reduced rate in Germany and Luxembourg when used by trams, metro and trolley buses but also when for business use in general. Regarding road freight transport, a reimbursement scheme for 'professional' diesel is in place in Belgium as well as in France, whereas no such schemes exist in the Netherlands, Germany and Luxembourg.
- Fuels for commercial navigation and aviation are exempted from excise duties, while rail transport tends to benefit from exemptions or reduced rates (mainly on electricity).

Prices – comparison with neighbouring countries

Figure 44, Figure 45 and Figure 46 below provide a comparison of final prices in 2017 for diesel (professional and non-professional) and petrol in Belgium and its neighbouring countries, these two energy products being the ones mainly used in the transport sector in Belgium.

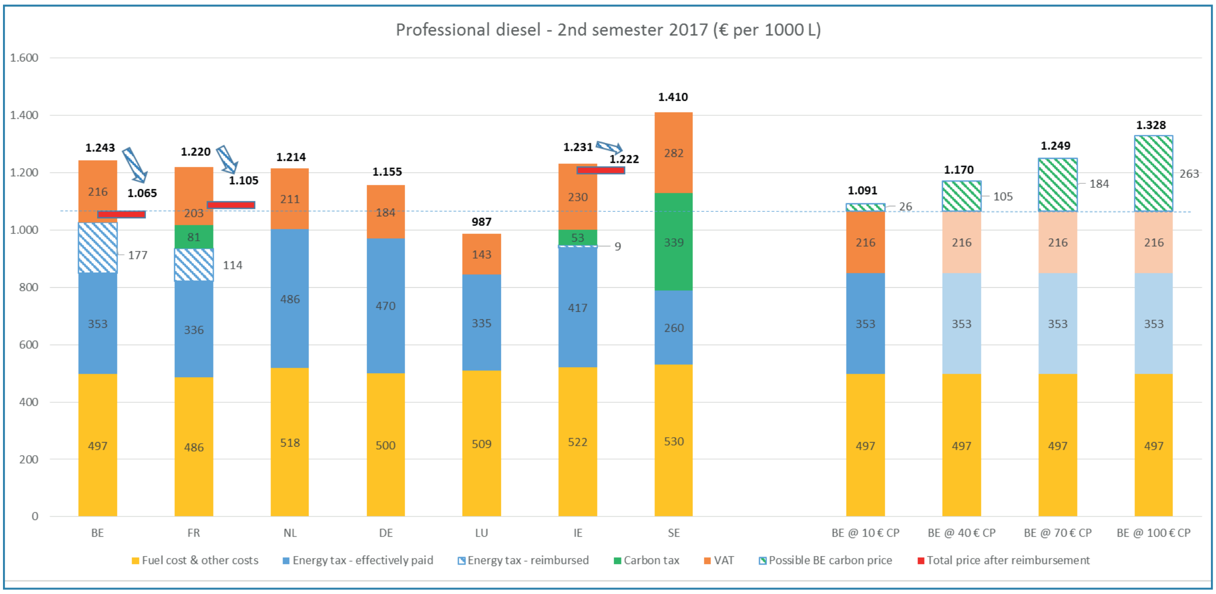
Regarding professional diesel, we can observe that, when reimbursement schemes are taken into account, final prices in Belgium (incl. VAT) are lower than in its neighbouring countries (with the exception of Luxembourg). The Belgian prices are about 5% lower than the average price of the four neighbouring countries and about 8% lower than the average price of France and the Netherlands. The difference with the average price in the four and in two (France and the Netherlands) neighbouring countries corresponds to a price of around 19 €/tCO_2e and 36 €/tCO_2e, respectively. More details can be found in Table A.4.14 of Appendix 4.

Regarding non-professional diesel, we observe that, given the alignment of excise duties on diesel and petrol in Belgium, final prices tend to be higher than in its neighbouring countries. The Belgian prices are about 9% higher than the average price of the four neighbouring countries and about 2% higher than the average price of France and the Netherlands together. Implementing a carbon price in Belgium of 10 €/tCO_2e above the current excise duty rates would rise the differential by about 2 percentage points. More details can be found in Table A.4.15 of Appendix 4.

Regarding petrol, final prices in Belgium (incl. VAT) are lower than in its neighbouring countries (with the exception of Luxembourg). Belgian prices are about 2% lower than the average price of the four neighbouring countries and about 8% lower than the average price of France and the Netherlands together. The difference with the average price in the four and in two (France and the Netherlands) neighbouring countries corresponds to a price of around 10 €/tCO_2e and 54 €/tCO_2e, respectively. More details can be found in Table A.4.16 of Appendix 4.

Regarding LPG and CNG, we can also observe that final prices in Belgium (incl. VAT) are lower than in its neighbouring countries (with the exception of Luxembourg). The Belgian LPG prices are about 19% lower than the average price of the four neighbouring countries and about 29% lower than the average price of France and the Netherlands together. The Belgian CNG prices are about 4% lower than the average price of the four neighbouring countries and about 15% lower than the average price of France and the Netherlands together. as the difference with the average price in the four and in two (France and the Netherlands) neighbouring countries corresponds to a price of around 71 or 15 €/tCO_2e and 123 or 64 €/tCO_2e, respectively. The figures providing a comparison of final prices in 2017 for LPG and CNG in Belgium and its neighbouring countries as well as more details can be found in Appendix 4, A.4.17 to 4.20.

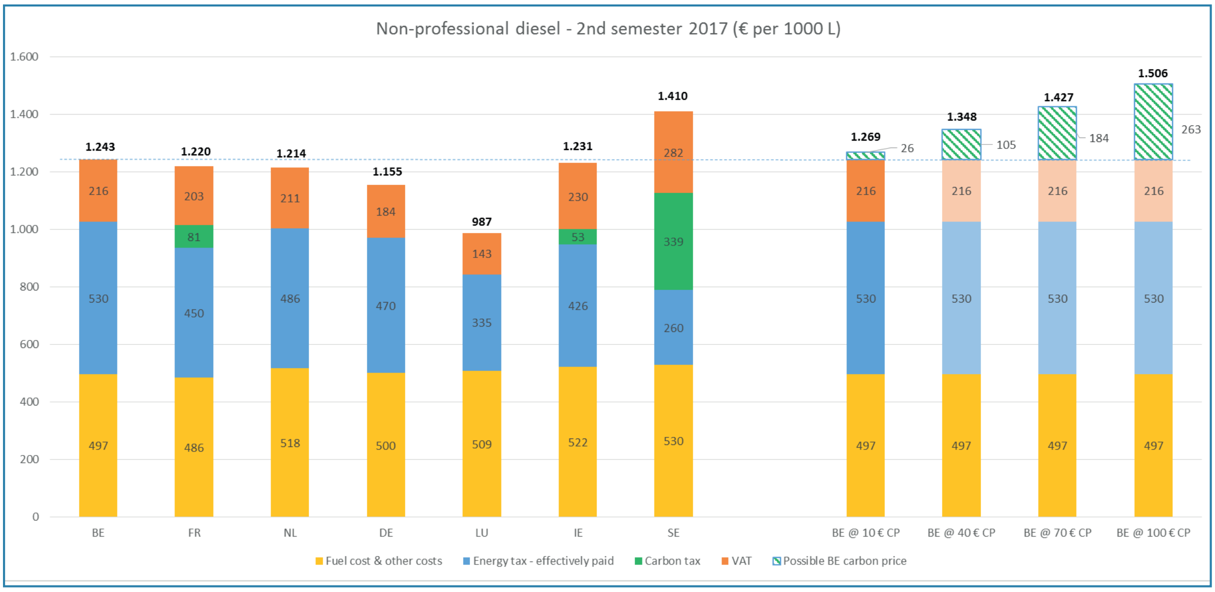
Figure 44: Comparison of final prices of professional diesel and impact of carbon price in Belgium[66]



Sources: EC Weekly Oil Bulletin for final prices (S2 2017 averages), EC excise duty tables on energy products and electricity (excise rates on 01/01/2017), information on carbon taxes from colleagues, own calculations.

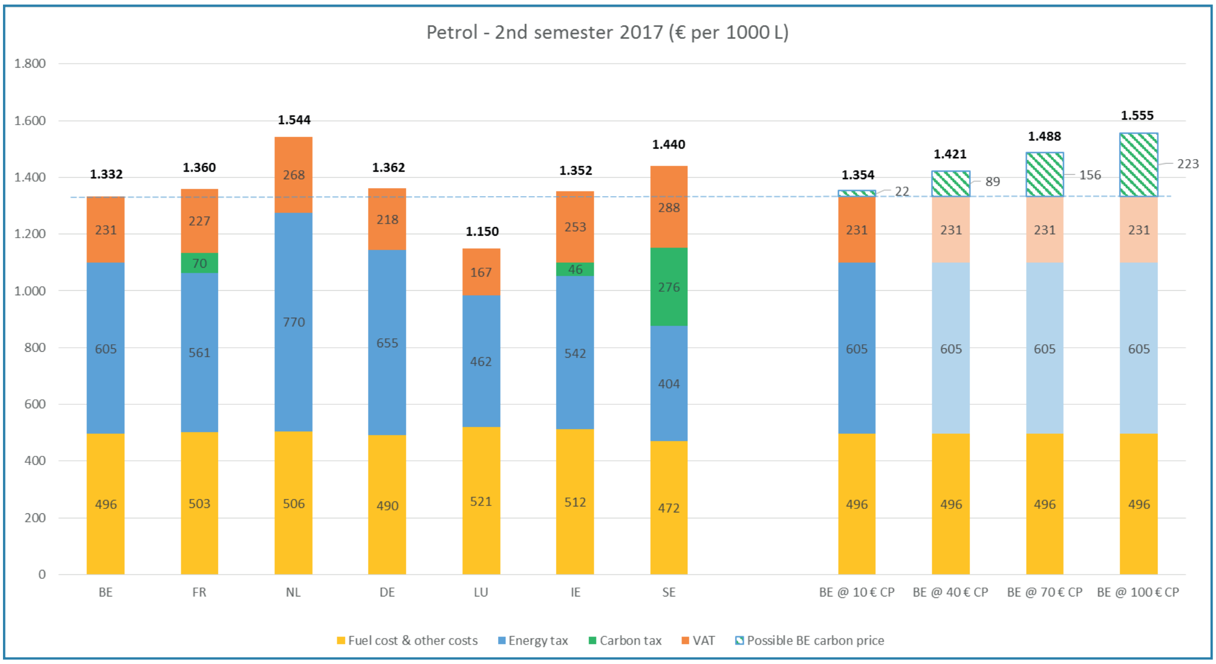
66 Methodology: use the average S2 2017 final prices as a basis, deduct the VAT from those prices, then the energy (and carbon) taxes to obtain 'fuel cost & other costs'.

Figure 45: Comparison of final prices of non-professional diesel and impact of carbon price in Belgium[67]



Sources: EC Weekly Oil Bulletin for final prices (S2 2017 averages), EC excise duty tables on energy products and electricity (excise rates on 01/01/2017), information on carbon taxes from colleagues, own calculations.

Figure 46: Comparison of final prices of petrol and impact of carbon price in Belgium[68]



Sources: EC Weekly Oil Bulletin for final prices (S2 2017 averages), EC excise duty tables on energy products and electricity (excise rates on 01/01/2017), information on carbon taxes from colleagues, own calculations.

67 Methodology: use the average S2 2017 final prices as a basis, deduct the VAT from those prices, then the energy (and carbon) taxes to obtain 'fuel cost & other costs'.

68 Methodology: use the average S2 2017 final prices as a basis, deduct the VAT from those prices, then the energy (and carbon) taxes to obtain 'fuel cost & other costs'.

5.2.2 Lessons learned from existing carbon taxes

KEY MESSAGES

Fully applying the carbon tax in the road transport sector is the standard in the analyzed countries, although two special cases have been identified, namely at the level of commercial road transport and at the level of natural gas and LPG. Regarding commercial road transport, some countries have a reimbursement scheme in place. Regarding natural gas and LPG: reduced or even zero energy tax rates apply (in one case, there is even a reduced carbon tax rate) in order to incentivize these fuels in the transport sector.

Regarding commercial navigation (sea and inland waterways), the relevant fuels are exempted from energy and carbon taxes in all analyzed countries.

Regarding railways, either a full exemption from or reduced rates of energy and carbon taxes apply in the analyzed countries.

Based on the publicly available information gathered, further information collected through contacts in the respective administrations, and available time and resources, it was possible to analyze in more detail the carbon tax features of the following countries: France, Ireland and Sweden. The focus lied on the scope of the tax within the transport sector, including whether any reduced rates / exemptions apply for some energy products / consumers / subsectors.

France

The carbon tax within the transport sector is applied through the taxes on energy products ("Taxe Intérieure de Consommation sur les Produits Energétiques" or TICPE) and the taxes on natural gas ("Taxe Intérieure de Consommation sur le Gaz Naturel" or TICGN).

Road freight transport

All TICPE taxes on diesel above a minimum level (0,4319 €/L) are reimbursed to road freight transport companies on request, if the diesel has been purchased in France and used in vehicles with a load capacity > 7,5 ton. In practice, this means that the carbon tax is fully reimbursed to these companies in France. The average reimbursement level during the first semester of 2017 was of 0,1142 €/L.

Road passenger transport

In general, there are no reduced rates or exemptions of the carbon tax for road passenger transport. However, reduced rates of the energy component of the TICPE/TICGN have been introduced for natural gas and LPG used as motor fuel (in order to incentivize these fuels in transport).

Regarding buses and small touristic road trains transporting passengers, all TICPE taxes on diesel above the minimum level of 0,3919 €/L are reimbursed to its operators on request. This means that, in practice, these operators also get a full reimbursement of the carbon tax in France (average reimbursement level during the first semester of 2017 was 0,1542 €/L).

Finally, regarding taxis, all TICPE taxes above a minimum level on diesel and on petrol (i.e. of 0,3020 €/L and of 0,3590 €/L, respectively) are reimbursed on request. So here as well, the carbon tax is in practice fully reimbursed to taxi operators (average reimbursement levels during the first semester of 2017 of 0,2422 €/L for diesel and of 0,299 €/L for petrol).

Railways

No reduced rates of the carbon tax apply to energy products used for railways, but there is a reduced rate of the energy component of the TICPE on diesel (the same rate than the one that applies for industrial/

commercial purposes applies to railways as well) and a reduced tax rate on electricity (no carbon tax applies to electricity).

Other

Maritime and inland waterways transport of goods and persons, as well as commercial aviation, are exempted from the TICPE, and therefore also from the carbon tax.

Finally, it is worth noting that the French regions have the possibility to 'modulate' the TICPE: they can slightly increase it (by up to 0,73 c€/L for petrol and 1,35 c€/L for diesel) or decrease it (by up to 1,77 c€/L for petrol and 1,15 c€/L for diesel). Any generated revenues have to be used for financing sustainable transport, railway or waterway infrastructure, or public transportation in the capital city.

Ireland

Road freight transport

In Ireland, a rebate scheme for qualifying road transport operators is in place since July 2013. These operators can request a reimbursement of a portion of the mineral oil tax (MOT) on diesel if it is purchased in Ireland and is used in vehicles with a load capacity > 7,5 ton. The reimbursement level is calculated on the basis of a sliding scale: there are no reimbursements if the final diesel price is lower than or at 1,23 €/L, while the maximum reimbursement amount is of 7,5 c€/L if the final price for diesel is at or above 1,54 €/L. The average reimbursement amount during the first semester of 2017 was of 1,25 c€/L. However, it is important to note that this rebate scheme only concerns the non-carbon component of the MOT, meaning that the carbon component is fully paid.

Road passenger transport

In general, there are no reduced rates or exemptions of the carbon tax for road passenger transport. The only exception is the slightly reduced rate of the carbon tax for natural gas used as vehicle propellant if it is partially composed of biogas (in which case the fuel is called 'vehicle gas').

Finally, regarding passenger operators (buses and mini buses with min. 9 passengers), the same rebate scheme applies for diesel as for road freight transport operators. Again, this rebate scheme only concerns the non-carbon component of the MOT, which means that these operators fully pay the carbon tax.

Railways

No reduced rates of the carbon tax apply to energy products used for railways, but there is a reduced rate of the non-carbon component of the MOT on diesel as well as a reduced tax rate on electricity (no carbon tax applies to electricity).

Other

The MOT on fuels used for commercial sea navigation, including sea fishing, is fully reimbursed, so in practice the carbon tax does not apply to this activity. Commercial aviation is exempted from the MOT, and therefore from the carbon tax as well.

Sweden

Road freight transport

In Sweden, there are no reimbursement schemes for diesel used by road freight transport operators. Therefore, the carbon tax is paid in full by these operators. However, since diesel is the most commonly used fuel by the commercial transport sector, its energy tax was set at a significantly lower level than for petrol (around 36% lower).

Road passenger transport

There are no reduced rates or exemptions of the carbon tax for road passenger transport. However, LPG and natural gas used in the transport sector are exempted from the energy tax.

Finally, there are also no reimbursement schemes for diesel used by road passenger operators (buses and mini buses, taxis, etc.).

Railways

In Sweden, all fuels used for railways are exempted from the energy tax and the carbon tax.

Other

No energy tax or carbon tax is due on fuels used for commercial sea navigation, inland waterways and commercial aviation.

Conclusions

Regarding road transport, we observe that fully applying the carbon tax is the standard in the analyzed countries, although there are two 'flexibilities':

1) commercial road transport: for road freight transport, we see either a full reimbursement of the carbon tax in France or no reimbursement at all in Ireland and Sweden (but with compensations at the level of the energy taxes, either through partial reimbursement or a lower rate). Regarding commercial road passenger transport (buses and taxis), we also either see a full reimbursement of the carbon tax in France, or no reimbursement of the carbon tax at all in Sweden and Ireland (but with compensations at the level of the energy taxes, either through partial reimbursement or a lower rate);
2) regarding natural gas and LPG used as motor fuel: there is either a reduced rate (in Sweden) or a zero rate of the energy tax (in France) to further incentivize the use of these fuels in the transport sector (but a full carbon tax), or even a slightly reduced rate of the carbon tax (in Ireland) if it is partially composed of biogas.

Regarding commercial navigation (sea and inland waterways), we observe that the relevant fuels are exempted from energy and carbon taxes in all analyzed countries.

Finally, regarding railways, we notice that there can either be a full exemption from energy and carbon taxes (in Sweden), reduced rates of energy and carbon taxes on diesel only (in France and Ireland), and reduced rates of energy taxes on electricity (in France and Ireland).

5.3 EVALUATION OF IMPACTS

5.3.1 On the energy bill

KEY MESSAGES

For car passenger transport, in the short-term (2020), a carbon price of 10€/tCO_2 would increase household's annual energy bill on average by 34 € (or 30€/vehicle). In the long-term (2050), a carbon price of 190€/tCO_2 (trajectory « B ») would lead to an average carbon payment of 42 € per vehicle per year.

For freight road transport, improved efficiency would on average compensate the higher energy prices resulting in a reduced average annual energy bill by 2030 and 2050 w.r.t. 2020 (under constant energy prices in the low-carbon scenario) both for LDV and HDV freight transport.

The impact of a 10€/tCO_2e carbon price on the energy price ranges between +1,6% and +2% according to the fuel used. This increase depends on the final energy price used in the baseline (that results from the commodity price, other distributions costs and levies) and the GHG emission intensity of the fuel. By 2030, energy prices would increase by around 11,2% and 13,5% under price trajectory "B".

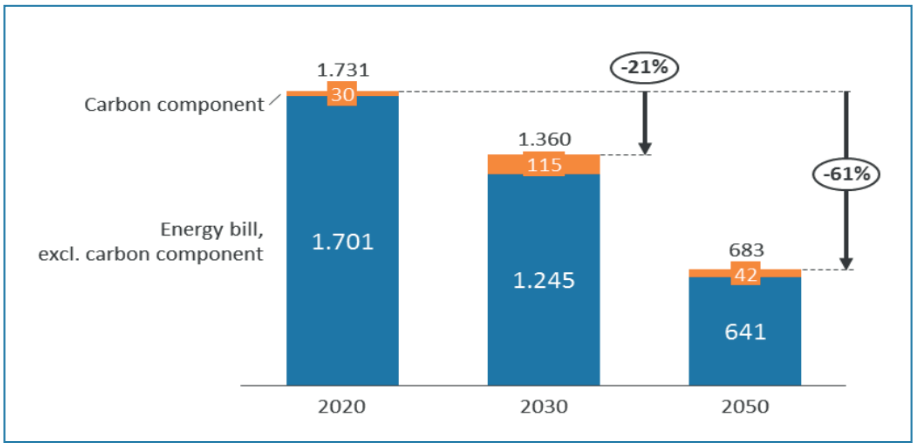
The average carbon payment of 42 € per vehicle per year in 2050 is the result of reduced demand (less km travelled), improved energy efficiency of vehicles and a switch to zero emission vehicles.

Analyses show that low-carbon alternatives to ICE vehicles for passenger transport become more and more economically competitive. Carbon pricing can contribute to making these alternatives even more competitive and can provide budget to invest in the infrastructure required to enable low-carbon alternatives for low-carbon freight transport.

Car passenger transport

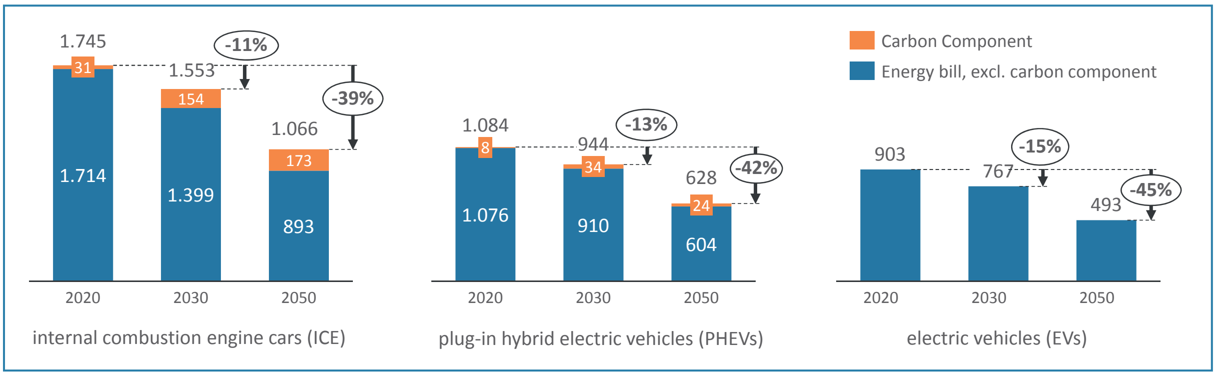
Under carbon price trajectory « B » and constant energy prices, the average energy bill would be reduced by 21% by 2030 w.r.t. 2020 and 61% by 2050 (see Figure 47) as energy savings supported, at least partly, by the carbon price largely outweigh (i) the carbon payment and (ii) the impact of the switch from fossil fuels towards electricity.

Figure 47: Evolution of the average annual energy bill for passenger transport, in the low-carbon scenario with Option B (in €/vehicle/year)[69]



Source: Own calculations

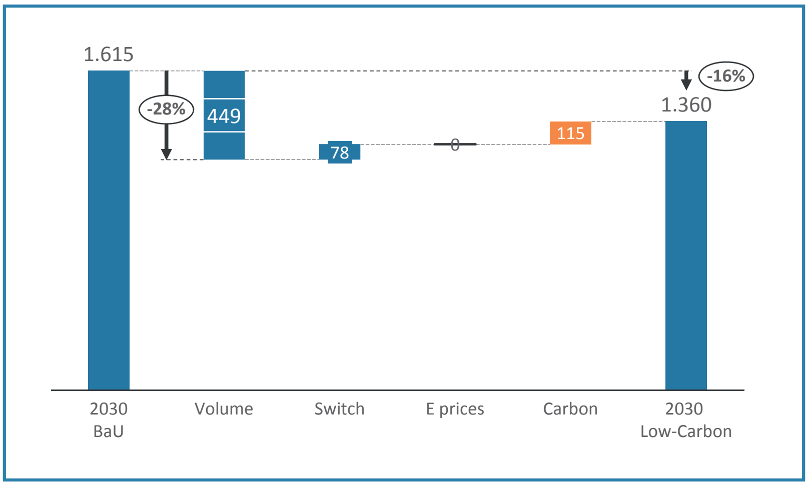
Figure 48: Evolution of the average annual energy bill for passenger transport, by type of vehicle in the low-carbon scenario with Option B (in €/vehicle/year)



Source: Own calculations

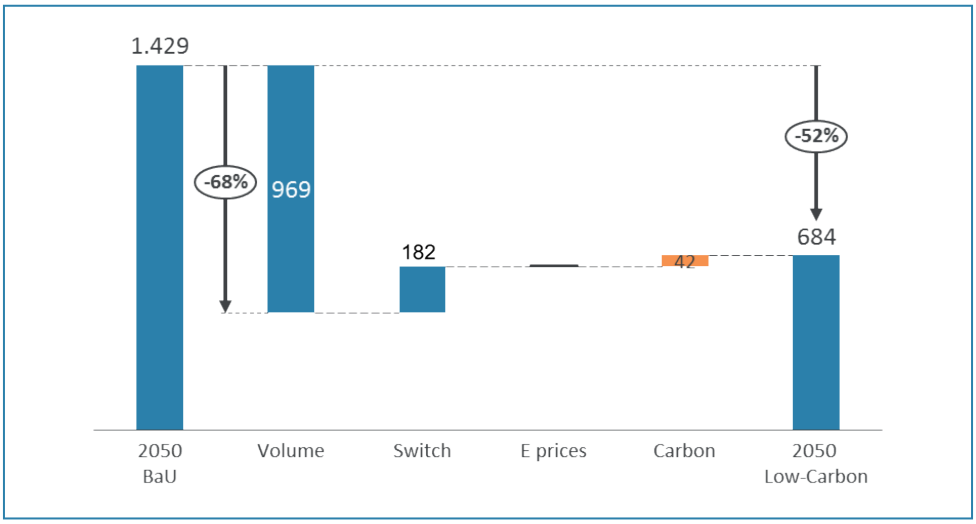
[69] Note: energy prices kept constant, and equal to 2016 final energy prices. Additional assumptions in A.4.21 of Appendix 4.

Figure 49: Drivers of the difference in the average annual energy bill for passenger transport by 2030 in the BaU and the low-carbon scenario (in €/vehicle/year)



Source: Own calculations

Figure 50: Drivers of the difference in the average annual energy bill for passenger transport by 2050 in the BaU and the low-carbon scenario (in €/vehicle/year)



Source: Own calculations

Although energy prices are a key factor of the energy bill, sensitivity analyses show that these messages are robust to different price assumptions. The situation obviously differs according to the type of vehicle as shown in Figure 48. Figure 49 and Figure 50 show the main drivers of the different energy bills between the BaU and the low-carbon scenario. An explanation on how to read these graphs is provided in Section 4.3.1 devoted to a similar analysis for the buildings sector. By 2030, reduced transport demand and improved efficiency would on average compensate the 70€/tCO_2e carbon price assumed in option B (see Figure 49). By 2050, the average energy bill would be divided by two despite the 190€/tCO_2e carbon price assumed in option B (see Figure 50).

The sensitivity analysis given in Figure A.4.21 of Appendix 4 shows that the conclusions stated above are robust to assumptions for the carbon price trajectory and the evolution of the energy prices.

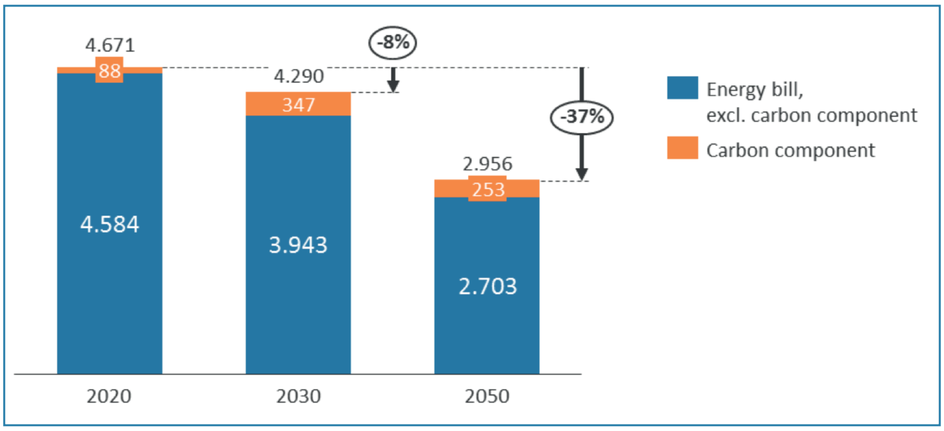
Freight

Light-duty vehicles

The average annual energy bill for LDV would be reduced by 36% w.r.t. 2020 under constant energy prices in the low-carbon scenario (Figure 51). By 2030, improved efficiency would on average compensate the higher energy prices and the 70€/tCO_2e carbon price assumed under option B (Figure 52). By

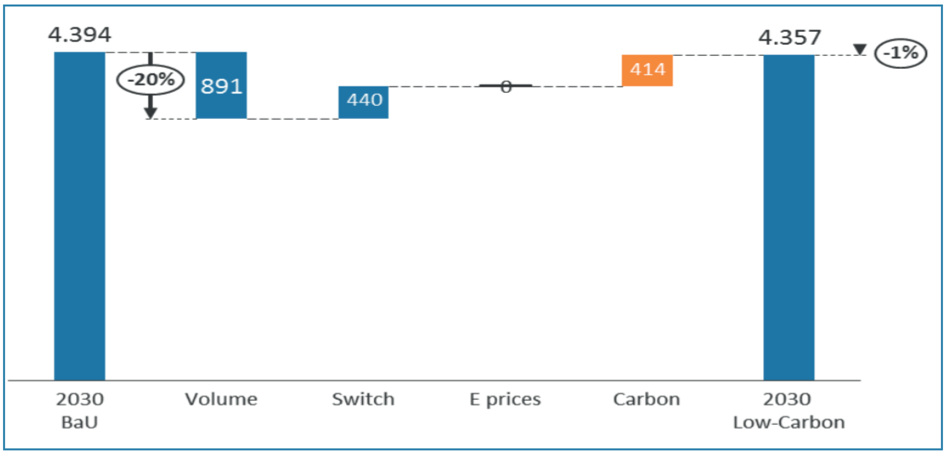
2050, improved efficiency would reduce the average energy bill by 21% with the 190€/tCO_2e carbon price assumed under option B (Figure 53). As was the case for car passenger transport, a sensitivity analysis for LDV is provided in Figures A.4.22 and A.4.23 of Appendix 4.

Figure 51: Evolution of the average energy bill for 10.000 t.km of LDV transport, in the low-carbon scenario with Option B (in €/10.000 t.km)



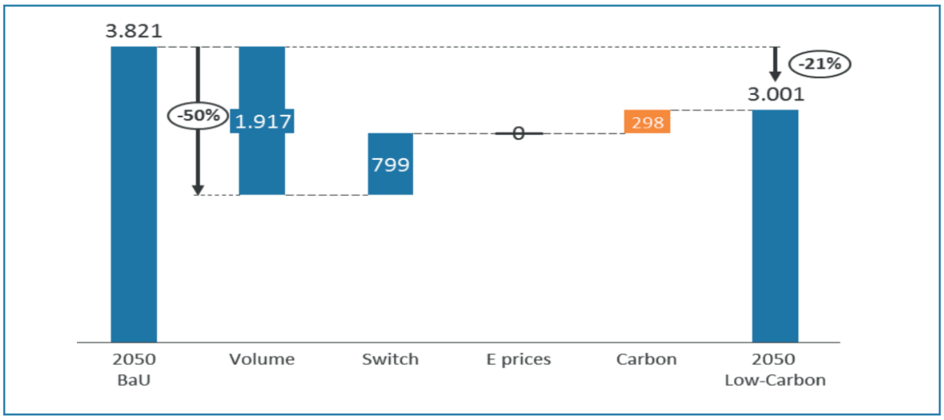
Source: Own calculations

Figure 52: Drivers of the difference in the Average annual energy bill for LDV transport by 2030 in the BaU and the low-carbon scenario (in €/10.000 t.km)



Source: Own calculations

Figure 53: Drivers of the difference in the Average annual energy bill for LDV transport by 2050 in the BaU and the low-carbon scenario (in €/10.000 t.km)

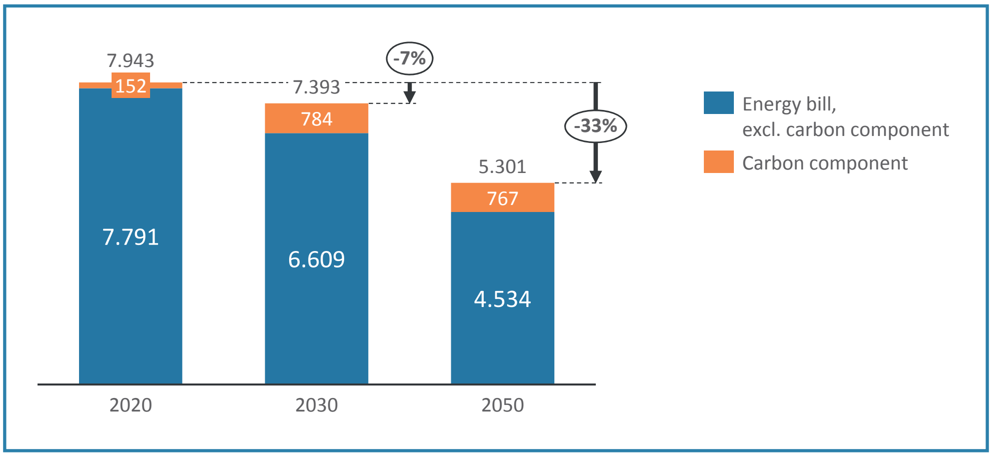


Source: Own calculations

Heavy-duty vehicles

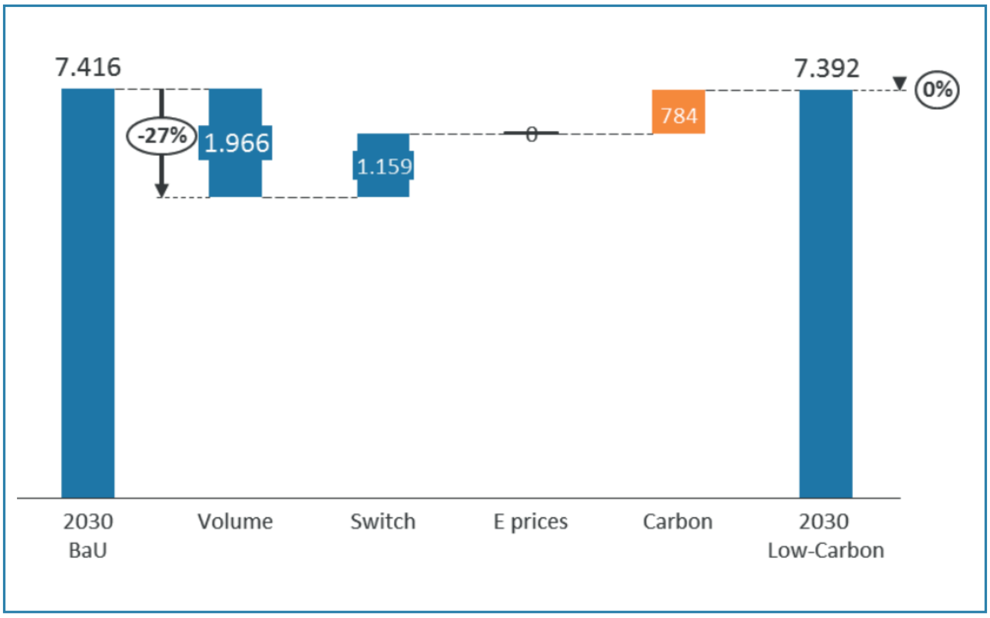
Similarly, the average annual energy bill for HDV would be reduced by 33% w.r.t. 2020 under constant energy prices in the low-carbon scenario (Figure 54). By 2030, improved efficiency would on average compensate the higher energy prices and the 70€/tCO_2e carbon price assumed under option B (Figure 55). By 2050, improved efficiency would reduce the average energy bill by 21% despite the 190€/tCO_2e carbon price assumed under option B (Figure 56). As was the case for car passenger transport, a sensitivity analysis for HDV is provided in Figures A.4.24 and A.4.25 of Appendix 4.

Figure 54: Evolution of the average energy bill for 100.000 t.km of HDV transport, in the low-carbon scenario with Option B (in €/100.000 t.km)



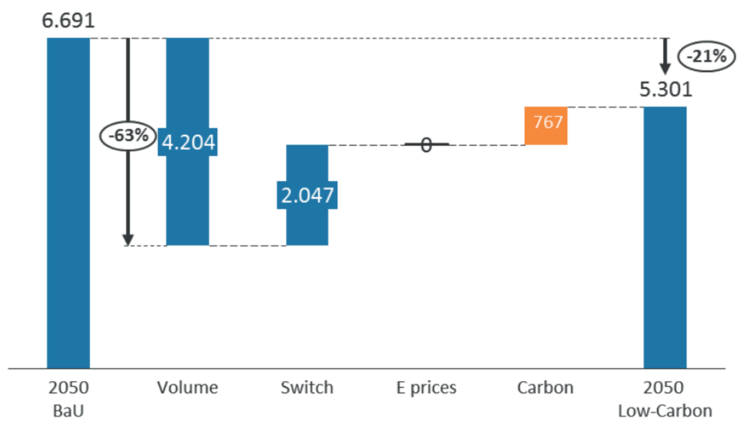
Source: Own calculations

Figure 55: Drivers of the difference in the Average annual energy bill for HDV transport by 2030 in the BaU and the low-carbon scenario (in €/100.000 t.km)



Source: Own calculations

Figure 56: Drivers of the difference in the Average annual energy bill for HDV transport by 2050 in the BaU and the low-carbon scenario (in €/100.000 t.km)



Source: Own calculations

5.3.2 On public carbon revenues

KEY MESSAGE

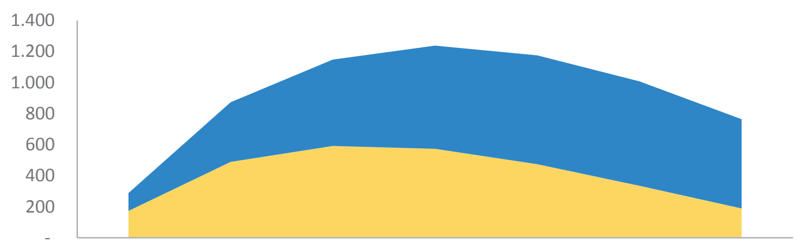
Public carbon revenues from the transport sector would amount to 288 M€ in 2020 and to 1,15 billion € in 2030.

Carbon pricing applied to energy for transport results in bell-shaped public revenues. Annual revenues would increase from 288 M€ in 2020 to 1.146 M€ in 2030 and 762 M€ in 2050, representing a cumulated budget of 30,1 billion € under price trajectory B (see Figure 57). This is detailed in Table A.4.26 of Appendix 4 for the three carbon price trajectories.

In the low-carbon scenario, the reduction of fossil fuels consumption leads to a reduction of revenues from excise duties on those fuels. Revenues from excise duties in the transport sector almost amounted to 5,8 billion € in 2017 (see Section 2.4 above).

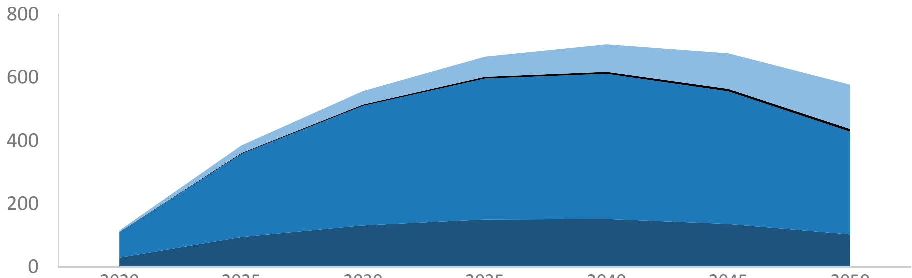
Looking into public carbon revenues from freight transport per sector reveals that LDVs contribute to ~25% of revenues from road transport and internal waterways (IWW) reach 8% of the total by 2030, 25% by 2050. This is shown in Figure 58 and detailed results are provided in Table A.4.27 of Appendix 4.

Figure 57: Annual carbon revenues for the transport sector under option B (in M€/year)



	2020	2025	2030	2035	2040	2045	2050
Domestic freight	116	384	556	663	701	671	573
Domestic passenger transport	173	488	591	573	474	335	189

Figure 58: Annual carbon revenues from freight transport under option B and considering the low-carbon scenario (in M€/year)



	2020	2025	2030	2035	2040	2045	2050
IWW	5,48	23,95	42,84	64,10	87,04	112,19	140,88
RAIL	0,60	2,43	4,00	5,42	6,54	7,32	7,73
ROAD HDV	80,13	264,04	378,77	445,60	459,23	420,33	325,63
ROAD LDV	29,33	93,75	130,93	150,27	151,40	135,53	102,39

5.3.3 On the profitability of investments

Investments in electric vehicles

KEY MESSAGES

Carbon pricing fosters the profitability of EVs by bringing their cost parity time w.r.t. ICE cars in the range of the vehicle lifetime.

Services that EVs can deliver to the grid enable to further reduce the parity time and the profitability of EVs w.r.t. ICE cars improves when energy prices rise.

The combination of carbon pricing, high energy prices and procurement of services to grid brings cost parity time to 4,5 years and 3 years for midsize and compact vehicles respectively.

Microeconomic analysis is proposed to exemplify how the business case for investment decisions is impacted by the carbon price, among other factors. The focus is on the investment in EVs compared to ICE vehicles. Undiscounted cumulated expenses of both vehicle solutions are assessed to discuss the cost-parity time between technologies, i.e. the time after which the cumulated total expenses (capex, opex, fuels) are similar with both solutions.

Note that other factors than the cost influence the business case of acquiring an EV: the availability and ease of access of fast charging points, and the driving range often have a strong influence on the final decision.

Investing in an EV is considered to be a profitable choice if the cost-parity time (w.r.t. ICE vehicle) is lower than the lifetime of the investments. Except when mentioned otherwise, energy prices are assumed to be flat and cashflows undiscounted.

The cumulated expenses depend on the following elements:

- An initial investment, that is higher to acquire EVs compared to ICE vehicles;
- Operation and maintenance costs, that are considered to be 60% lower for EVs versus ICE[70], given that EV engines are significantly less complex and generate less frictions and vibrations;
- Fuel costs that depend on the energy efficiency of the vehicles and on energy prices.

Cost parity occurs when reduced annual costs compensate for the higher investment costs. Both midsize and compact passenger vehicles are considered, with characteristics provided in Table A.4.28 of Appendix

70 Global Calculator.

4. The analysis focuses on vehicles accessible to mass market consumers at less than $40,000, thereby excluding the Luxury segment from the vehicle samples. Results are provided in the next paragraphs and detailed assumptions can be found in the Appendix 4.

Four scenarios were considered to discuss the impacts of a selection of variables on the cost-parity of EV w.r.t ICE. The assumptions defining the scenarios are provided in Table 11 along with the corresponding parity time for compact and midsize vehicles. The time evolution of the cumulated expenses is provided in Figures A.4.29 and A.4.30 of Appendix 4. This brings the following conclusions:

- **Base case**: The lower price of batteries for smaller vehicles – that need to be replaced at least once during the vehicle lifetime – make EVs already a competitive solution for compact vehicles;
- **Carbon pricing**: A carbon price of 100€/tCO_2 enables to reduce EV parity time by 1/3, resulting from increased fuel costs of ICE vehicles;
- **Higher energy prices**: ICE vehicles are more sensitive to high energy prices than EVs. Energy prices evolving as suggested in the Business as usual scenario of the IEA *World Energy Outlook 2016* would reduce the parity time by another 30 to 50% (in addition to the reduction obtained with the carbon price);
- **Services to grid** (S2G) are tested as a means to value the battery and thereby reduce the annual costs. It enables to reduce the parity time by another 50% for midsize vehicles[71], approximately;

This shows that carbon pricing improves the profitability of investing in compact EVs and contributes to making the business case for mid-size EVs since, with a 100€/tCO_2 carbon price, the cost-parity time w.r.t. midsize ICE cars goes down to 17 years, which is closer to the vehicle's lifetime.

Table 11: Cost parity times for different scenarios

<table>
<tr><th rowspan="2">Scenario</th><th rowspan="2">Description</th><th colspan="2">Cost-parity time [years]</th></tr>
<tr><th>Compact</th><th>Midsize</th></tr>
<tr><td>Base case</td><td>Energy prices are assumed flat
EV battery is considered as an OPEX of 250 €/kWh(1)</td><td>9 years</td><td>no parity (2)</td></tr>
<tr><td>Carbon pricing</td><td>A carbon price of 100€/tCO_2 is considered on top of the assumption of the Base case scenario</td><td>6 years</td><td>17 years</td></tr>
<tr><td>Higher energy prices</td><td>Increasing energy prices are considered w.r.t. 2016 both for electricity and fossil fuels, as follows:
2020: +43% · 2025: +55% · 2030: +67% · 2035: +60%</td><td>4 years</td><td>8 years</td></tr>
<tr><td>Services to grid</td><td>EV car owners are prosumers and are remunerated for the energy they battery supplies to the grid</td><td>3 years</td><td>4,5 years</td></tr>
</table>

These results are sensitive to cost assumptions. Current costs have been considered for both batteries and vehicles. Cost reductions expected in the coming years will significantly improve the business case of EVs. A 50% reduction in battery costs brings the cost-parity time in the base case down to 6 years for compact vehicles and 14 years for midsize vehicles. A 10% vehicle cost reduction lowers cost-parity times to 3 years for compact vehicles and 6 years for midsize vehicles.

[71] S2G consists of allowing grid operators to value the storage capacity of the battery for grid services. It is modeled here as a remuneration for the energy supplied to the grid. Considering that S2G generate revenues equal to the electricity consumption costs Based on the Guardian https://www.theguardian.com/business/2017/oct/02/electric-car-battery-savings-nissan-leaf-ovo), it enables to make the EV cost independent of the electricity price changes.

Investments in freight transport

KEY MESSAGES

A carbon price could improve the average load of freight transport.

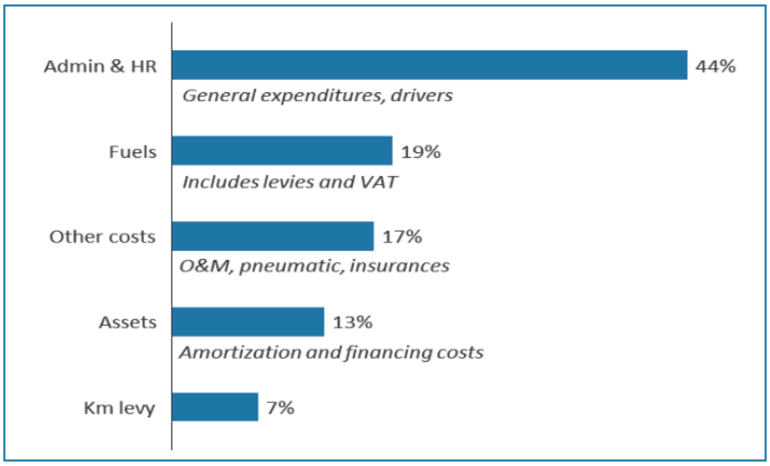
The main drivers of freight transport costs in Belgium are labour costs and then fuel costs.

The literature[72] on decarbonizing freight transport shows that neither low-hanging fruits (defined as off the shelf technologies) nor new technologies will be sufficient to drastically reduce freight GHG emissions. It indicates that a significant shift in policy is necessary to enhance ambitious short-term action. Regarding road transport, next to fuel efficiency standards reinforcements, investments in infrastructures are needed to make alternative freight solutions economically viable and to increase the share of rail and waterway freight transport. Further improving logistics efficiency[73] is also a key lever to reduce energy consumption and GHG emissions. In addition, modal shift and intermodal transport can significantly decrease freight emissions.

Our analysis of the possible carbon costs per t.km for three categories of vehicles (5t, 15t and 30t) showed that carbon pricing improves the average load of freight transport. Considering the average annual mileage of the Belgian vehicle fleet, working assumptions for the average load and average fuel consumptions, the carbon cost per unit of transport (in c€/t.km) would be twice as high for LDV w.r.t. HDVs. Namely, it would amount to 0.09c€/t.km for LDVs and 0.04c€/t.km for HDVs (see Figure A.4.31 of the Appendix 4).

The average cost structure for general freight transport is shown in Figure 59. The administrative and HR costs stand for 44% of total expenditures for general freight transport, followed by fuel costs with 19% of the total. These figures somewhat differ for the transport of small parcels, with respectively 53% and 14%. A 10€/tCO_2 carbon price – that would increase the price of propellants by around 2% – would amount to 0,4% the total costs (and 0,7% of non-administrative and HR expenditures).

Figure 59: Repartition of the annual average expenditures for general freight transport in Belgium[74] (in % of total expenditures)



Sources: « ITLB, 2018. Quelques chiffres clés du secteur du transport routier de marchandises » and « ITLB, Simulation Taxe Kilométrique[75] »

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72 Roadmap to climate-friendly land freight and business in Europe, June 2017, T&E.

73 By increasing transport-km costs, that could in turn fund the transition of the sector, helping to build the right infrastructure, the application of green freight programs and through digitalization.

74 The traffic tax assessed based on the cost structure applying by 1/9/2015 (ITLB, Simulation Taxe Kilométrique) is added on top of the cost structure reported applying by 31/12/2017 (ITLB, 2018. Quelques chiffres clés du secteur du transport routier de marchandises)

75 Available on http://94.23.228.57/ITLB_WEB/Documents/fr/Indices/Taxe%20km/Taxe%20kilom%20SIMULATION%20fr.pdf last consulted on 30/05/2018.

5.3.4 Impact at sectoral level

KEY MESSAGES

The transformation of the transport sector to reach low carbon levels decreases the total costs of the sector.

Carbon pricing further reinforces the gap between the low-carbon and the BaU scenarios, to the advantage of the low-carbon scenario.

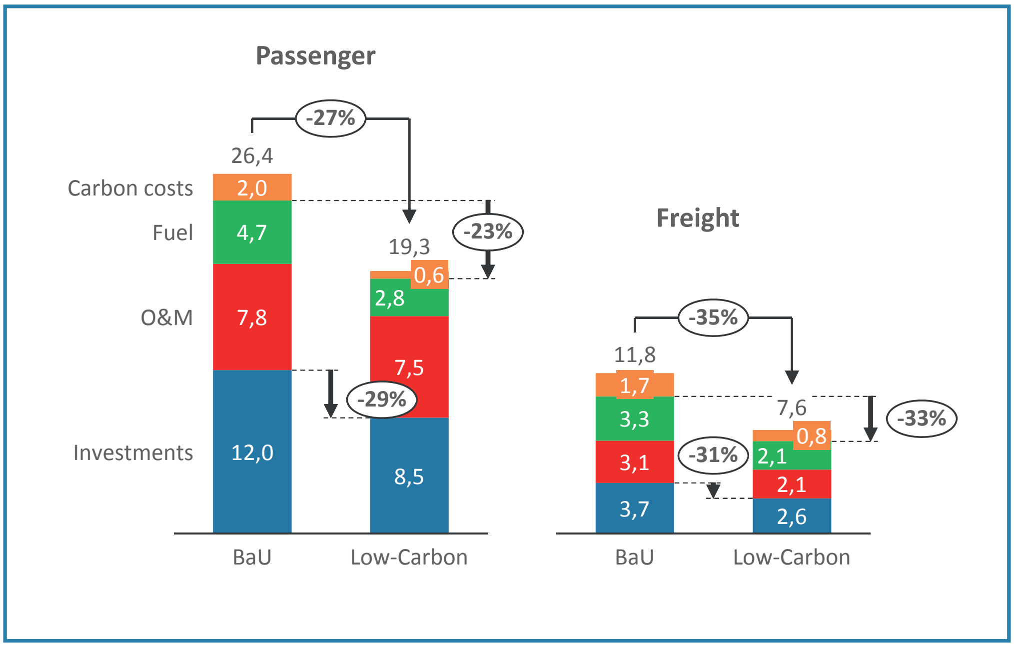
The low-carbon scenario relies among others on assumptions on transport demand (travel transport per person and freight transport) and the share of road in covering that demand. The evolution of the costs components (investments, O&M, fuels and carbon costs) in the low-carbon scenario w.r.t. the BaU shows that lower energy bills compensate for the higher investments. This is illustrated in Figure 60, with energy prices kept constant and equal to 2016 prices.

Macroeconomic analysis not only considers investments into the car fleet, but also the investments into alternative mobility and transport solutions.

The reduced demand leads to lower costs. At the same time, public transport costs increase to a lesser extent since the low-carbon scenario assumes an overall combination of lower travelled distances, longer lifetimes of public transport vehicles and higher vehicle occupation rates. Altogether, domestic passenger transport could be 23% cheaper in a low carbon scenario and even 27% with a carbon price. Freight transport could be 33% cheaper in a low carbon scenario and even 35% with a carbon price. This of course has very different implications for private and public stakeholders as the shift to public transport has to be managed.

Results with different price evolutions for the different energy vectors, given in Figure A.4.32 of Appendix 4, confirm this message.

Figure 60: Average annual costs in transport with energy prices kept constant and equal to 2016 prices, 2020-2050 (in b€/year)



5.4 POLICY ALIGNMENT

The three Regions are currently working on/implementing projects and strategies in the transport sector. These strategies aim to reduce greenhouse gas and air pollutant emissions originating from the transport sector and are constituted of a broad range of measures (standards, fiscal incentives and subsidies, communication tools, …). Therefore, when considering the implementation of a carbon price in Belgium, it is of the utmost importance to ensure a proper coordination and alignment of policies between the different entities competent for transport and mobility matters within Belgium, in order to make sure that these policies are coherent and efficient. We will briefly touch upon some issues that deserve consideration in this context.

5.4.1 Road pricing

KEY MESSAGES

When looking at Belgium and its neighbouring countries, France is the only country where a kilometric levy also applies on light duty vehicles on top of heavy duty vehicles (motorways). This is currently being considered in Germany, while the Flemish and Brussels-Capital Regions are evaluating this possibility as well.

In function of the type of existing road pricing system, a carbon price could complement such a system and thus reinforce mobility policies, or pricing carbon could potentially be integrated in a road pricing system.

Based on previous experiences and the current situation within Belgium, it will probably take a few years for a system including light duty vehicles to become fully operational once a decision is taken in this sense.

In the transport sector, it will be important to ensure a proper interaction between any existing road pricing system and a possible carbon price. In function of the type of existing road pricing system, a carbon price could complement such a system and thus reinforce mobility policies, or it could be envisaged to potentially include CO_2 emissions as a parameter within a road pricing system so that it takes this into account and thus puts a price on these emissions[76]. Some experts are indeed in favour of a reform to internalize environmental (possibly including CO_2 emissions) and congestion externalities into smart road pricing as tax base in the transport sector[77].

To date, a kilometric levy (i.e. a type of road pricing that is mainly an infrastructure charge that usually only covers highways in the current systems) for heavy duty vehicles has been implemented in Belgium and in its neighbouring countries, either through a distance-based system (toll: the charge is calculated on the basis of the distance travelled by the vehicle and then modulated by other parameters characterizing the vehicles - like, for instance, the type of vehicle and number of axles, and the Euro emission norm (that does not take into account CO_2 emissions)) or a period-based system (vignette: the charge is calculated on the basis of the time the user is paying for, while the charge is also here modulated in function of the vehicle characteristics).

In Belgium, a distance-based kilometric levy is applied on heavy duty vehicles (+3,5t) since 2016. By the end of 2017, around 6.492km of roads (of in total around 150.000km) fall under the kilometric levy system. 44,1% of registered trucks are Euro norm 6 (37,8% are Euro norm 5) and 87,2% of registered trucks are >32t (7,4% are trucks between 12 and 32t, and 5,4% are >12t). Regarding the origin of registered trucks, 18% come from Belgium, followed by Poland (14%), the Netherlands and Germany (10% each), Romania and France (7% each), Spain (5%), Lithuania (4%), Bulgaria (3%) and other countries (22%). In total, registered

[76] In this respect, it is important to keep track of the scheduled revision of Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures and of EU Directive 2003/96/CE of 27/10/2003 on taxation of energy products and electricity.

[77] See for instance the presentation by A. Van Steenbergen during the technical workshop on the transport sector.

trucks have travelled 6,13 billion km on Belgian toll roads in 2017 (of which more than 50% by Euro 6 norm trucks), generating 676 million € of revenues. 54% of these revenues have been generated by vehicles registered outside Belgium.

France is the only neighbouring country where this type of road pricing also applies to light duty vehicles, while Germany has been considering to broaden it to light vehicles for some time now. Within Belgium, this possibility is also being explored in Flanders and Brussels.

Based on previous experiences and the current situation within Belgium, it can be expected that once a political decision to implement road pricing for light duty vehicles as well is taken (that would include or not a parameter related to CO_2 emissions for setting the tariffs), it will probably take a few years for the system to become fully operational.

5.4.2 Company cars

KEY MESSAGES

The current system of company cars has led to the number of company cars increasing significantly over the past years, while encouraging the possession of more expensive vehicles and their use. It is not aligned with the implementation of a carbon pricing mechanism in the transport sector.

The system has already been partially reviewed by the current government, and it is expected to be further reviewed in the short term. The contribution of these measures to the reduction of the number of company cars is, however, difficult to assess.

Under this Section, a brief overview of the current and possible future system for company cars is presented, given that the fiscal regime of this system could potentially have a negative impact on the objective of implementing a carbon pricing mechanism in the transport sector. Although the favourable tax treatment of company cars is the result of the high level of taxation on labour in Belgium and should, as such, be dealt with within the broader context of labour taxation, it is important to highlight its effect on the environment and thus on any environmental policies implemented or under development. Indeed, while the exact number of company cars is unknown, it has been established that it is rapidly growing these past few years (when only looking at company cars for employees[78], there has been a 54% increase between 2007 and 2016, from around 289.000 company cars to 445.000, respectively), and that the system also encourages the possession of more expensive vehicles[79] and the use of the car (in km travelled). According to some experts, this fiscal regime would represent annual fiscal expenditures of around 2 billion €, while other studies (from the European Commission, OECD and IEW) mention considerably higher fiscal expenditures[80].

In the context of company cars, there is a difference between their private and their business use. The main tax advantage of a company car lies in the valuation of the taxable benefit for its private use by the beneficiary, while its business use is a non-taxable cost proper to the employer. In most EU member states, the taxable benefit for the private use of a company car is computed as a percentage of the car price (imputation rate). In Belgium, the rate for computing the taxable benefit is variable: in order to stimulate the purchase of less polluting cars, it increases in function of the CO_2 emissions of the car, and it also depends on the fuel type and age of the car. The Belgian imputation rate is rather low when compared to rates applied in other members states.

78 Based on the payment of so-called 'CO_2 solidarity contributions' that are only paid by employees (not by heads of companies) – presentation of X. May from ULB/IGEAT during the technical workshop on the transport sector, data from FPS Mobility.

79 The extent to which the system makes the Belgian vehicle fleet greener because of the speedier replacement of cars with more efficient and thus less polluting engines, is still a matter of debate among experts.

80 Presentation of X. May from ULB/IGEAT during the technical workshop on the transport sector.

The current system has already been partially reviewed by the current government, and it is expected to be further reviewed in the short term. On March 15th, 2018, the federal parliament adopted legislation on the so-called 'mobility allowance' (more commonly known as the 'cash for car' option). The main stated objective of this legislation is to tackle the congestion problem, that does not only have a big impact on mobility and environmental aspects of our society, but also on the well-being of the citizens and on the Belgian economy.

If an employer already providing company cars to its employees decides to implement this 'cash for car' measure within its company, and if an employee requests to make use of this option, the employee may choose to return its company car for an amount that equals the yearly value of the advantage of using the returned company car. This amount, that can be seen as salary that was otherwise provided as a benefit in kind through the company car, receives the same fiscal treatment as would be the case for the returned company car. It should be said, however, that there is uncertainty as to whether this legislation will reach its stated objective[81].

The government is currently also developing a system that would complement the ' mobility allowance' measure, namely the so-called 'mobility budget'. There are not many details available at this stage, but this system intends to give the possibility to employees with company cars to switch to smaller and more environmentally friendly models, and to use any surplus budget for acquiring other, more sustainable transport modes (purchase of a public transportation subscription, of a bicycle, etc.), while any remaining amount could be disbursed to the employee in cash (tax-free, with the exception of the social contributions).

5.4.3 Other

KEY MESSAGES

In most analyzed countries, different mechanisms are deployed to incentivize the purchase and use of more environmentally friendly vehicles, although at different scales.

Those countries with a combination of high taxation (on purchase/possession and annual use) of (more polluting) conventional cars and low taxation of less polluting and electric vehicles, show the highest market penetration of environmentally friendly vehicles.

In this section, we provide a brief overview of other road transport taxation in Belgium and its neighbouring countries, namely vehicle purchase and registration taxation on the one hand (VAT on purchase and registration tax), and vehicle ownership and driving taxation on the other hand (excise duties and other taxes, VAT on fuel, km charge, annual road tax), as well as of support for and taxation of electric vehicles (EVs) compared to conventional cars.

Other road transport taxation

Figure 61[82] and Figure 62[83] provide a comparison of road transport taxation other than excise duties on fuels (although these are also included here for comparison purposes) in Belgium and its neighbouring countries on the basis of a concrete example for road passenger transport and road freight transport, respectively.

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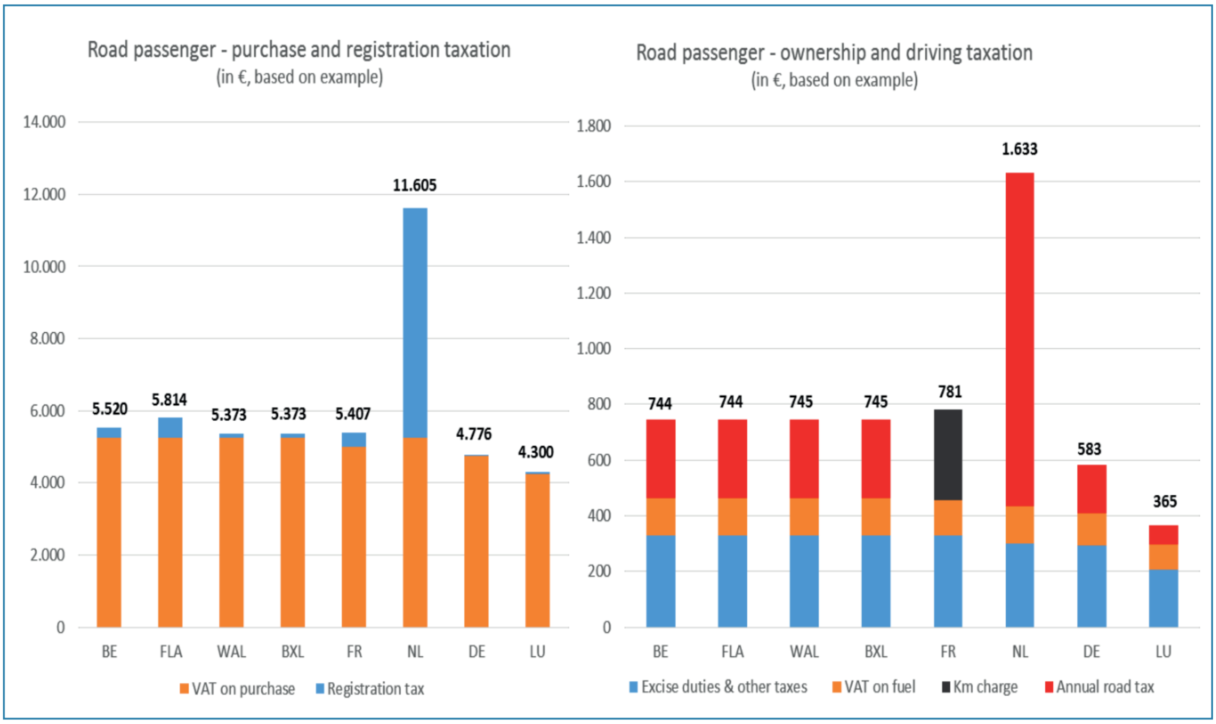
81 Among others, the Council of State points out in its advice that there is no demonstrable link between the designed measure included in the proposed legislation and its stated objective – see report of the plenary meeting of the federal parliament that discussed this legislation: https://www.dekamer.be/doc/PCRI/pdf/54/ip218.pdf.

82 Example: a new Volkswagen Golf VII 5p 1.6 TDI 66kW Sound with a purchase price of €25.000, driving 15.151 km/year in the same country and consuming 4,1l/100 km of diesel.

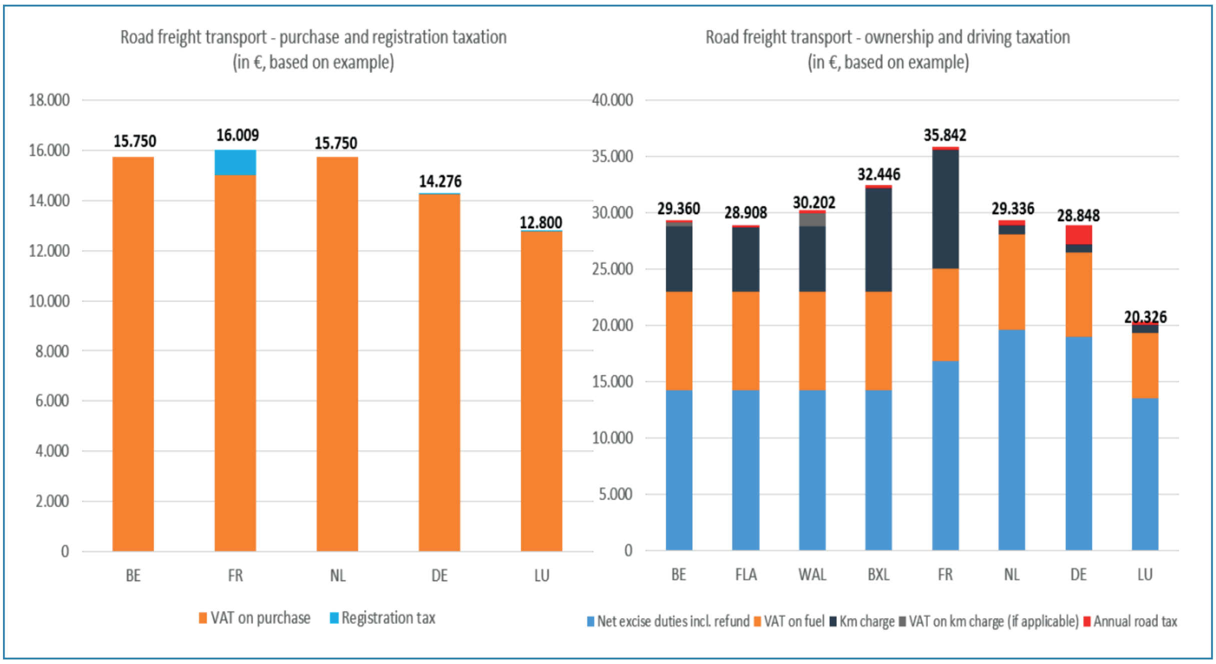
83 Example: a 40t truck without coupling, with 3 axles, airspring action, driving 124.000km a year in the same country. It consumes 32,5l/100 km of diesel (Euro norm 6). This truck was purchased in 2017 for €75.000.

Figure 61: Comparison other taxation – road passenger transport



Sources: ACEA Tax Guide 2017, tax websites of the different countries and of the EU Commission

Figure 62: Comparison other taxation – road freight transport



Sources: ACEA Tax Guide 2017, tax websites of the different countries and of the EU Commission

When comparing these data, we observe significantly higher taxation on road passenger vehicles in the Netherlands, mainly due to a very high registration tax and annual road tax, while this taxation is considerably lower in Germany and Luxembourg. When having a specific look at road freight vehicles, we observe comparable yearly driving taxation levels across most countries, with the exception of Luxembourg where this taxation is very low, and France where this taxation is high, mainly due to the km charge.

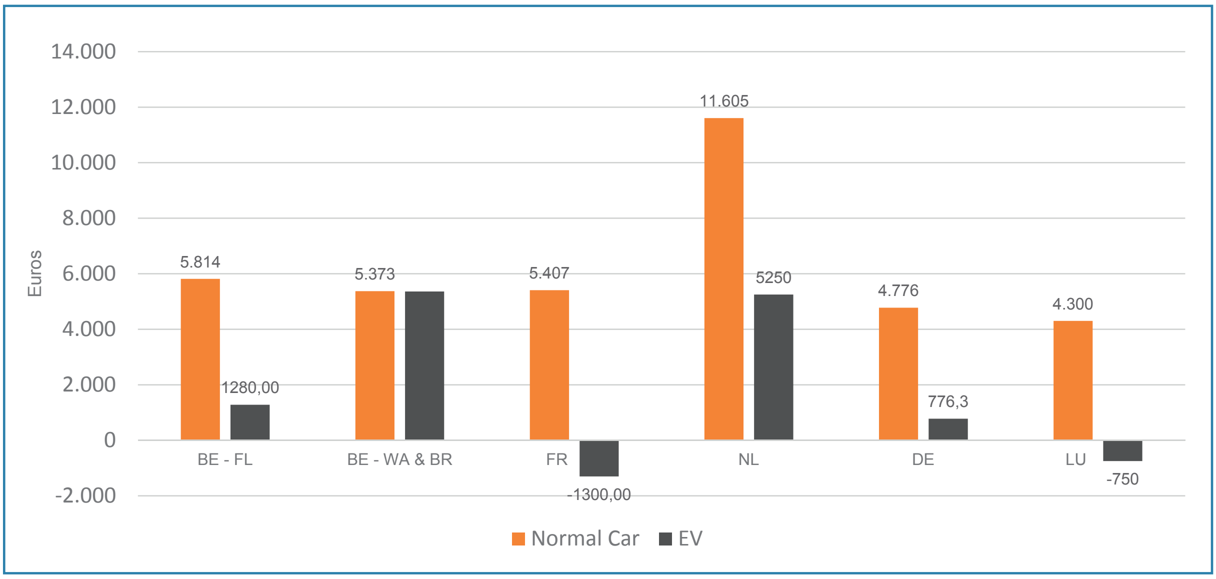
Several actors within Belgium are in favour of taxing the use of the vehicle rather than its ownership. This would be done via the implementation of a 'smart' road pricing system not only for trucks (cf. also Section 5.4.1), but also for personal cars. According to those actors, this system could replace existing taxes on the ownership of a car (vehicle tax, annual road tax) and be part of a global mobility plan (encompassing measures to improve public transport, stimulate bicycle use and car-sharing, etc.). The system would be 'smart' in the sense that it should apply a mileage tax in function of the duration, location and environmental impact of the use of a specific car, so that it can be an effective tool to steer mobility and reduce the environmental impact of road transport.

Several other actors are not in favour of reforming the system as explained above, since their fear is that if the ownership of a car is no longer taxed, consumers might more easily purchase less environmentally-friendly models, while not taking the additional cost of using the car properly into consideration at the moment of decision-making. According to them, this would result in similar use of the car (in km travelled), but with more polluting models.

Support/taxation related to Electric Vehicles (EVs)

Different fiscal mechanisms are deployed to stimulate the purchase of EVs. Incentives for more environmentally friendly cars are usually linked to the purchase price, CO_2 emissions, personal income taxes, etc. Still, many of these incentives are scheduled to decrease over time, as penetration rates are expected to rise. Figure 63 and Figure 64 present a comparison between EVs and Internal Combustion Engine Vehicles (ICEVs) of acquisition taxes[84] taking into account incentives for EVs where applicable, and of taxes on the use[85] of these cars, respectively, on the basis of an average ICEV and EV example[86].

Figure 63: Comparison of acquisition taxes on ICEVs and EVs, taking incentives into account



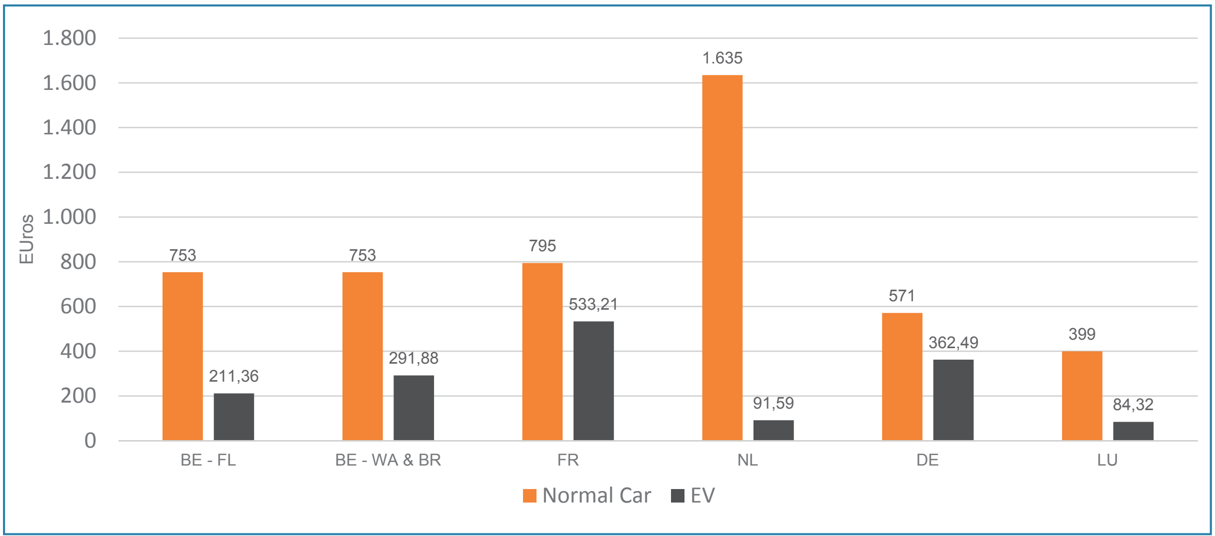
Source: PwC

[84] VAT on purchase, registration tax and number plate.

[85] Annual road tax, mileage levy, and VAT and other (recoverable) taxes.

[86] Example of ICEV: Volkswagen Golf VII 5p 1.6 TDI 66kW Sound with a purchase price of 25.000€, driving 15.151 km/y in the same country and consuming 4,1l/100km of diesel. Example of EV: Nissan Leaf with a purchase price of 25.000€, driving 15.151 km/y and consuming 15 kWh/100km.

Figure 64: Comparison of taxes on the use of ICEVs and EVs



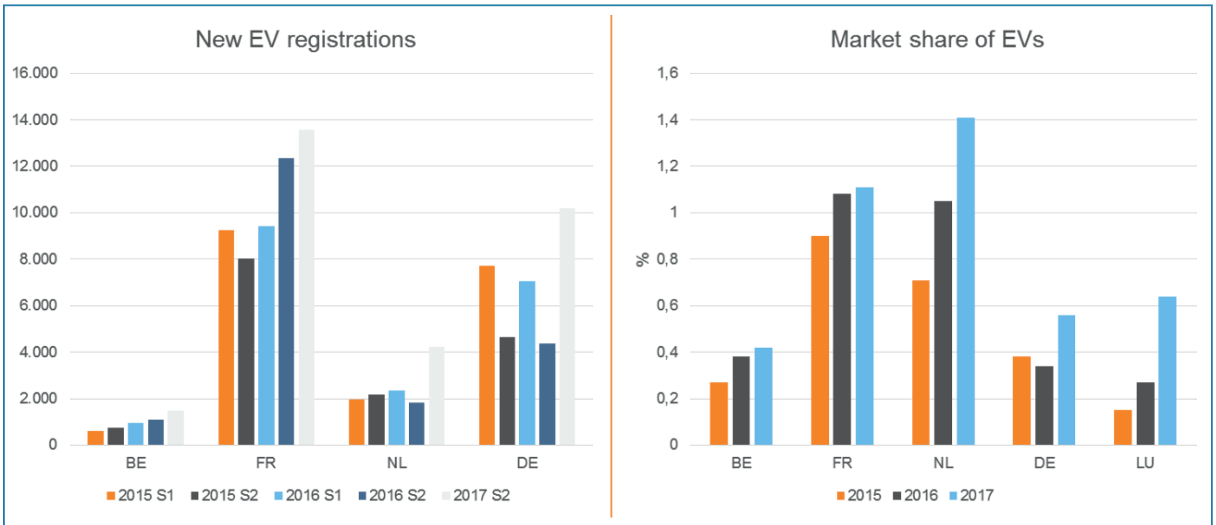
Source: PwC

Firstly, we observe that in some countries (France and Luxembourg), incentives for acquiring EVs are currently larger than the taxes on acquirement, while the Netherlands sees a drastic decrease in annual recurring taxes for EVs.

We also observe that within Belgium, the incentives for EVs of the Flemish Region are similar to those in France, Germany and Luxembourg, while there are no such similar incentives in the Walloon or Brussels-Capital Regions.

Finally, based on the abovementioned observations and the Figure 65 below, it could be stated that success of EVs also depends on the fiscal treatment of conventional cars. Indeed, those countries with a combination of high taxation (on acquirement and annual use) of conventional cars and low (annual) taxation of the use of EVs show the highest market penetration of EVs. In this context, it is also important to highlight that incentives for charging stations are crucial to enable a critical mass.

Figure 65: Penetration and market share of EVs



Source: ACEA and EAFO

5.5 KEY IMPLEMENTATION ISSUES AND OPTIONS

Different options for each of the four identified implementation modalities emerge from all previous analyses and from discussions with key actors. These options are summarized at the end of the Section.

Scope

Three issues in relation with the benchmark analysis (Section 5.2.1) deserve particular attention when defining the scope of carbon pricing in the transport sector.

First, for freight transport, **competitiveness** with respect to the final fuel price matters, especially for heavy duty vehicles in a sector with a high degree of competition. However, as we have seen, a reimbursement scheme is in place in Belgium that applies to all transport companies and the price actually paid is lower in Belgium than in the neighbouring countries, Luxembourg excluded.

Second, **cross-border shopping** is an important issue for heavy duty vehicles (international transport) and potentially important for passenger transport (people living near the frontiers) in the case of a significant price differential. We have not found any quantitative analysis on this issue. For sure, the incentives to cross the border are related to the size of the price gap. This gap will also evolve depending on the fiscal treatment of fuels abroad. In France, the rising trajectory of the carbon tax and the announced excise duties catch-up are such that, even if Belgium implements a carbon price, cross-border shopping is not likely to be an issue. Moreover, cross-border shopping raises a fiscal competition - mitigation targets compliance dilemma: via cross-border shopping, those countries that implement lower taxes tend to enlarge their tax base and thereby to increase their revenues but, at the same time, make it more difficult to reach their non-ETS mitigation targets (see also the discussion hereafter).

Third, **neighbouring countries also face the challenge of drastically reducing their emissions** in the transport sector[87], meaning that (i) measures can be expected in that respect and (ii) any non-alignment in terms of fiscal policy (fuel prices) potentially forces countries to implement further measures because of cross-border shopping that tends to increase accounted domestic emissions. Such a problem of coordination or harmonization of fiscal treatment of fuels could be touched upon in the context of the Energy Union's governance that foresees a regional cooperation on Integrated National Energy and Climate Plans.[88]

The carbon price would apply to all GHG emissions from fossil fuels (petrol, diesel, gas). The **biomass** component of the fuels would be subject to the carbon price with, for instance, an emission factor equivalent to the corresponding fossil fuel.

Option 1

A **first option** is to implement any given carbon price trajectory by setting the corresponding carbon price **on all fossil fuels through additional fuel taxes** (e.g. carbon component of excise duties).

For **professional diesel**: if the carbon price in Belgium is such that the fuel price after reimbursement rises above the average price in neighbouring countries (i.e. when the carbon price would increase beyond 20-40 €/tCO_2, under current legislation and according to the performed benchmark analysis), then (i) the **reimbursement would be increased** by such a difference and (ii) the part of the carbon price to be reimbursed would potentially[89] be **implemented via the current road pricing** system for trucks by means of an approximation of fuel consumption per type of truck.

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87 2030 nETS targets w.r.t. 2005: BE: -35%, LU: -40%, FR: -37%, NL: -36%, DE: -38%.

88 In France, there is currently a political agreement for the catching up of excise duties between diesel and petrol and the carbon price on non-professional diesel is projected to continuously rise. In the Netherlands, the National Climate and Energy Agreement will be developed, including a -49% national target by 2030 w.r.t. 1990 (ETS & nETS), while the introduction of mileage taxation for freight transport is foreseen as soon as possible and a green tax shift has been announced. Finally, the Netherlands advocates for a -55% target by 2030 w.r.t. 1990 at EU level or, if not feasible, for more ambitious targets together with its neighbouring countries. In Luxembourg, analyses have been performed (Nov. 2016) and a political debate has been launched on the impact of fuel cross border shopping, with an expressed willingness to further reduce the price differential with neighbouring countries.

89 In this respect, it is important to keep track of the scheduled revision of Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures and of EU Directive 2003/96/CE of 27/10/2003 on taxation of energy products and electricity.

Such an option allows for the complete coverage of GHG emissions from the transport sector, as is the case in most countries having a carbon price in place. The specific treatment for professional diesel avoids hindering the competitiveness of the Belgian freight transport sector as price increases above average prices in neighbouring countries would potentially take place via road pricing, which applies to the Belgian territory, i.e. also to foreign transport companies.

Option 2

A **second option** consists in applying the carbon price via a road pricing system. If and when a road pricing system for private cars is implemented in the three regions of Belgium, then the carbon price or part of the carbon price could be implemented via such a system on the basis of an approximation of fuel consumption per type of vehicle. The total carbon price would need to be the same in the three regions and correspond to the trajectory defined.

The carbon component of the road pricing contribution may either complement the carbon component of fuel taxes (cf. Option 1) or potentially replace it; in any case, the sum of the carbon components cannot exceed the level of the carbon price defined in the trajectory.

In terms of timing, there is no decision at this moment to implement a road pricing system for cars in any of the three regions. When any decision in this sense is taken, time will be required to design and to implement the scheme so that, even if this option is favoured, carbon pricing could be implemented through energy taxes in a first phase.

Price

The question of whether **current excise duties** play, at least partly, the role of a carbon price is still a matter of debate. On the one hand, current levels of excise duties on diesel and petrol are very high if they are expressed only in terms of a CO_2 price. On the other hand, excise duties have historically been implemented for reasons other than environmental concerns and all countries implement their carbon taxes above the current energy tax levels[90].

It is suggested that the carbon price follows the default trajectories A, B or C.

A **variant** that could apply to the scope as determined in Option 1 would consist in applying the initial carbon price level within current taxation levels. Under this variant, excise duties on transport fuels would be redefined in 2020 so as to include a carbon component of 10 €/tCO_2 with no change in the total level of each duty. As the level of the duty does not change, reimbursement levels would not change. For the fuels with no excise duty, such a duty would be implemented at this level of 10 €/tCO_2. Then, after this initial implementation phase, the carbon price would rise according to the foreseen trajectory.

This variant corresponds to the way France has implemented its initial carbon price level (7 €/tCO_2). Obviously, no or few net additional revenues would be raised in the first year.

Use of carbon revenues

A first possibility is to allocate part or all of the revenues to reduce either labour taxes or taxes and levies on electricity. See Section 3.2.3 for more details.

Other possibilities include:

(i) Redistributing the revenues stemming from carbon pricing on passenger transport in the form of a **lump-sum transfer to all households** (possibly in addition to a lump-sum transfer of revenues from carbon pricing in the buildings sector, cf. the discussion on key implementation modalities in the buildings sector) or allocating these revenues to the promotion of low carbon transport modes, including electric mobility and public transport.

(ii) Allocating the revenues stemming from carbon pricing on **freight transport to investments in transport infrastructure**, including multi-modality or to a specific **fund for technological innovation** and

[90] Except for heavy duty vehicles in France because of competitiveness issues.

deployment in freight road transport (such as hydrogen technology, eco-combis, …), inland navigation and modal shift.

Policy alignment

When considering the implementation of a carbon price in the transport sector, it will be important to ensure its alignment with policies currently under development or already implemented in the three regions and at local level. The most relevant policies identified throughout the national debate for which an alignment must be ensured, are the following. First of all, the current system of road pricing in Belgium as well as any future reform of this system should be followed-up closely, since carbon pricing could complement this system and thus reinforce mobility policies, or since carbon pricing could potentially be integrated in this system (cf. Section 5.4.1). Secondly, the current system of company cars as well as any future development in this area should be carefully looked at. The current system has led to the number of company cars increasing significantly over the past years, while encouraging the possession of more expensive vehicles and their use, which could all have a negative impact on the objective of a carbon price in the transport sector (cf. Section 5.4.2). Thirdly, an alignment must be guaranteed between a carbon price and other fiscal treatment of vehicles so that low-carbon alternatives are favoured (cf. Section 5.4.3). Finally, air pollution policies must be taken into account when considering the implementation of a carbon price (cf. Section 9.1).

Summary

Emissions in 2016	26,3 MtCO_2e 35% total non-ETS
Scope	All fossil fuel emissions (petrol, diesel, gas) Via (Option 1) component of energy taxes and, for freight transport, potentially via road pricing for the part of the carbon price above benchmark with neighbouring countries or (Option 2) road pricing if/when fully implemented;
Price	Trajectory A, B or C (*) Variant: initial carbon price level implemented within current taxation levels
Public carbon revenues (uses)	General tax shift away from labour and/or electricity Passenger transport revenues: ➤ Lump-sum transfers to all households ➤ Infrastructure investments ➤ Promotion of low carbon transport modes (incl. electric mobility, public transport, and walking and biking ('soft modes') Freight transport revenues: ➤ Infrastructure investments (incl. multi-modality) ➤ Fund for technological innovation and deployment (all modes)
Max. expected annual revenues (trajectory B)	2020: 289 M€ 2030: 1146 M€
Policy alignment	Road pricing for cars, potential extension of current road pricing for freight Company cars fiscal treatment Air pollution policies

(*) From 10€/tCO_2e in 2020 to 40, 70 or 100 €/tCO_2e in 2030.

6 Industry

The implications of setting a carbon price on GHG emitted in the non-ETS industry sector are discussed in this Section. The context of the sector is first described, in terms of emissions and long term low carbon perspectives. Second, current levels of energy prices and taxes in the sector are analysed together with experiences in pricing GHG emissions from non-ETS industry abroad. In the third subsection, impact analyses are provided on expected public carbon revenues. The main policy alignment issues are outlined in a fourth subsection. Finally, key implementation options are described on the basis of all these analyses and the discussions held with key actors.

6.1 CONTEXT

6.1.1 Emissions

KEY MESSAGES

Non-ETS industry emissions amounted to 17% of total emissions in industry in 2016. 65% of those emissions stem from fuel combustion, 35% from processes.

Non-ETS industry relies more heavily on electricity than the ETS industry.

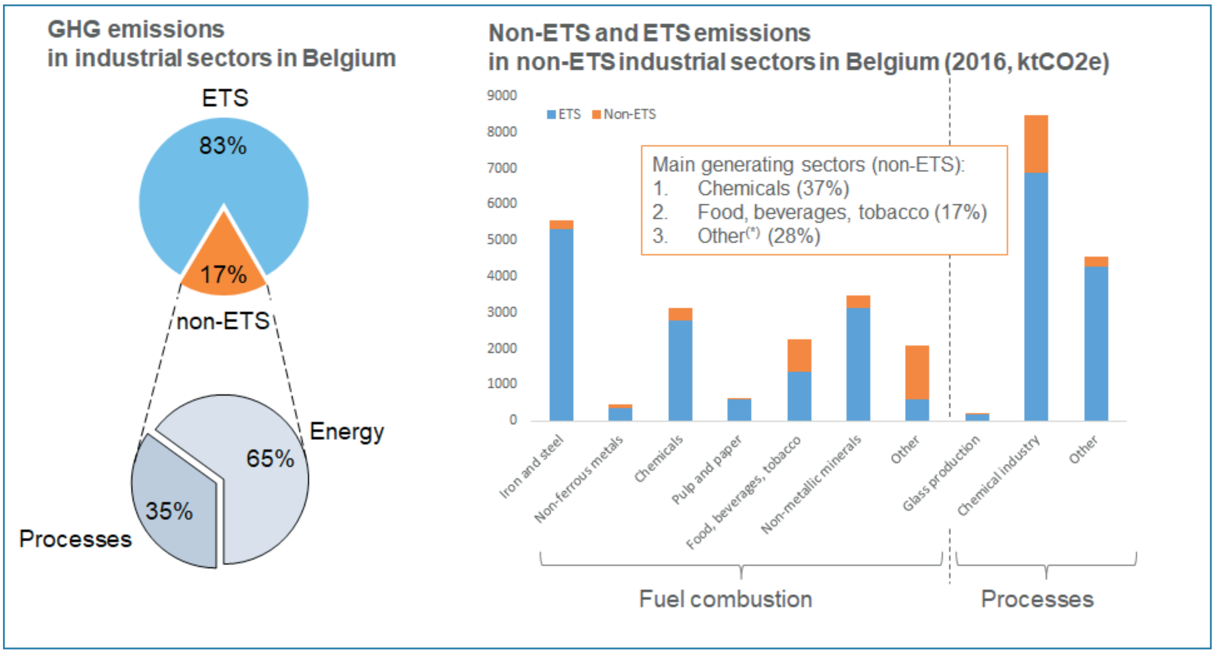
Non-ETS industry emissions amount to 17% of total emissions in industry in 2016. 65% of those emissions stem from fuel combustion, 35% from processes (Figure 66). Within a quite heterogeneous sector, the main sectors generating GHG emissions in the non-ETS industry are chemicals, food & drinks, other industry[91] and non-metallic minerals[92].

Non-ETS industry relies more heavily on electricity than the ETS industry (Figure 67). A detailed comparison for each sector is available in Appendix 5 (Figures A.5.1 to A.5.9).

[91] Textile, off-road emissions from industry and construction, manufacture of wood and wood products, of rubber and plastic products.

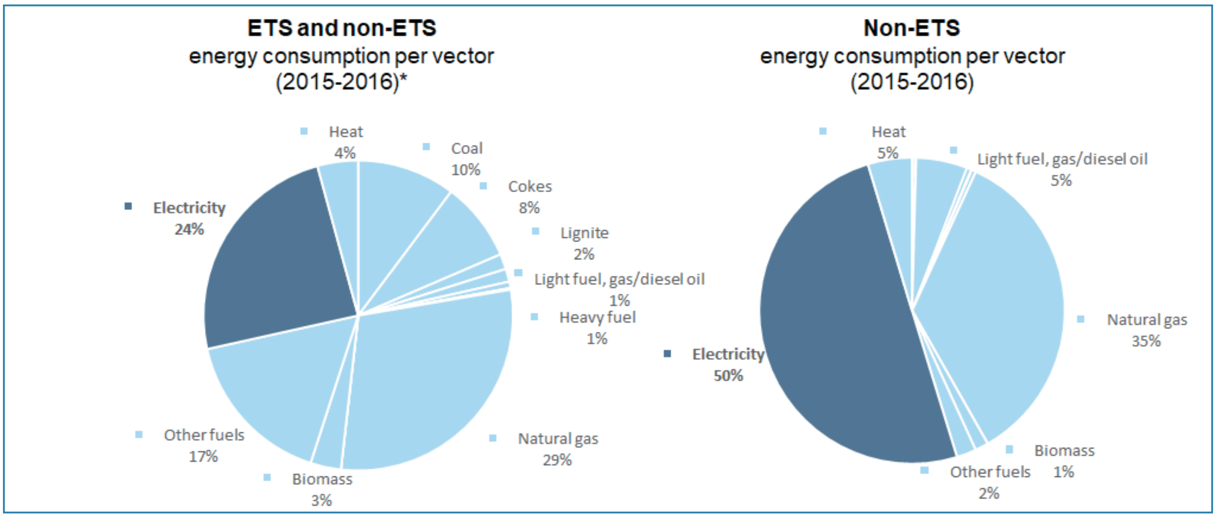
[92] Glass, ceramics, cement, lime, plaster, etc.

Figure 66: GHG emissions in industrials sectors in Belgium



Source: NIR 2018 and MMR 2018

Figure 67: Energy consumption by vector in ETS and non-ETS in Belgium



Source: NIR 2018 and MMR 2018

6.1.2 Low-carbon scenarios and perspectives

> KEY MESSAGES
>
> Many industrial actors have already invested in reducing their energy and emissions intensities.
>
> No specific low carbon scenarios have been built for the non-ETS industrial sectors. However, analyses show that several levers are still available to reduce GHG emissions further. One important avenue is the electrification of heating processes. Preliminary analyses show that, given current energy prices, relatively high carbon prices are usually needed to make the switch profitable. Complementary measures, on top of carbon pricing, might thus be required at least in the short and mid-terms for the transition to take place.

Companies in Europe and in Belgium take action to reduce fossil fuel consumption. Energy and emission intensities of the industry, i.e. the ratio between the energy consumption or GHG emissions and the production, have been monitored in the context of the voluntary agreements discussed below. Among the industrial sectors participating to these agreements, energy intensity has been improved by 10,6% on average both in Wallonia (between 2005 and 2015) and Flanders[93] (between 2002 and 2014), i.e. a reduction of 1%/year. Regarding the GHG emission intensity, it has been reduced by 14,8% in Wallonia (excl. emissions from electricity production) and 10,4%[94] in Flanders (including emissions from electricity) in the same respective periods.

The available data are too limited to provide insights on the contribution of non-ETS actors within these results. We can, however, note that non-ETS industry actors participating in the current agreement in Flanders have further reduced their energy intensity by 1,5% between 2014 and 2016.

In the buildings and transport sectors, forward-looking perspectives were based on the 'Low-Carbon Belgium 2050' study. It provides GHG emission scenarios at sector level and insights on the drivers (and required efforts) for the low-carbon transition. While that study covered the entire economy, it focused on the industrial activities responsible for the highest energy consumption share, i.e. mainly ETS industries. Consequently, industry GHG emission scenarios developed in the 'Low-Carbon Belgium 2050' study are not necessarily representative of non-ETS industries and low-carbon drivers are not all suited to non-ETS industries.

However, the 'Low-Carbon Belgium 2050' study showed that all sectors will have to contribute to GHG emission reductions. Besides demand, it showed the importance of improved design and processes and of the following actions:

1. The switch to lower-carbon materials and the continuous improvement of material intensity, which requires major R&D investments;
2. There is still room for energy efficiency improvements, but there will always remain physical boundaries;
3. Electrification could theoretically allow to reach full decarbonization of non-ETS industries:
   a. most heating processes can be converted to electricity, especially for the smaller production volumes observed in the non-ETS;
   b. further efforts are required (demand, EE, …) to avoid doubling the electricity demand of non-ETS industries.

An important barrier perceived by industry actors[95] is the high investment cost of electrification. However, it can be shown that the essential driver of the total cost of electrification, and thereby of the CO_2 abatement cost, is the price gap between electricity and fossil fuels rather than the investment cost itself.

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93 Leading to 3,5% reduction of the energy consumption and 3,1% reduction in annual GHG emissions (emissions from electricity included)

94 Own calculations based on the reported emissions and the ratios between energy consumptions provided with constant and real industry production

95 CLIMACT, from the industry consultation in preparation of the workshop on industry non-ETS.

Indeed, an analysis by ICEDD (2018) [96] shows that introducing a carbon price that significantly reduces the price gap has a strong impact on the CO_2 abatement costs. Assuming a cost of investment two times higher for an electric technology with respect to the fossil fuel equivalent, the average cost of CO_2 abatement via electrification would range between 180€/tCO_2 and 250€/tCO_2 for industrial energy profiles ranging from 10GWh/year to 0,5GWh/year. The author then shows that introducing a carbon price of 100€/tCO_2 would lower these average abatement costs by as much as 25%.

Moreover, a sensitivity analysis on the relative costs of investments shows that increasing the investment cost of the electric technology by a factor of 10 would increase the average abatement cost by about 20% only.

Even if it will not suffice on its own, pricing carbon can thus be considered as an essential measure to foster electrification in industrial sectors.

6.2 PRICES AND TAXES

6.2.1 Current levels and comparison with neighbouring countries

KEY MESSAGES

In general, excise duties only apply to the separate use of energy products either as heating or as motor fuel, and if not used for electricity production, chemical reduction, or metallurgical and mineralogical processes. With the exception of Luxembourg, standard excise tariffs on natural gas in Belgium are lower than even the reduced rates in its neighbouring countries. The same is true for electricity, gasoil and heavy fuel oil.

Natural gas prices excluding VAT and other recoverable taxes are generally lower in Belgium than in its neighbouring countries, and this for almost all analyzed consumption profiles. Depending on the consumption profiles, the difference with the average in the four and in two (the Netherlands and France) neighbouring countries corresponds to a price between 20 to 50 €/tCO_2e and 10 to 70 €/tCO_2e, respectively.

Regarding electricity, prices excluding VAT and other recoverable taxes are higher in Belgium than in its neighbouring countries for all consumption profiles, with the exception of Germany.

Current taxes and tax levels

Table 12 below provides an overview of excise tariffs[97] applicable to the main energy products used in the non-ETS industry in Belgium and its neighbouring countries in 2017.

Unless indicated otherwise, energy products and electricity used for purposes other than heating or propellant, but also as dual use, use for chemical reduction, metallurgical and mineralogical processes, and for electricity production, are exempted from excises.

The main conclusions that can be formulated regarding taxes and tax levels, are the following:

- In general, excises only apply to the separate use of energy products either as heating or as motor fuel, and if not used for electricity production, chemical reduction, or metallurgical and mineralogical processes. In the Netherlands, excises also apply to these particular uses when energy products other

[96] ICEDD, 2018. Analysis performed in the context of the stakeholders consultation on the « Plan air, climat et énergie 2030 pour la Wallonie ».

[97] The excise tariffs presented here include excises, exceptional excises and the energy contribution. Sources: PwC, EU Commission excise tables.

than electricity and natural gas are used. In Luxembourg, excises do apply to energy products used for metallurgical and mineralogical processes, although the excise rates are very low.

- With the exception of Luxembourg, standard excise tariffs on natural gas in Belgium are lower than even the reduced rates in its neighbouring countries. The same is true for electricity, gasoil and heavy fuel oil.

Table 12: Overview of 2017 excise tariffs on main energy products in Belgium and neighbouring countries – non-ETS industry

	Product/ Applicable excise tariff	**Natural gas (MWh)**	**Electricity (MWh)**	**Gas oil (1000L)**	**Heavy fuel oil (1000 kg)**	**Coal, cokes, lignite (MWh)**
BE	Standard business use rate	0,9978	1,9261	18,6521 22,8845 (2)	16,34	1,44
	Reduced rate (3)	0,54 (1)/0	NA/0	NA/0	NA/0	NA/0
	Difference	0,4578 - 0,9978	0 - 1,9261	0 - 22,8845	0 - 16,34	0 - 1,44
FR	Standard business use rate	5,88	22,5	118,9 150,9 (2)	95,4	9,99
	Reduced rate (4)	0 - 1,52 - 1,60	NA/0	NA/0 - 38,2 - 70,2	NA/0	0 - 1,19 - 2,29
	Difference	0 - 4,36	0 - 22,5	0 - 150,9	0 - 95,4	0 - 8,80
NL	Standard business use rate	1,216 - 25,244	0,53 - 101,3	485,92 485,92 (2)	36,44	1,836
	Reduced rate (5)	NA/0	NA/0	NA	NA	NA
	Difference	0 - 25,244	0 - 101,3	0	0	0
DE	Standard business use rate	5,5	15,37	46,01 61,35 / 485,7 / 470,4 (2)	25	0,612
	Reduced rate	4,12	NA/0	NA/0	NA/0	NA/0
	Difference	1,38	0 - 15,37	0 - 470,4	0 - 25	0 - 0,612
LU	Standard business use rate (6)	0,05 / 0,3 / 0,54 / 1,08	0,1 / 0,5 / 1	0 21,002 (2)	15	18
	Reduced rate	NA/0	NA/0	NA/0	NA/0	NA/0
	Difference	0 - 1,08	0 - 1	0 - 21,002	0 - 15	0 – 18

(1) Reduced rate for companies engaged in energy policy agreements.

(2) Rate when used as motor fuel for stationary engines, plant & machinery used in construction, civil engineering and public works, and vehicles intended for use off public roads.

(3) 0 rate also if used for CHP.

(4) Reduced rates apply for companies under the EU ETS and/or for energy-intensive companies that are at risk of carbon leakage (zero-rate on electricity can apply for the last two categories) – link with the carbon tax.

(5) Only natural gas and electricity are exempted from excises when used for other purposes mentioned in the second paragraph of this chapter. Direct use of gas for production of electricity through CHP is also exempted.

(6) Natural gas: 1,08 €/MWh if the yearly consumption is max. 550 MWh (Cat.A), 0,54 €/MWh if the yearly consumption > 550 MWh (Cat.B), 0,3 €/MWh if the yearly consumption is > 4.100 MWh and an EE agreement is concluded with the government (Cat.C2), 0,05 €/MWh for the same consumption profile and if it concerns ETS companies or if the main use is for chemical reduction or metallurgical / mineralogical processes. Exemption if used for CHP.

Electricity: 1 €/MWh if the yearly consumption is max. 25 MWh (Cat.A), 0,5 €/MWh if the yearly consumption is > 25 MWh (Cat.B), 0,1 €/MWh if used for metallurgical / mineralogical processes (Cat.C).

Prices – comparison with neighbouring countries

Figure 68, Figure 69, Figure 70 and Figure 71 below provide a comparison of final prices in 2017 for natural gas (consumption profiles I2 and I4[98]) and electricity (consumption profiles IB and IE[99]) in Belgium and its neighbouring countries, these two energy products being the most important ones in the non-ETS industry in Belgium. The comparison of additional consumption profiles for natural gas and electricity can be found in Appendix 5 (Figures A.5.10 to A.5.16).

Although final prices based on Eurostat data are illustrated in the figures (as consistently done throughout the national debate on carbon pricing), prices excluding VAT and other recoverable taxes are used as a basis for formulating conclusions for industry.

Regarding natural gas, we observe that prices excluding VAT and other recoverable taxes are generally lower in Belgium than in its neighbouring countries, and this for all analyzed consumption profiles (with one exception: the price for the lowest consumption profile in Luxembourg). The differences are biggest in the lower consumption profiles, while these tend to become smaller in the higher consumption profiles. The Belgian prices for the larger consumption profiles are on average at least about 10% lower than in the neighbouring countries, while prices for the lower consumption profiles can on average be up to 30% lower than in the neighbouring countries. Depending on the consumption profiles, the difference between Belgium and its neighbouring countries corresponds to a price between 10 to 70 €/tCO_2e when compared to the average of France and the Netherlands together, or between 20 to 50 €/tCO_2e when compared to the average of the four neighbouring countries. More details can be found in Tables A.5.17 to A.5.22 of Appendix 5.

Regarding electricity, Eurostat prices excluding VAT and other recoverable taxes are clearly higher in Belgium than in its neighbouring countries for all consumption profiles, with the exception of Germany. The price difference with its neighbours, however, tends to decrease as consumption profiles are bigger. The Belgian prices are about 10% higher for the bigger and 20% higher for the lower consumption profiles than the average of the four neighbouring countries, while prices are about 15% higher for the bigger and 25% higher for the lower consumption profiles than the average of France and the Netherlands together. More details can be found in Tables A.5.23 to A.5.29 of Appendix 5, including on electricity prices for larger industrial consumers from a study performed by PwC for the CREG[100], since this study provides more detailed information for these consumption profiles that complements the insights provided by the Eurostat data. The same study also concludes that it is very important to make the difference between electro intensive and non-electro intensive consumers, since Belgian industrial consumers that compete with non-electro intensive consumers in the neighbouring countries have a net competitive advantage in terms of total energy cost. The opposite is true when competing with electro intensive consumers in the neighbouring countries (especially Germany, France and the Netherlands)[101].

Finally, regarding gasoil, no specific data on final prices applicable to the non-ETS industry were available. Therefore, a comparison at the level of applicable excise duty tariffs was performed, as well as the calculation of the carbon price that corresponds to the tariff differential. This can be found in Table A.5.30 of Appendix 5.

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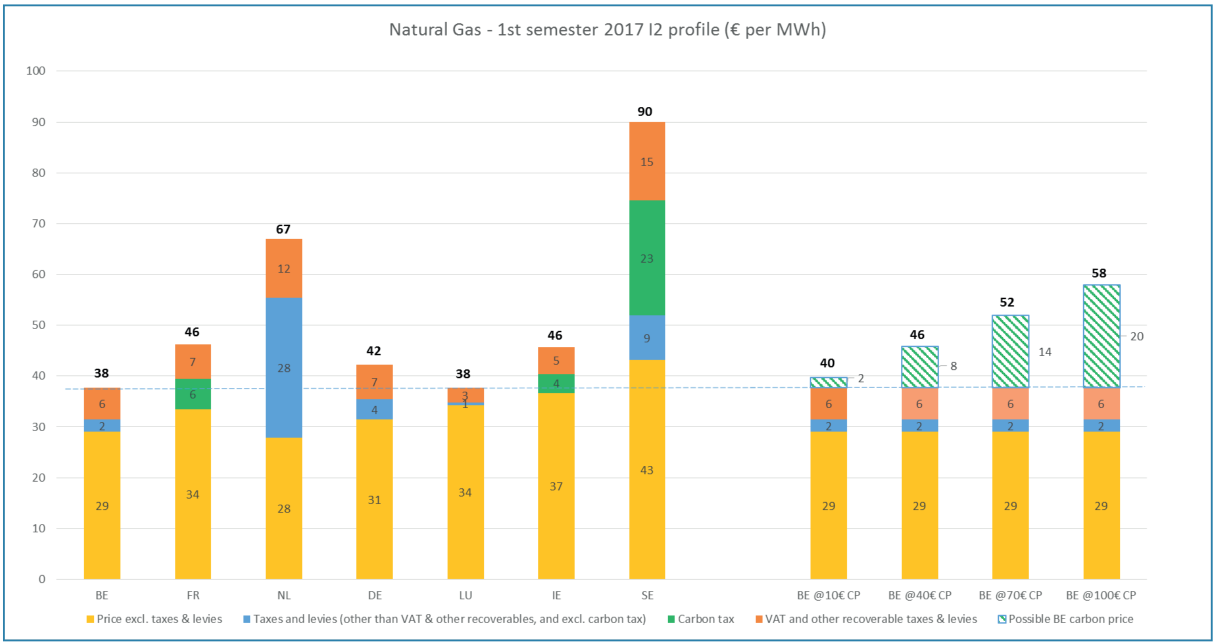
98 I2 profile: 1.000 GJ < consumption < 10.000 GJ. I4 profile: 100.000 GJ < consumption < 1.000.000 GJ

99 IB profile: 20 MWh < consumption < 500 MWh. IE profile: 20.000 MWh < consumption < 70.000 MWh

100 A European comparison of electricity and gas prices for large industrial consumers, 2017 update – PwC study for the CREG

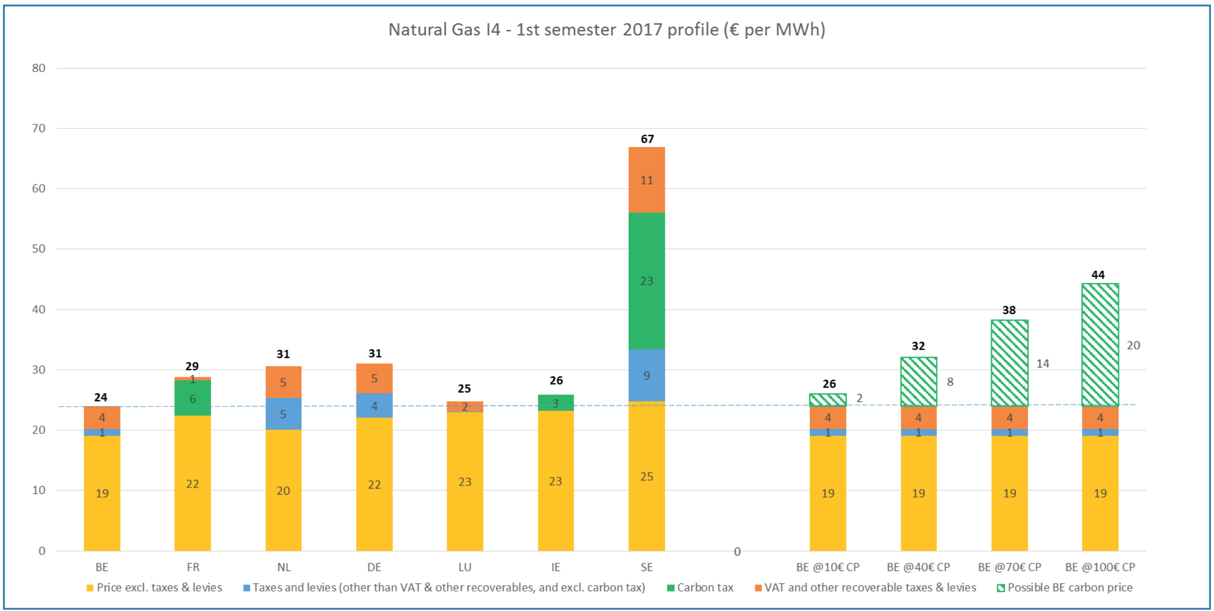
101 Regarding this conclusion, it should, however, be noticed that the countries included in this analysis tend to have a significantly different definition of what is considered to be an electro intensive consumer.

Figure 68: Comparison of final prices of natural gas (I2 profile) and impact of carbon price in Belgium[102]



Sources: Eurostat data on gas prices (S1 2017 averages for industrial profile I2 1000 GJ < consumption < 10000 GJ), information on carbon taxes from IE, FR and SE, own calculations.

Figure 69: Comparison of final prices of natural gas (I4 profile) and impact of carbon price in Belgium[103]

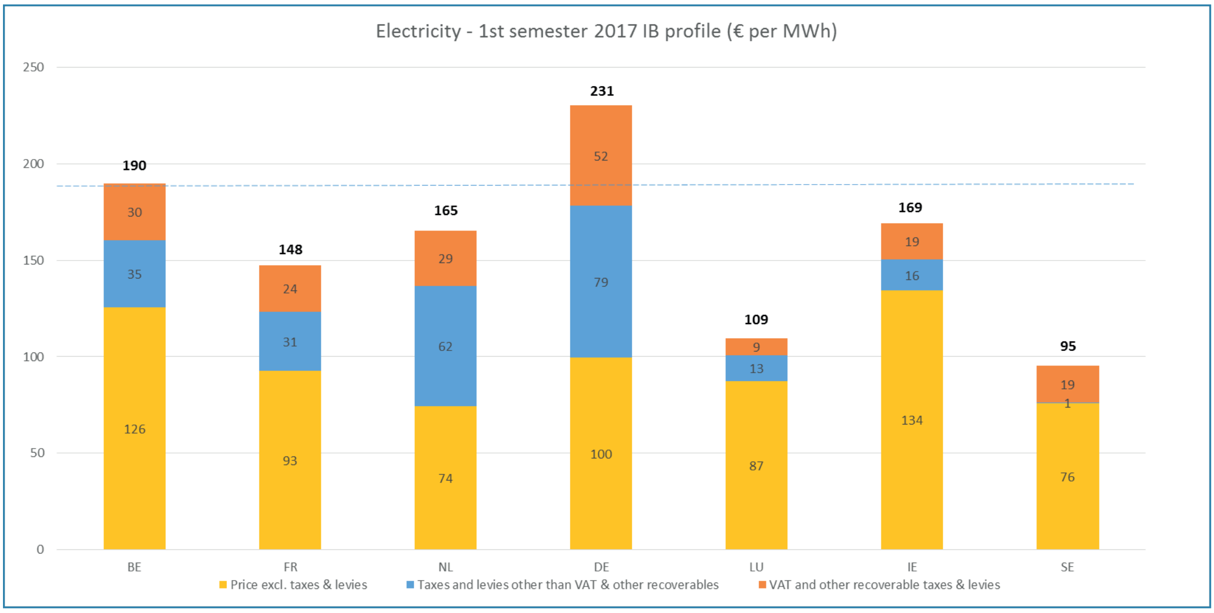


Sources: Eurostat data on gas prices (S1 2017 averages for industrial profile I4 100000 GJ < consumption < 1000000 GJ), information on carbon taxes from IE, FR and SE, own calculations.

102 Methodology: use of the Eurostat data and price components, while presenting standard (i.e. not the possible reduced) carbon taxes separately where applicable, by taking these out of the relevant components used by Eurostat (generally the VAT and other recoverable taxes & levies component).

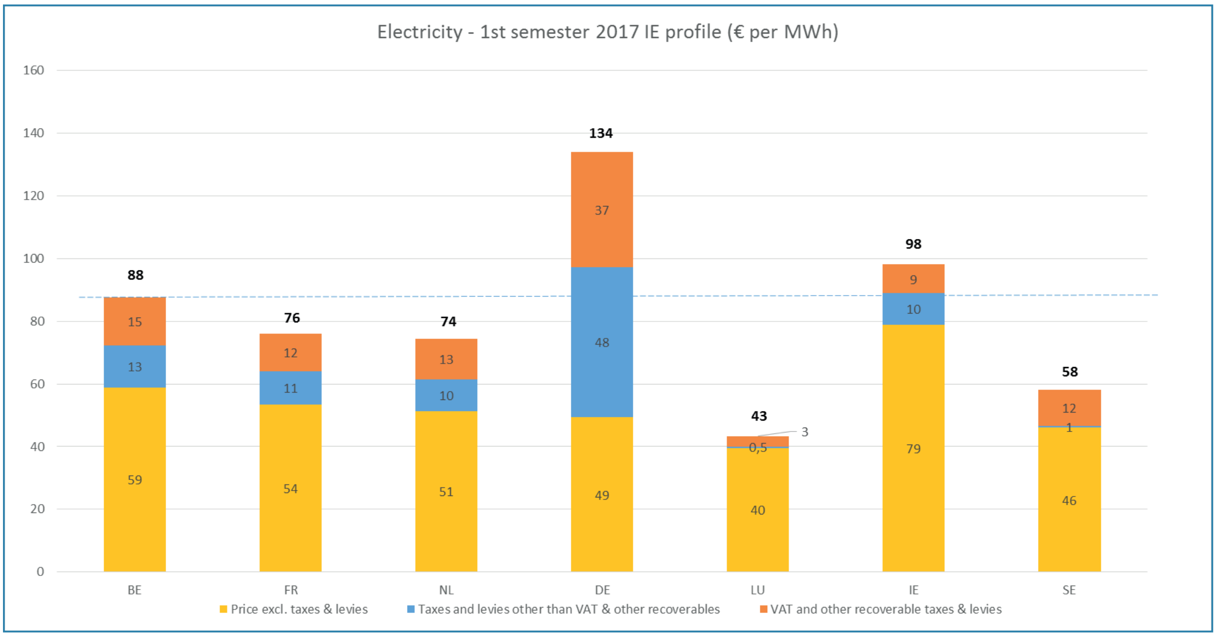
103 Methodology: use of the Eurostat data and price components, while presenting standard (i.e. not the possible reduced) carbon taxes separately where applicable, by taking these out of the relevant components used by Eurostat (generally the VAT and other recoverable taxes & levies component).

Figure 70: Comparison of final prices of electricity (IB profile)



Source: Eurostat data on electricity prices (S1 2017 averages for non-household consumers IB - 20 MWh < consumption < 500 MWh)

Figure 71: Comparison of final prices of electricity (IE profile)



Source: Eurostat data on electricity prices
(S1 2017 averages for non-household consumers IE - 20000 MWh < consumption < 70000 MWh)

6.2.2 Lessons learned from existing carbon taxes

KEY MESSAGES

There is a broad spectrum on how the carbon tax is applied to the non-ETS industry across the analyzed countries. It goes from virtually no exemptions or reduced rates of the carbon tax at one side of the spectrum, over a full exemption for those companies that voluntarily engage in GHG emission reduction agreements, to a full exemption for those companies that are energy-intensive and that have a significant risk of carbon leakage at the other side of the spectrum.

Based on the publicly available information gathered, further information collected through contacts in the respective administrations, and available time and resources, it was possible to analyze in more detail the carbon tax features of the following countries: France, Ireland, Switzerland and Sweden. The focus lied on the scope of the tax within the non-ETS industry sector, including whether any reduced rates / exemptions apply for some energy products / consumers / subsectors. It should be noted from the outset that, in none of the analyzed countries, process emissions are covered by the carbon tax.

France

The carbon tax within the non-ETS industry is mainly applied through the taxes on energy products ("Taxe Intérieure de Consommation sur les Produits Energétiques" or TICPE), the taxes on natural gas ("Taxe Intérieure de Consommation sur le Gaz Naturel" or TICGN), and the taxes on coal ("Taxe Intérieure de Consommation sur le Charbon" or TICC).

Non-ETS industrial companies that are big energy consumers ánd that are exposed to a significant risk of carbon leakage (these criteria are thus cumulative) benefit from a reduced carbon tax rate. The same definition of big energy-consuming companies as under the EU Directive 2003/96/CE of 27/10/2003 on taxation of energy products and electricity is applied in this case, as does the EU ETS definition of significant risk of carbon leakage.

The reduced carbon tax that applies to these companies corresponds to the initial level of the carbon tax at the time of its introduction, i.e. 7 €/tCO_2e, that is moreover applied within the existing excise duties and thus not on top of the existing excise duties. However, should the excise duties on specific products not reach the equivalent level of taxation of 7 €/tCO_2e, the excise duties would be increased up to that level. Still, this means that in practice, there is no significant increase of excise duties for these companies following the introduction of the carbon tax.

Non-ETS industrial companies that do not fulfill both criteria at the same time, pay the carbon tax in full.

Unfortunately, no data is available on which part of the non-ETS industry falls under this reduced carbon tax regime or under the full carbon tax regime.

In France, the principle is that the generated revenues from the carbon tax are used to reduce taxes elsewhere. The main vehicle it uses in this context for industry, is the so-called "Crédit d'Impôt pour la Compétitivité et l'Emploi" or CICE, a tax credit intended to give to companies (all companies, not only the companies particularly impacted by the carbon tax) the possibility to invest, innovate, accompany the ecological and energy transition. It is estimated that the carbon tax generated about 3,8 billion € in 2016, of which around 3 billion € served to finance CICE.

Ireland

In general, no exemptions or reduced rates have been foreseen for the non-ETS industry. However, it should be noted that there is a full reimbursement of the carbon component of the energy tax on coal, peat and natural gas when these energy products are used for cogeneration.

Sweden

Reduced rates or exemptions from the carbon tax have been gradually phased out in Sweden. By the beginning of 2018, most of these have been completely phased out. An exception is diesel used as a motor fuel for heavy mining trucks, where a 40% reduction of the standard carbon tax is still applied. It should also be pointed out that the energy tax rate for heating fuels and fuels used in stationary motors in industry is 70% lower than the general energy tax level. Still, given that the carbon tax is the main tax on energy products in Sweden, the impact of this energy tax reduction on total taxation is limited and energy taxation remains highest in Sweden, when compared to the countries analyzed in detail.

Finally, in order to create an administratively simple system, all companies (regardless of their energy intensity) falling within the NACE codes defining the manufacturing industry benefit from the lower energy tax rates (and also benefited, up until the end of 2017, from the reduced carbon rates).

Switzerland

The carbon tax in Switzerland only applies to fuels (excluding biomass) used in thermal installations or as input for CHP installations. Companies performing specific activities listed in legislation, producing at least 60% of their GHG emissions through these activities and emitting in total more than 100 tCO_2e/y can, on request, be exempted from the tax on the condition that they commit to GHG emission reductions through voluntary agreements. If an exemption request is granted, companies get reimbursements.

The specific activities for which exemption from the carbon tax can be requested, are roughly industrial activities as defined under NACE (a.o. manufacture of pulp and paper, coke and refined petroleum products, chemical and pharmaceutical products, glass, ceramics), but also other activities like operation of public baths and tourist hotels. Since January 1st, 2018, cogeneration plants generating electricity based on fossil fuels (plants with a rated thermal input of between 0,5 and 20 MW), may also be exempted from the carbon tax.

There are two types of voluntary agreements companies can commit to: agreement to take on an emissions target or a measures target. Under an emissions target, a starting point is set, together with a linear emission reduction course and an end point in terms of maximum emissions to be emitted in 2020, based on the economically viable reduction potential. Under a measures target, companies commit to undertaking a list of economically viable measures by 2020.

Failure to comply with the emission reduction commitments leads to penalties. Firstly, a fee of 125 CHF (around 105 €) per tCO_2e exceeding the target is due and on top of that, the excess emissions need to be compensated (through carbon credits).

Finally, around 25 million CHF stemming from the carbon revenues are earmarked for a technology fund every year. This fund promotes innovative technologies that reduce GHG emissions and the consumption of resources, support the use of renewable energy and increase energy efficiency.

Conclusions

Regarding the non-ETS industry, we observe a broad spectrum on how the carbon tax is applied across the analyzed countries.

In Ireland and Sweden, we see there are virtually no exemptions or reduced rates. In France, we notice that energy-intensive companies that have a significant risk of carbon leakage, can benefit in practice from a (almost) full exemption from the carbon tax, while the remaining companies pay the carbon tax in full. Regarding Switzerland, we observe a full exemption from the carbon tax for those companies that engage in voluntary agreements to reduce their GHG emissions. Companies not engaging in such agreements, have to pay the full carbon tax.

Finally, except for Switzerland where part of the revenues are paid back to companies and another part is directed to a technology fund available to companies, revenues have not been specifically earmarked for supporting the non-ETS industry.

6.3 EVALUATION OF POTENTIAL PUBLIC CARBON REVENUES

KEY MESSAGE

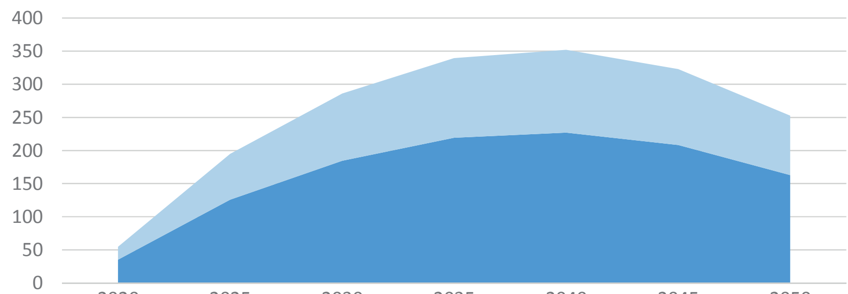
Maximum theoretical revenues from pricing emissions in the non-ETS industrial sectors amount to 55 M€ in 2020 and 286 M€ in 2030.

The actual level of revenues from carbon pricing in the sector will critically depend on the scope, whose options are detailed in Section 6.5 below. The assessment provided here corresponds to a maximum, theoretical level of revenues corresponding to the implementation of carbon pricing on all sources of emissions in the sector [104].

Moreover, given that no specific low carbon scenarios could be built for the sector, simplifying assumptions have been made on the trajectory of emissions. It has been assumed that emissions of the sector follow a linear trajectory between 2020 and 2050, from a level in 2020 corresponding to the 2016-2020 relative evolution of industrial emissions under the 'with existing measures' official projections applied on 2016 actual non-ETS industrial emissions to a level in 2050 based on total (all sectors) average reduction rate in the CORE low carbon scenario[105].

Under such assumptions, maximum theoretical revenues from carbon pricing in the non-ETS industry would amount to 55 M€ in 2020, 286 M€ in 2030 and 253 M€ in 2050, representing a cumulated budget of 8,3 billion € under the carbon price trajectory « B » (prices of 10, 70 and 190€/tCO_2 in 2020, 2030 and 2050, respectively), as illustrated in Figure 72. Further details are provided in Table A.5.31 of Appendix 5 for the three carbon price trajectories.

Figure 72: Annual carbon tax revenues under option B (M€/year)



	2020	2025	2030	2035	2040	2045	2050
Process	19	69	101	120	125	115	90
Energy combustion	35	126	185	219	227	208	163

Source: Own calculations

[104] Implicitly corresponding to the assumption that no sub-sector would be at risk of carbon leakage or would sign a voluntary agreement. In practice, the number of companies at risk or signing a voluntary agreement could be very large, which would lead to significantly less revenues.

[105] Namely -80% between 1990 and 2050, that is -75% between 2020 and 2050.

6.4 POLICY ALIGNMENT: VOLUNTARY AGREEMENTS

KEY MESSAGE

Voluntary agreements in industry have been an important tool for promoting energy efficiency measures and supporting competitiveness. The current agreements run up to 2020 in the Walloon Region and 2022 in the Flemish Region. Given the importance of these tools in both regions, it will be important to ensure a proper alignment between these agreements and a possible carbon price to be applied to the non-ETS industry, in particular if these agreements are extended beyond 2020 and 2022.

In both the Walloon and Flemish regions, the possibility to conclude voluntary agreements was provided to industry. These policies are considered to be an important tool for promoting energy efficiency measures within energy-intensive industries and cover most of these industries present in the two Regions.

The current agreements run up to 2020 in Wallonia and up to 2022 in Flanders. In both cases, it is not yet clear whether and how these agreements might be extended beyond their respective current timeframes.

In any case, given the importance of these tools in both Regions, it will be important to ensure a proper alignment between these agreements and the possible implementation of a carbon price to be applied to the Belgian non-ETS industry.

In what follows, a brief overview of the main features regarding the voluntary agreements implemented in the Walloon ("Accords de Branche (AdB)") and Flemish ("Energiebeleidsovereenkomsten (EBO)") Regions is provided. There is currently no voluntary agreements system in place in the Brussels-Capital Region[106].

Energiebeleidsovereenkomst (EBO) in the Flemish Region

The EBO is the cornerstone of the Flemish policy for the energy-intensive industry that aims to promote energy efficiency measures in this sector. The Flemish Region introduced the first generation of voluntary agreements for industry in 2002 (benchmark and audit covenants), while the EBO is the second generation of voluntary agreements that runs from 2015 up to 2022 included. As mentioned by J. Recko (2018), the current EBO strives to strike the right balance between commitments from the companies (additionality vs. feasibility) and compensation measures from the government.

Companies performing industrial activities, as specified in NACE under codes 05 up to and including 33, on sites with a primary energy consumption of at least 0,1 PJ per year, can conclude an EBO with the Flemish government. Through this EBO, in which the sectoral organization of the respective company also has a role to play, the company takes several commitments, of which the most important one is to improve its energy efficiency by implementing identified, profitable measures (measures having an IRR of 12,5% or of 14% if it concerns companies that fall under the EU ETS) that have been identified in an Energy plan drawn by the company and audited by an energy expert. In exchange, the Flemish government also takes several commitments, of which the most important ones are to provide specific support and not to put additional burden on the companies through supplementary taxes, or energy efficiency or other targets/measures for the duration of the agreement.

The current EBOs cover around 98% of the energy consumption of the target group. To date, 193 non-ETS companies (representing 13% of total energy consumption, and where electricity plays a more important role – 75% vs. 25% fossil fuels, based on emission figures) and 141 ETS companies (representing 87% of total energy consumption) have signed an EBO. For the period 2015-2018, non-ETS companies have identified 1.334 profitable measures to be implemented, that should result in around 4,58% energy savings (of which 74% for electricity and 26% for fuels).

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[106] The most important non-ETS sectors in the Brussels-Capital Region being the foods and drinks, construction, and chemicals and pharmaceutical sectors.

Accords de Branche (AdB) in the Walloon Region

In the Walloon Region, the AdB are an important instrument to improve energy efficiency, reduce CO_2 emissions from energy combustion and for competitiveness purposes, that should contribute to a sustainable energy transition. The first generation of these voluntary agreements for industry ran from 2003 up to 2013, while the second generation runs from 2014 up to 2020 included.

Similar to the EBO in the Flemish Region, Walloon companies take several commitments through the AdB, of which the most important one is to improve their energy efficiency and reduce their CO_2 emissions by implementing identified, profitable measures (being measures having a PayBack Time (PBT) of less than 2 years or between 2 years and a number of years agreed with each sectoral federation, and with a guaranteed technical feasibility) that have been identified in an Action plan drawn by each company following an initial, in-depth audit of a company's activities and energy consumption profile. In exchange, the Walloon government also takes several commitments, of which the most important ones are to provide specific support and not to put additional burden on the companies through supplementary taxes, or energy efficiency or other targets/measures for the duration of the agreement.

As explained by C. Maschietto (2018), main changes of the second generation w.r.t. the first generation include the possibility to exploit RES on industrial sites, the possibility to make use of an energy/CO_2 analysis of the lifecycle of a company's main product, and the mandatory development of roadmaps by the sectoral federations.

The sectoral objectives for the first generation covered around 90% of the final industrial energy consumption in the Walloon Region. The AdB covered 16 sectors, 173 companies and 203 production sites. It resulted in an improvement of the industry's energy efficiency by around 16,5% and a decrease of GHG emissions by 19,3% during the covered period.

The second generation covers around 190 companies and around 80% of the final industrial energy consumption in the Walloon Region. In 2015, 360 potential measures identified were also implemented, representing a total investment of around 64 million €. The energy efficiency index, based on the base year 2005, amounted to 10,6% in 2015 (while the 2005-2020 commitment is 11,4%). The CO_2 index, also based on the base year 2015, amounted to 14,8% in 2015 (while the 2005-2020 commitment is 16,1%).

6.5 KEY IMPLEMENTATION ISSUES AND OPTIONS

Different options for each of the four identified implementation modalities emerge from all previous analyses and from discussions with key actors. These options are summarized at the end of the Section.

Preliminary remarks

Our benchmarking analysis on energy prices and taxes has shown that gas prices are lower in Belgium than in the neighbouring countries. As for electricity, prices are usually higher in Belgium, especially for Belgian industries competing with industries that benefit from compensations (in the form of reduced tax rates or exemptions) abroad. Also, many factors do potentially affect competitiveness at sectoral level. In all cases, modalities for implementing carbon pricing in non-ETS industrial sectors should account for any carbon leakage risk.

Scope

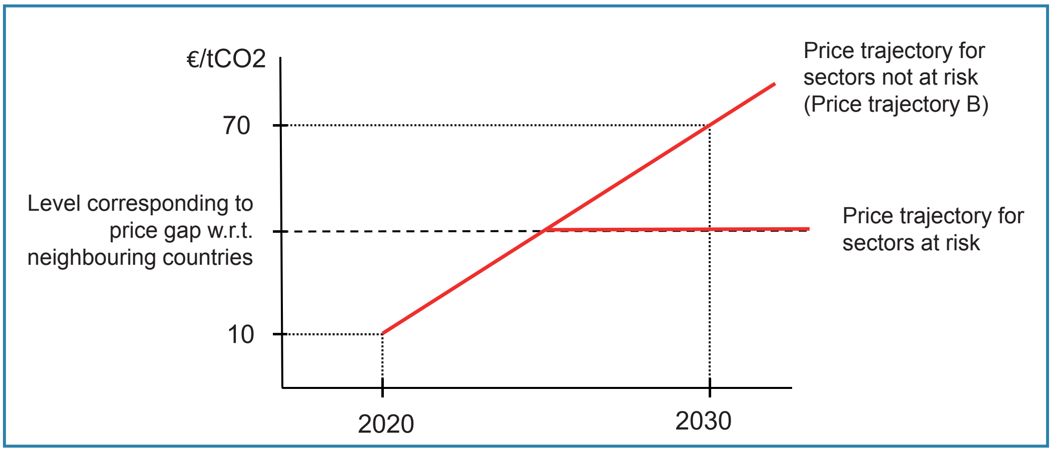
Two options have been identified.

Option 1: Carbon leakage list and capped carbon price

Under this option, the first step consists in identifying the sectors at risk of carbon leakage. Such an analysis has not been performed in the context of the present debate and requires further investigation. A possibility is to use the list of sectors at risk under the EU ETS, as is currently (partly) done in France, namely the Commission decision of 27 October 2014 (2014/746/EU). Further work is then needed as information up to 4 digits of the NACE code is currently not available at the level of energy consumption or GHG emissions in Belgium. Another possibility is to develop specific criteria that should reflect risks of leakage not between EU and non-EU industries, but between Belgian and other (mainly EU) industries, taking into account policy developments outside Belgium, in particular fiscal and carbon pricing policies. This also requires further research.

As a second step, all fossil fuel emissions from combustion would be gradually priced at a level corresponding to the default carbon price trajectory. However, for sectors at risk of carbon leakage, the price would be capped at a level corresponding to the current fossil fuel (mainly gas) price gap (all taxes and levies included) with respect to neighbouring countries[107]. Such a cap would then need to be defined and revised periodically. Figure 73 illustrates such an option under price trajectory B.

Figure 73: Illustration of option 1 under price trajectory B



As for process emissions, specific levers need to be used to reduce them. Special treatment could therefore be required based for instance on ETS practices involving benchmarks.

Option 2: Price signal through voluntary agreements

The second option builds on the voluntary agreement instruments currently in place at the regional level up to 2020 in Wallonia and 2022 in Flanders[108]. The agreements might be renewed after these dates (see Section 6.4). Under this second option, the new agreements will need to be reformed. Companies that do not sign the agreement would be subject to a carbon price in the form of an additional carbon component on energy taxes. Companies that do sign the new agreement are exempted from the carbon tax. However, the new agreement would then have to foresee the introduction of the carbon price into the evaluation of all projects or investments in such a way that it fosters low carbon investments with respect to high carbon alternatives (see the illustration in Figure 74).

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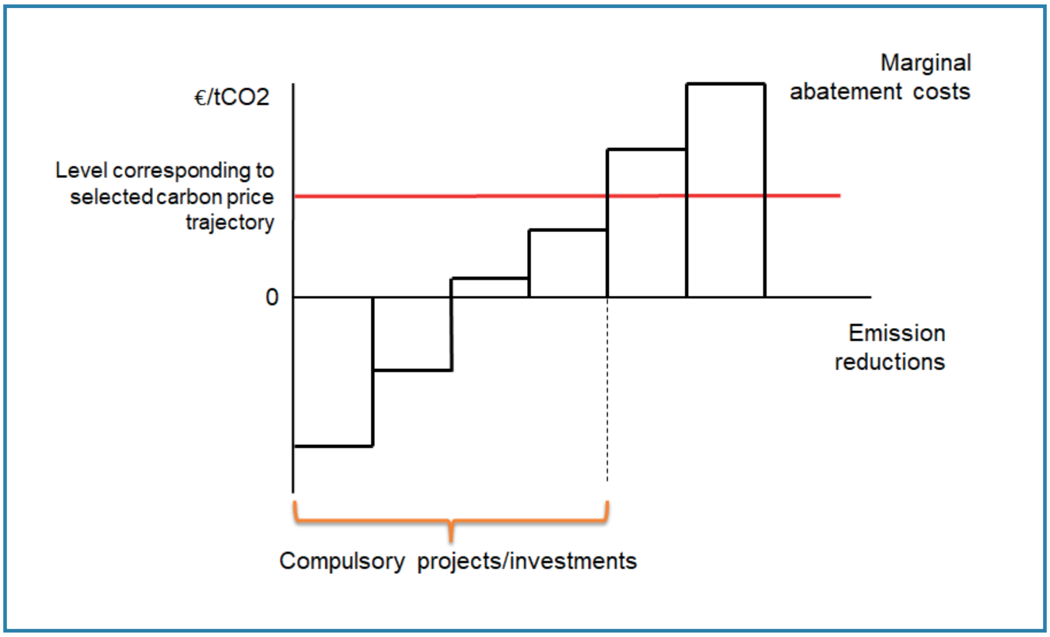
107 And potentially other countries, if relevant.

108 Under this option, given that there is currently no voluntary agreements system in place in the Brussels-Capital Region, and if there is still not such a system in place by the time a carbon price would be implemented, an alternative treatment might need to be foreseen for non-ETS industries located in Brussels.

Figure 74: (static) Illustration of option 2



Of course, such a reform must include a revision of a series of parameters influencing the profitability of the investments, such as the pay-back time or the minimal level of the internal rate of return of the investments at stake.[109]

Price trajectory

As a main option, it is proposed that the carbon price follows the default trajectory A, B or C as described in Section 3.2.2. In all cases, i.e. also under scope Option 2, the price trajectory should be the same in all regions.

Variant 1: ETS price

Because some non-ETS industries may compete with ETS industries, a first variant consists in establishing a price trajectory on the basis of ETS prices. Under scope option 1, the price could be based on average past prices, to be reviewed on a regular basis. Under scope option 2, forecasted prices would have to be used and also regularly reviewed.

Variant 2: First component within current taxes

A second variant that could apply to scope option 1 would consist in implementing in all sectors (i.e. at risk or not at risk) the first component of the carbon price trajectory (namely 10 €/tCO_2e in 2020) within the current taxation level. This variant is similar to the one proposed in the transport sector.

Use of carbon revenues

A first possibility is to allocate part or all of the revenues to reduce either labour taxes or taxes and levies on electricity. See Section 3.2.2 for more details. In particular, given the relatively high electrification level of the non-ETS industry and the need to further electrify all sectors, the reduction of charges and levies on electricity is a good option for the sector. Such tax shifts would favour all economic sectors, in particular energy intensive sectors (or labour intensive sectors in the case of a tax shift away from labour), and not specifically non-ETS industrial sectors. For the impact to be significant also on non-ETS industries, revenues from other important emitting sectors need to be allocated to such shifts.

109 The fact that, under the EBO in Flanders (see Section 6.4), the internal rate of return of projects to be implemented differs depending on whether the company belongs to the ETS or not, must be accounted for.

Another possibility that has been identified as valuable by actors is to accompany the small and medium size industries (SMEs) in the transition. Part or all of the revenues could finance such accompanying measures. One of these could be the creation of a fund for innovation.

Policy alignment

Under scope option 2, voluntary agreements would, by definition, be aligned with the carbon price as they would explicitly include it. Under scope option 1, new voluntary agreements, if these are established, need to be fully coherent with the carbon price trajectory.

Policy support to SMEs, including at regional and local levels, should be fully aligned with carbon pricing and facilitate its implementation (see also the uses of carbon revenues).

Summary

Emissions in 2016	5,4 $MtCO_2e$ 8% total non-ETS
Scope	All fossil fuel emissions Via (Option 1) component of energy taxes with special treatment for sectors at risk of carbon leakage (to be assessed) or (Option 2) carbon price in projects to be implemented under voluntary agreements Process emissions: specific treatment (incl. benchmark and/or voluntary agreement)
Price	Trajectory A, B or C (*) Price capped at a level corresponding to the fossil fuel price benchmark for sectors at risk of carbon leakage (under scope Option 1 only) Variant 1: ETS price instead of trajectory A, B or C (under both scope Options) Variant 2: initial carbon price level implemented within current taxation levels (under scope Option 1 only)
Public carbon revenues (uses)	General tax shift away from labour and/or electricity Fund for innovation in industries and support to SMEs
Max. expected annual revenues (trajectory B)	2020: 55 M€ (**) 2030: 286 M€ (**)
Policy alignment	Voluntary agreements reform SMEs policy support

(*) From 10€/tCO_2e in 2020 to 40, 70 or 100 €/tCO_2e in 2030.
(**) Theoretical maximum under price trajectory B; depends on actual scope and price trajectory.

7 Agriculture and waste

The implications of setting a price on GHG emitted in the agriculture and waste sectors are discussed in this Section. The context of the sector is first described, in terms of emissions, key characteristics and long term low carbon perspectives. Second, current levels of energy prices and taxes in the sector are analysed together with experiences in pricing GHG emissions from agriculture and waste abroad. In the third sub-section, impact analyses are provided on expected public carbon revenues. Finally, key implementation options are described on the basis of all these analyses and the discussion held with key actors.

7.1 CONTEXT

7.1.1 Emissions

KEY MESSAGES

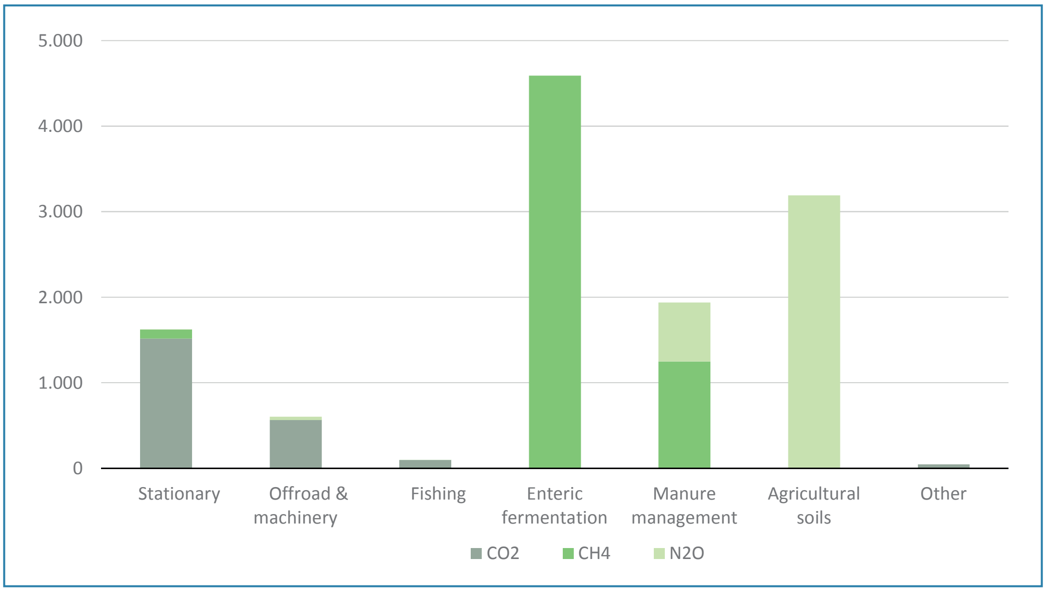
Emissions from fuel combustion in the agriculture sector represent around 19% of total GHG emissions of the sector in 2016. Other activities generating GHG emissions are enteric fermentation, agricultural soils and manure management.

Two thirds of non-ETS GHG emissions stemming from the waste sector originate from waste incineration with recuperation of electricity and heat, the other main sources of emissions being solid waste disposal and waste water treatment and discharge.

Regarding the agriculture sector, emissions from fuel combustion represent around 19% of total GHG emissions (in tCO_2e) of this sector in 2016, as can be seen in Figure 75.

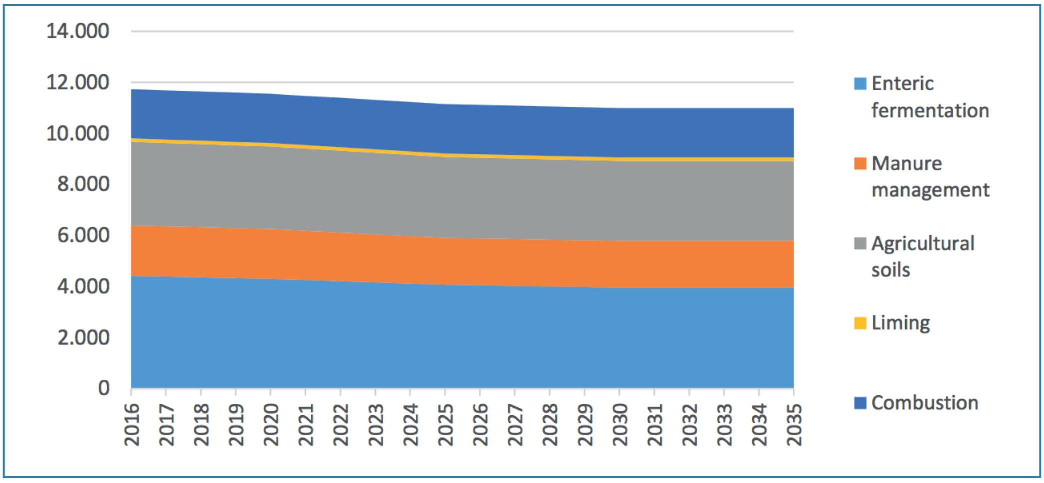
Other activities mainly generating GHG emissions are enteric fermentation (CH_4), agricultural soils (N_2O) and manure management (CH_4 and N_2O). Under existing measures, as can be seen in Figure 76, GHG emissions are projected to decrease by about 7% in 2035 w.r.t. 2015. This would mainly be the result of an 8% reduction of non-CO_2 emissions over 20 years, while emissions from combustion would remain relatively constant with an increase of less than 0,5% between 2015 and 2035.

Figure 75: 2016 GHG emissions in agriculture per type of gas (in $ktCO_2e$)



Source: NIR 2018

Figure 76: projected emissions in the agriculture sector under existing measures (in $ktCO_2e$)

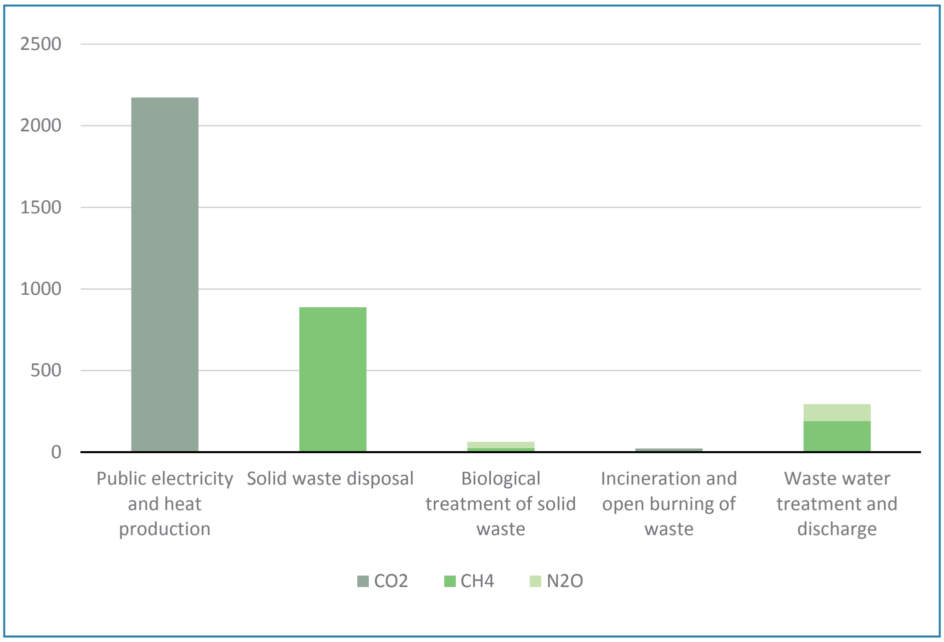


Source: MMR 2017

Regarding the waste sector, Figure 77 shows that around two thirds of its non-ETS emissions originate from waste incineration combined with generation of electricity and heat (CO_2 emissions), followed by emissions from solid waste disposal (26% - CH_4) and emissions from waste water treatment and discharge (9% - CH_4 and N_2O).

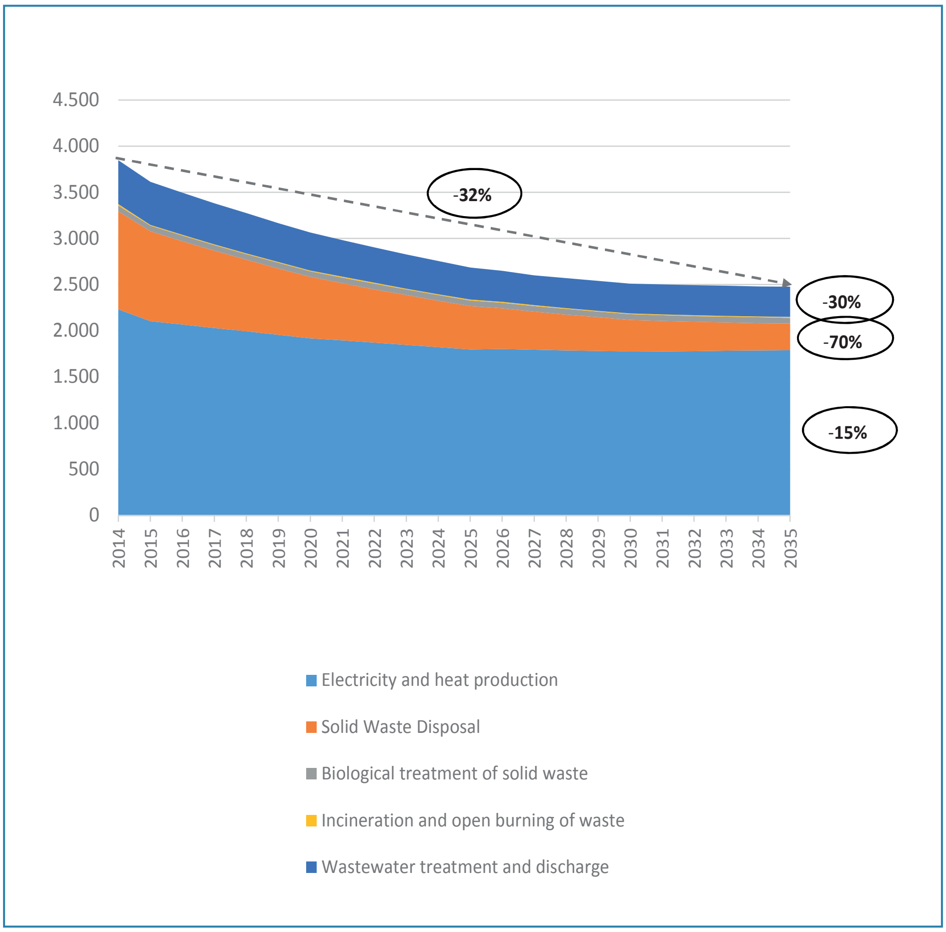
Under existing measures, GHG emissions in the waste sector are projected to decrease by about 32% in 2035 w.r.t. 2015 (see Figure 78 below). This would mainly be the result of a 70% reduction of solid waste disposal emissions over 20 years, while emissions from waste water treatment and discharge and emissions from waste incineration with electricity and heat production would decrease by 30% and 15%, respectively.

Figure 77: 2016 GHG emissions in waste per type of gas (in $ktCO_2e$)



Source: NIR 2018

Figure 78: Projected GHG emissions in the waste sector under existing measures (in $ktCO_2e$)



Source: MMR 2017

7.1.2 Key characteristics

KEY MESSAGES

The Belgian agriculture sector is an export-oriented sector.

Although cultivated surfaces remain relatively constant, the number of farms and the work-force have been decreasing constantly. The number of animals has been relatively stable over time.

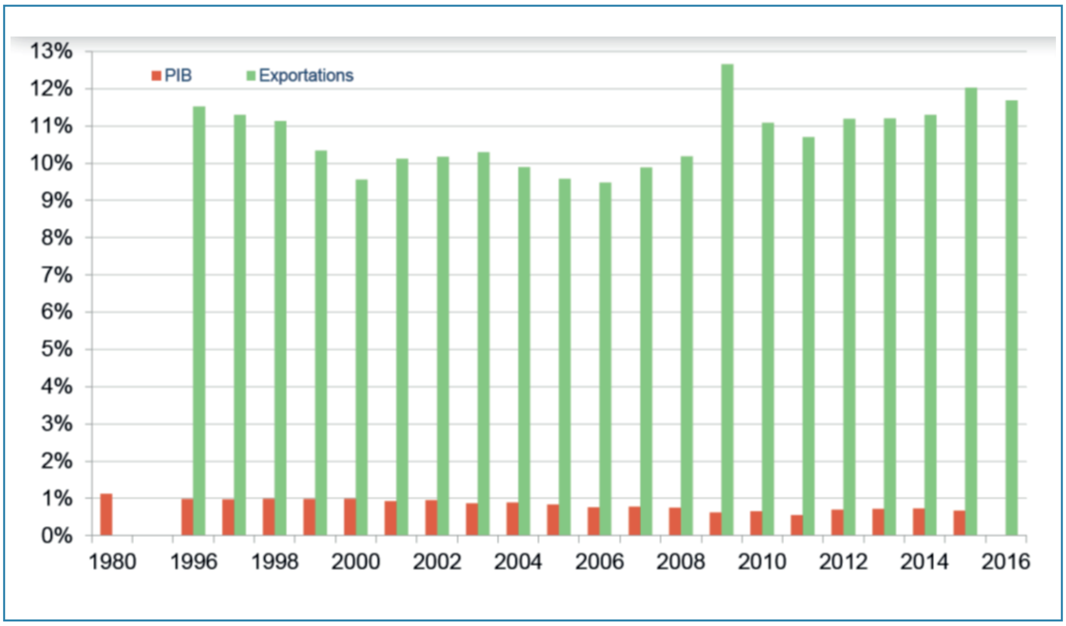
Greenhouse crops are mainly located in Flanders and the sub-sector mainly uses natural gas with cogeneration.

Even though municipal waste per capita has decreased substantially in Belgium between 2007 and 2016, waste incineration per capita has remained stable during the same period. The number of actors in the waste sector is not necessarily large.

Agriculture

As Figure 79 shows, the share of agricultural activities in Belgian GDP has experienced a slightly downward evolution in the period 1996-2015, representing less than 1% of Belgian GDP in 2015. Nevertheless, these activities represent around 5% of Belgian exports (and even 12% if the food industry is taken into account), making this sector and export-oriented sector.

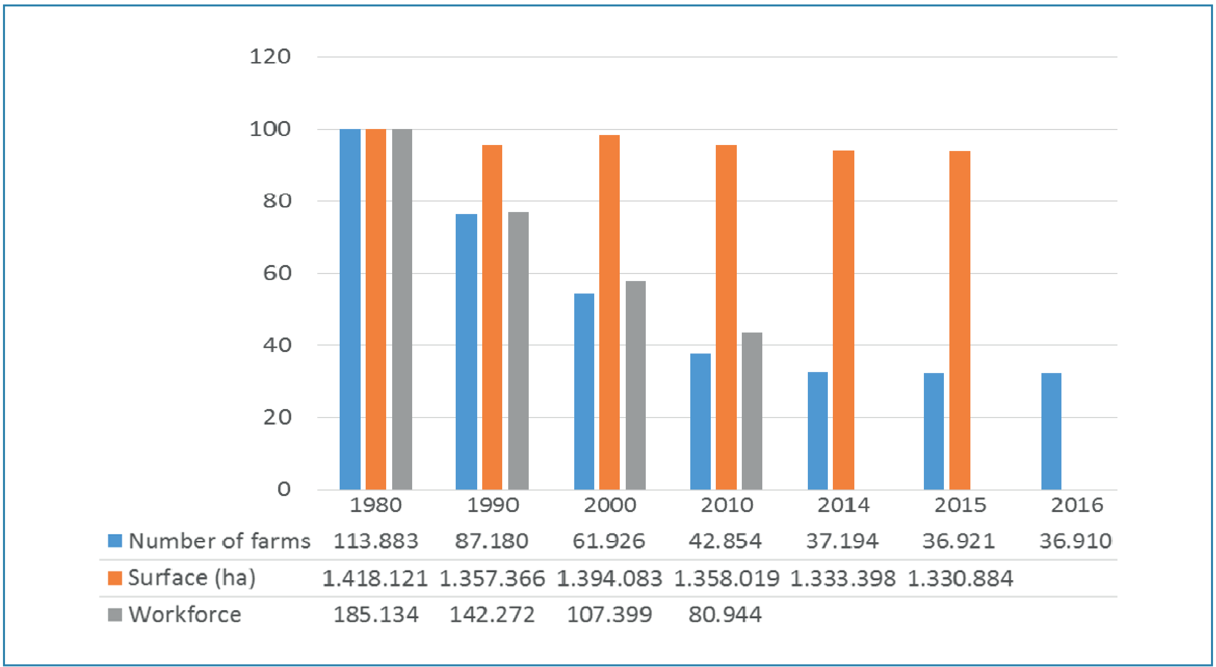
Figure 79: Share of agriculture in GDP and in exports in Belgium (1996-2016)



Source: Statbel, Institut des comptes nationaux

When looking at Figure 80, we observe that between 1980 and 2016, cultivated area in Belgium has reached between 1,33 and 1,42 million Ha, thus remaining relatively stable. Still, it is clear that during the same period, the number of farms and the workforce have significantly decreased from around 113.000 in 1980 to around 37.000 in 2016, and from around 185.000 in 1980 to around 81.000 in 2010, respectively.

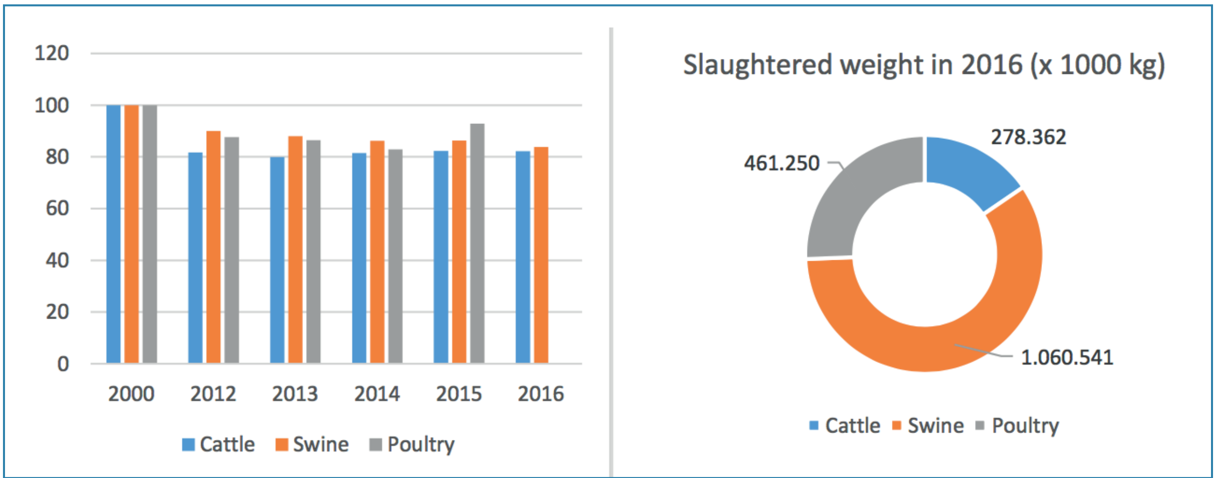
Figure 80: Evolution of number of farms, surface and workforce (1980 = 100, selected years)



Source: Statbel

Between 2012 and 2016, the number of animals has been relatively stable, as can be seen in Figure 81. When looking at the slaughtered weight in 2016, around 59% was swine, 26% poultry and around 15% cattle.

Figure 81: Evolution of the number of animals (2000 = 100) and slaughtered weight in 2016 (in 1000kg)



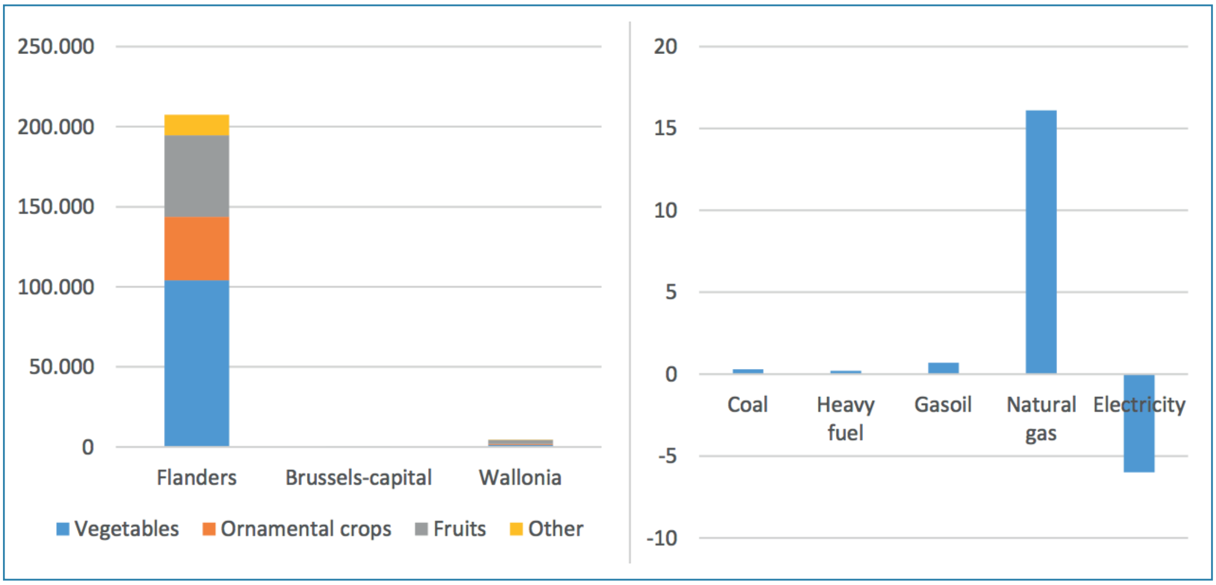
Source: Statbel

As Figure 82 shows, around 98% of greenhouse crops (vegetables, fruit, ornamental crops, other) were located in Flanders in 2016. Dutch companies are the main competitors for Flemish greenhouse crops producers[110]. From 2007 onwards, a transition from oil to natural gas with cogeneration took place within the sector[111].

110 Other important competitors for the Flemish agriculture sector, including greenhouse cultivations, are e.g. Spain for the cultivation of tomatoes and Africa for floriculture.

111 Part of the CO_2 generated by the combustion of natural gas is reinjected in the greenhouses to stimulate additional growth of plants.

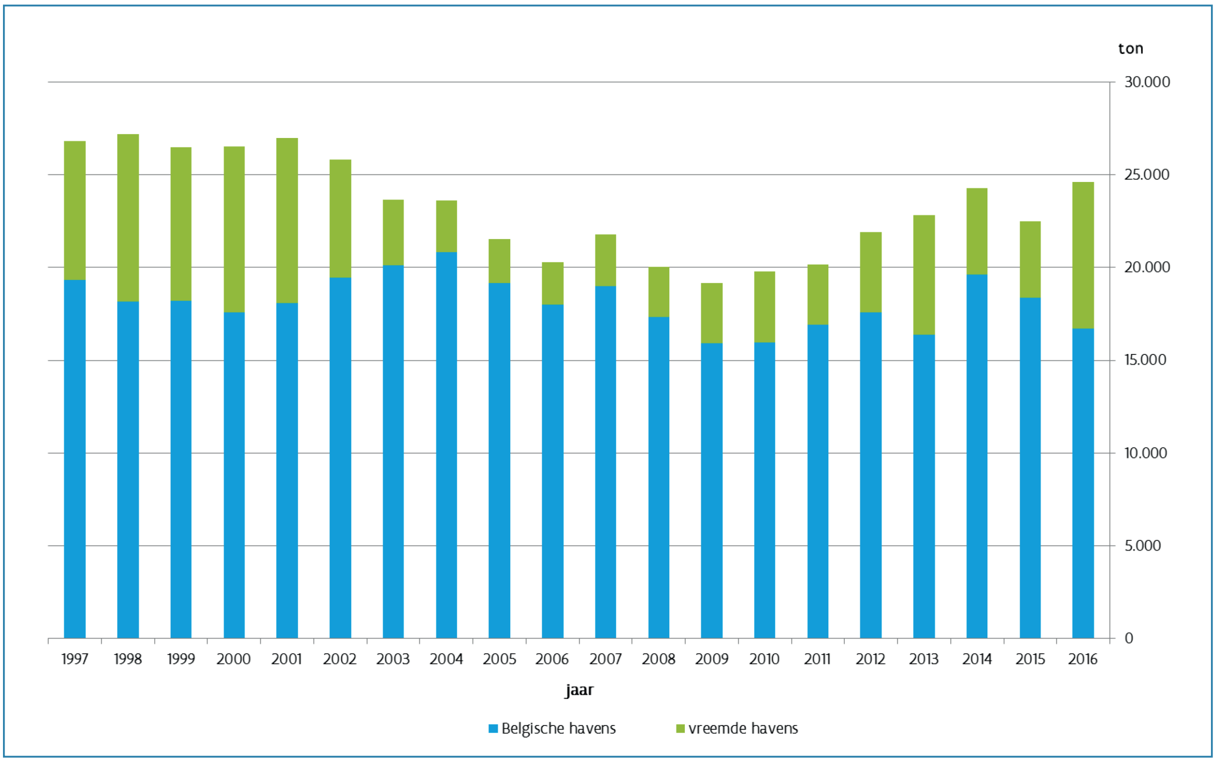
Figure 82: Greenhouse crops (2016, in ares), and greenhouses' energy consumption in Flanders (2016, PJ)



Source: Statbel and Flemish Energy Balance, December 2017

Finally, regarding fishing, Figure 83 shows that total landings have been relatively stable these past few years, amounting to 24.583 tons in 2016 (with 72 vessels having a total capacity of 45.051 kW) and representing a total value of 93,3 million €. Total GHG emissions of this sector amounted to 94,55 ktCO_2e in 2016.

Figure 83: Total annual landings Belgian vessels (ton/year)



Source: NIR 2018, Report "De Belgische zeevisserij 2016" (Department 'Landbouw en visserij')

Waste

As can be seen in Table 13, there are 16 waste incineration plants for household and comparable corporate waste in Belgium, with a total capacity of 3,4 million tons per year. The number of actors in this sector is thus not very large.

Table 13: List of waste incineration plants in Belgium and their respective capacities (in ton/year)

	Waste incineration plants (HH and comparable corporate waste)	Capacity (t/y)
Flanders	IVBO	206.500
	Ivoo Oostende	77.000
	Imog Harelbeke	84.000
	Bionerga (huisvuilverbranding met energierecuperatie)	89.000
	Indaver Roosteroven	382.000
	Isvag	158.000
	IVM huisvuilverbranding	104.000
	IVRO huisvuilverbranding (= MIROM)	68.000
	Restafvalverbranding IVAGO	99.500
	SLECO Wervelbedoven	466.000
	Biostoom installatie (plassendale II Oostende)	180.000
Wallonia	IPALLE (Thumaide)	400.000
	ICDI (Charleroi)	110.000
	IBW (Ittre)	116.000
	UVELIA (Herstal - formerly INTRADEL)	370.000
Brussels	Bruxelles-Energie (Neder-Over-Heembeek)	500.000
Belgium	**Total capacity**	**3.410.000**

In Belgium, municipal waste per capita decreased significantly from 493kg in 2007 to 420kg in 2016. Nevertheless, waste incineration per capita remained stable in the same period, from 186kg in 2007 to 187kg per capita in 2016[112].

7.1.3 Low-carbon scenarios and perspectives

KEY MESSAGES

Even though the emission reduction potential in the agriculture sector is limited when compared to other sectors, several levers that can reduce fuel combustion and non-CO_2 emissions have been identified.

The agriculture sector could have an important role to play in the context of reaching net-zero/negative emissions in the long term, through maintaining/increasing carbon in soils.

In the waste sector, the key lever is the reduction of the amount of waste.

The emission reduction potential in the agriculture sector is usually assumed to be lower than in other sectors, particularly at the level of non-CO_2 gases. Both the European Commission's low carbon economy roadmap from 2011 and the study on low carbon scenarios for Belgium from 2013 have confirmed this assumption.

112 Source: Eurostat.

Even though the emission reduction potential in the agriculture sector is lower than in other sectors, the following main levers for reducing emissions have been identified, next to further energy efficiency improvements in general:

- Regarding fuel combustion emissions – emissions mainly stem from (i) greenhouses, where levers include heat from industry, geothermal energy, heat recovery and biomass; and (ii) offroad activities, where levers include electrification and alternative fuels from RES like for instance bio-methane and hydrogen;
- Regarding non-CO_2 GHG emissions – at the level of (i) animals, levers include genetics, food (including additives), lifetime, etc., (ii) soils, levers include optimizing the balance between different uses and management methods.

Finally, it is worth noting that, in the perspective of reaching net-zero/negative emissions in the long term, the agriculture sector could have an important role to play through maintaining/increasing carbon in soils.

7.2 PRICES AND TAXES

It was not possible, due to time constraints, to perform a detailed analysis on prices and taxes related to the waste sector. Therefore, this chapter focuses on information for the agriculture sector, although basic information for the waste sector was included wherever possible.

7.2.1 Current levels and comparison with neighbouring countries

KEY MESSAGES

There are reduced excise rates and/or exemptions in all analyzed countries when energy products are used for agricultural purposes. When comparing it with its neighbours, Belgium is the only country where full exemptions apply on all main energy products used in the agriculture sector.

The difference in excise duties on natural gas used for heating between Belgium and its neighbouring countries corresponds to a price between 10,5 €/tCO_2 and 14 €/tCO_2 for the low consumption profiles, or between 5 €/tCO_2 and 10 €/tCO_2 for the higher consumption profiles.

The difference in excise duties on heating gasoil between Belgium and its neighbouring countries corresponds to a price between 54 €/tCO_2 and 100 €/tCO_2.

Only Belgium has a zero excise rate on electricity, while the neighbouring countries do not have specific (reduced) rates for electricity used in the agriculture sector. Still, as is the case for the non-ETS industry, electricity prices excluding VAT and other recoverable taxes are higher in Belgium than in its neighbouring countries for all consumption profiles, with the exception of Germany.

Belgian waste incineration installations have to pay an environmental tax based on the amount of waste incinerated, that is different in each Region because of differences in basic rate and additional charges linked to this environmental tax. Among its neighbouring countries, France and the Netherlands have also introduced a waste incineration tax.

Current taxes and tax levels

Table 14 below provides an overview of excise tariffs[113] applicable to the main energy products used in the agriculture sector in Belgium and its neighbouring countries in 2017.

Table 14: Overview of 2017 excise tariffs on main energy products in Belgium and neighbouring countries – Agriculture sector

	Product/ Applicable excise tariff	Natural gas (MWh)	Electricity (MWh)	Gas oil (1000 L)
BE	Standard business use rate	0 (propellant)	1,9261	18,6521
		0,9978 (heating)		22,8845 (2)
	Reduced rate (1)	0 (heating)	0	0
	Difference	0,9978	1,9261	18,6521 - 22,8845
FR	Standard business use rate	5,50 (propellant)	22,5	118,9
		5,88 (heating)		150,9 (2)
	Reduced rate (1)	0,119	NA	38,6 (propellant)
	Difference	5,381 – 5,761 (3)	0	112,3
NL	Standard business use rate	16,45 (propellant)	0,53 - 101,3	485,92
		1,24 - 25,84 (heating) (4)		485,92 (2)
	Reduced rate (1)	1,24 - 4,15 (heating in greenhouses)	NA	NA
	Difference	0 - 21,69 (heating in greenhouses) (4)	0	0
DE	Standard business use rate	13,9 (propellant)	15,37	46,01
		4,12 (heating)		61,35 / 485,7 / 470,4 (2)
	Reduced rate (1)	12,52 (propellant) - NA (heating)	NA	255,6 (propellant) / 46,01 (other)
	Difference	1,38 (propellant)	0	15,34 - 214,8
LU	Standard business use rate	0 (propellant)	0,5	NA
		0,05 – 1,08 (heating) (5)		21,002 (2)
	Reduced rate (1)	NA	NA	0
	Difference	0	0	21,002

(1) Reduced rates apply for agricultural, horticultural and piscicultural works and in forestry, unless stated otherwise.
(2) Rate when used as motor fuel for stationary engines, plant & machinery used in construction, civil engineering and public works, and vehicles intended for use off public roads.
(3) Reimbursement of 5,381 €/MWh when used as propellant, and of 5,761 €/MWh when used as heating fuel.
(4) Depending on the amount used: 0 – 170.000 m^3: 25,84 €/MWh for standard business use, 4,15 €/MWh for heating greenhouses. 170.001 – 1.000.000 m^3: 6,36 €/MWh for standard business use, 2,40 €/MWh for heating greenhouses. 1.000.001 – 10.000.000 m^3: same tariff of 2,32 €/MWh. > 10.000.000 m^3: same tariff of 1,24 €/MWh.
(5) In function of yearly consumption, company profile, engagement in voluntary agreements and/or type of use (cf. industry).

[113] The excise tariffs presented here include excises, exceptional excises and the energy contribution. Sources: PwC, EU Commission excise tables.

The main conclusions regarding taxes and tax levels in the agriculture sector are the following:

- There are reduced excise rates and/or exemptions in all analyzed countries when energy products are used for agricultural purposes.
- When looking at the analyzed countries presented in the overview table, Belgium is the only country where full exemptions apply on all main energy products used in the agriculture sector.
- The more significant reduced rates in France apply to natural gas and gasoil used as motor fuel. In the Netherlands, the only reduced rate applies to natural gas used for heating greenhouses. Finally, in Luxembourg, there is a full exemption of excises on gasoil used for agricultural purposes.

Regarding the waste sector, waste incineration installations have to pay an environmental tax based on the amount of waste incinerated. This environmental tax was introduced to steer waste policies so that less waste is incinerated, but rather recycled as much as possible. Basic 2018 tax rates for incinerating regular waste by recognized installations are 12,91 €/t in the Flemish Region, 11,76 €/t in the Walloon Region and 6,30 €/t in the Brussels-Capital Region (these amounts are indexed on a yearly basis). The total environmental tax level on waste incineration is different in each Region because of the different basic rates, but also because of other charges that are directly linked to this environmental tax and that can be different in each Region:

- Additional charges from a Region or communes: in Flanders, each commune can decide to charge so-called 'opcentiemen' (or 'centimes additionnels' in French) on top of this environmental charge. Intercommunal waste incineration plants are exempted from these opcentiemen, that are capped at max. 20% of the environmental tax on waste incineration (i.e. 20% of 12,91 €/t in 2018 in Flanders = 2,852 €/t of waste). No opcentiemen are charged in the Walloon or Brussels-Capital Regions, but in the latter a lump-sum has to be paid.
- In the 3 Regions, the environmental tax is taxed as income, which means an additional expense for the waste incineration plants.

Applicable tariffs – comparison with neighbouring countries

No comparison at the level of prices was performed, since no specific data on prices applicable to the agriculture sector was available. Instead, a more detailed comparison was made at the level of the applicable excise tariffs. However, regarding electricity, we can assume that prices excluding VAT and other recoverable taxes are higher in Belgium than in its neighbouring countries for all consumption profiles, with the exception of Germany[114]. Indeed, the Belgian standard excise tariff on electricity is low when compared to its neighbouring countries, and is as such a less important component of total electricity prices in Belgium. The exemption of this component for agriculture companies in Belgium will thus not have a significant impact on the final electricity prices applicable to them and it is therefore safe to assume that the comparison of electricity prices with the neighbouring countries as done for the non-ETS industry will not change for the agriculture sector as a result of this exemption.

Appendix 6 (Tables A.6.1 and A.6.2) provides details on the comparison of applicable tariffs for natural gas and gasoil in the agriculture sector in Belgium and its neighbouring countries.

The main conclusions regarding applicable tariffs in Belgium and its neighbouring countries are the following:

- Regarding natural gas, Belgium and Luxembourg have zero rates for natural gas used as motor fuel, while only Belgium has a zero rate for natural gas when used as a heating fuel. The difference in excise duties on natural gas used for heating between Belgium and its neighbouring countries corresponds to a carbon price between 10,5 €/tCO_2 and 14 €/tCO_2 for the low consumption profiles, or between 5 €/tCO_2 and 10 €/tCO_2 for the higher consumption profiles. If used as motor fuel, such a carbon price would lie between 35 €/tCO_2 and 48 €/tCO_2.
- Regarding gasoil, both Belgium and Luxembourg have zero rates for gasoil used as heating and as motor fuel. The difference in excise duties on heating gasoil between Belgium and its neighbouring

[114] The Netherlands, for instance, is an important competitor for many Belgian agricultural products, but Dutch agricultural companies benefit from significantly lower electricity prices than Belgian companies.

countries corresponds to a carbon price between 54 €/tCO_2 and 100 €/tCO_2. If used as motor fuel, such a carbon price would lie between 74 €/tCO_2 and 100 €/tCO_2.

- Finally, regarding electricity, we observe that only Belgium has a zero rate, while the neighbouring countries do not have specific rates for electricity used in the agriculture sector.

Regarding the waste sector, according to CEWEP[115], no waste incineration tax is in place in Luxembourg and Germany, while a tax of 15€/t and of 13,11 €/t applied in 2017 in France and in the Netherlands, respectively.

7.2.2 Lessons learned from existing carbon taxes

KEY MESSAGES

In the agriculture sector, only emissions from combustion fall under the scope of the carbon tax in the analyzed countries.

There are broadly two approaches on how to apply the carbon tax to this sector in the analyzed countries: i) applying a reduced rate of the carbon tax for specific activities and/or energy products, or ii) having the agricultural companies pay the carbon tax and subsequently reimbursing them only for specific agricultural activities, either if voluntary emission reduction agreements have been signed with the government or with no specific conditions.

None of the analyzed countries have included GHG emissions from the waste sector in the scope of their carbon taxes. However, one country included waste incineration plants in the EU ETS and another country concluded a voluntary emission reduction agreement with the waste incineration sector.

Based on the publicly available information gathered, further information collected through contacts in the respective administrations, and available time and resources, it was possible to analyze in more detail the carbon tax features of the following countries, specifically for the agriculture sector: France, Ireland, Switzerland and Sweden. The focus lied on the scope of the tax within the agriculture sector, including whether any reduced rates / exemptions apply for some energy products / consumers / subsectors. It should be noted from the outset that the non-fuel combustion emissions of GHG are not covered by the carbon tax in any of the analyzed countries.

Finally, regarding waste, we have observed that none of the analyzed countries have included GHG emissions from this sector in the scope of their carbon taxes. Therefore, the following analysis only focuses on the agriculture sector. Nevertheless, the following two points regarding waste are worth mentioning:

- Sweden did include the emissions of waste incineration plants under the EU ETS, unlike other EU member states;
- Swiss legislation foresaw the inclusion of waste incineration plants in their ETS, but also provided the possibility to conclude a voluntary agreement with the sector, which is the option that the sector eventually chose. Through this agreement (signed in the end of 2014), the sector commits to the reduction of 1 million tons of CO_2 between 2010 and 2020 (through energy efficiency improvements and better recycling of metals, as well as through indirect emission reductions from heat and electricity produced through incineration of waste that replaces heat and electricity produced with fossil fuels).

France

Since 2014 (i.e. the year of introduction of the carbon tax), agricultural companies benefit from a partial reimbursement of the TICPE/TICGN on purchased natural gas, LPG, diesel used offroad and heavy fuel. Given that the amount reimbursed is equal to the difference between the applicable TICPE/TICGN and

[115] The Confederation of European Waste-to-Energy Plants

minimum tax levels per energy product, and that this reimbursement scheme was introduced before the introduction of the carbon tax, agricultural companies in practice get a full reimbursement of the carbon tax.

Ireland

When introducing its carbon tax, no exemptions or reduced rates were foreseen for agricultural companies. However, it was decided not to apply the last carbon tax increase (from 15 to 20 € / tCO_2e) to this sector.

Finally, there is a partial repayment of the Mineral Oil Tax (MOT) on fuels used in horticultural production and cultivation of mushrooms, but this measure already existed before the introduction of the carbon tax and is thus not linked to it.

Sweden

Reduced rates or exemptions from the carbon tax have been gradually phased out in Sweden. By the beginning of 2018, most of these have been completely phased out. An exception is diesel used in machinery and boats in agriculture, forestry and piscicultural works, that still benefits from a tax reduction of 1.700 SEK / 1000L (around 170 € or 50% of the full carbon tax) until the end of 2018, and of around 1.430 SEK / 1000L (around 140 €) after 2018. It should also be pointed out that the energy tax rate for heating fuels and fuels used in stationary motors in agriculture, forestry and aquaculture is 70% lower than the general energy tax level. Still, given that the carbon tax is the main tax on energy products in Sweden, the impact of this energy tax reduction on total taxation is limited and energy taxation remains highest in Sweden, when compared to the countries analyzed in detail.

Finally, in order to create an administratively simple system, all companies falling within the NACE codes defining agriculture, forestry and aquaculture benefit from the lower energy tax rates.

Switzerland

The carbon tax in Switzerland only applies to fuels (excluding biomass) used in thermal installations or as input for CHP installations. Companies performing specific activities listed in legislation, producing at least 60% of their GHG emissions through these activities and emitting in total more than 100 tCO_2e/y can, on request, be exempted from the tax on the condition that they commit to GHG emission reductions through voluntary agreements. If an exemption request is granted, companies get reimbursements.

The specific activities linked to agriculture for which exemption from the carbon tax can be requested, are the cultivation of plants in greenhouses, the processing of agricultural products for production of food and animal feed products, and the fattening of pigs and poultry.

Conclusions

Regarding the agriculture sector, we observe that only emissions from combustion fall under the scope of the carbon tax in the analyzed countries.

We can also state that there are broadly two approaches on how to apply the carbon tax to this sector in the analyzed countries: either applying a reduced rate of the carbon tax for specific activities and/or energy products (like in Sweden and Ireland), or having the agricultural companies pay the carbon tax and subsequently reimbursing them only for specific agricultural activities and if voluntary emission reduction agreements have been signed with the government (like in Switzerland), or with no specific conditions (like currently in France).

Finally, regarding waste, we have observed that none of the analyzed countries have included GHG emissions from this sector in the scope of their carbon taxes. However, one country included waste incineration plants in the EU ETS and another country concluded a voluntary agreement with the waste incineration sector.

7.3 EVALUATION OF POTENTIAL PUBLIC CARBON REVENUES

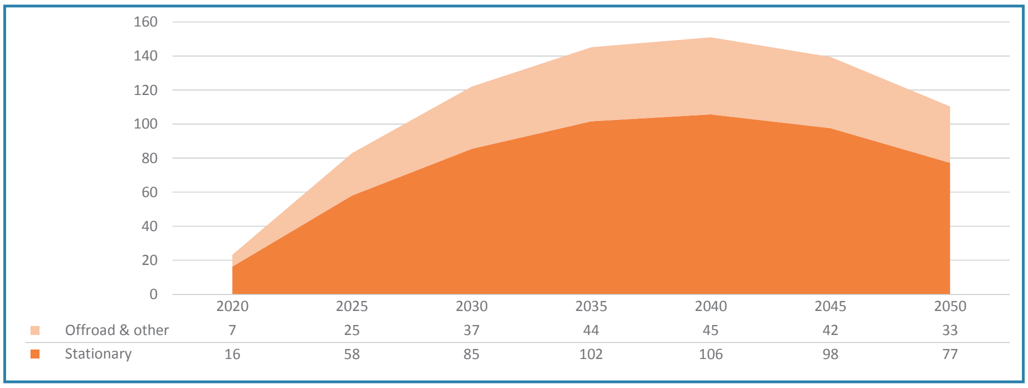
KEY MESSAGES

Estimated public carbon revenues from the agriculture sector would amount to 23 M€ in 2020 and 122 M€ in 2030.

Estimated public carbon revenues from the waste sector would amount to 30 M€ in 2020 and 159 M€ in 2030.

Given that no specific low carbon scenarios have been built for these sectors, simplifying assumptions have been made on the trajectory of emissions. It has been assumed that emissions of the sectors follow a linear trajectory between 2020 and 2050, from a level in 2020 corresponding to the 2016 level of emissions to a level in 2050 based on total (all sectors) average reduction rate in the CORE low carbon scenario[116]. On this basis, estimated revenues from carbon pricing in the agriculture sector would amount to 23 M€ in 2020, 122 M€ in 2030 and 110 M€ in 2050, representing a cumulated budget of 3,6 billion € under the carbon price trajectory « B » (prices of 10, 70 and 190 €/tCO_2 in 2020, 2030 and 2050, respectively) as illustrated in Figure 84. Further details are provided in Table A.6.3 of Appendix 6 for the three carbon price trajectories.

Figure 84: Annual carbon tax revenues in the agriculture sector (fuel combustion only) under option B (M€/year)

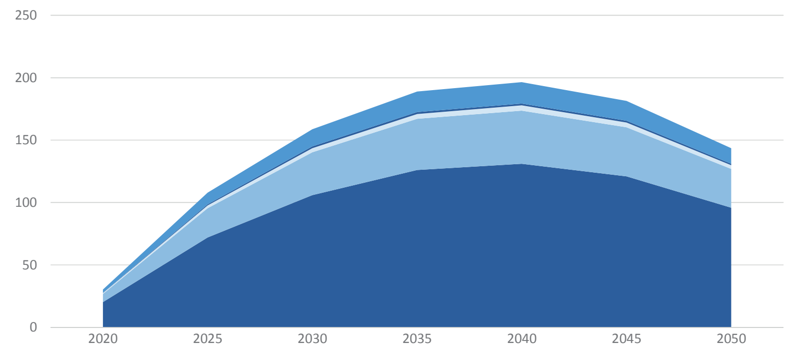


Source: Own calculations

In the waste sector, carbon revenues would amount to 30 M€ in 2020, 159 M€ in 2030 and 144 M€ in 2050, representing a cumulated budget of 4,6 billion € under the carbon price trajectory « B » (prices of 10, 70 and 190€/tCO_2 in 2020, 2030 and 2050, respectively) as illustrated in Figure 85. Further details are provided in Table A.6.4 of Appendix 6 for the three carbon price trajectories.

[116] Namely -80% between 1990 and 2050, that is -75% between 2020 and 2050.

Figure 85: Annual carbon tax revenues in the waste sector by subsector under option B (M€/year)



	2020	2025	2030	2035	2040	2045	2050
Waste water treatment and discharge	3	9	14	17	17	16	13
Incineration and open burning of waste	0	1	1	1	2	1	1
Biological treatment of solid waste	1	2	3	4	4	4	3
Solid waste disposal	7	23	34	41	43	39	31
Electricity and heat	20	72	106	126	131	121	96

Source: Own calculations

7.4 KEY IMPLEMENTATION ISSUES AND OPTIONS

Different options for each of the four identified implementation modalities emerge from all previous analyses and from discussions with key actors. These options are summarized at the end of the Section.

Scope

Agriculture

All energy-related fossil fuel emissions from non-stationary sources would be subject to the carbon price through (increased) energy taxes (biogas would not be subject to the carbon price). As seen above, these sources are most of the time exempted from taxes on energy in Belgium, which is not the case in the neighbouring countries (with the exception of Luxembourg). Revenues from such carbon pricing could then be redistributed back to the actors.

As for energy-related fossil fuel emissions from stationary sources, which mainly originate from greenhouses, an approach similar to the one proposed for the non-ETS industrial sectors is suggested. Either a carbon price would be implemented but capped at a level corresponding to the fossil fuel (gas) price gap with respect to neighbouring countries in case of risk of carbon leakage, or voluntary agreements would be signed that foresee the implementation of a carbon price (biogas would not be subject to the carbon price). Such an approach would account for both potential competitiveness issues and the fact that current fossil fuel tariffs are lower in Belgium. As for the industrial sectors, it deserves further investigation.

Finally, non-CO_2 emissions (enteric fermentation, manure management and soils) would currently be out of scope due to the difficulty to accurately measure those emissions at the source level.

Waste

While emissions from waste disposal are projected to decrease significantly, and waste and circular economy strategies at EU and regional levels should also drastically reduce the amount of waste in the years to come, we observe that emissions from waste incineration with production of electricity and heat are projected to remain at important levels around 2MtCO_2e in the mid-term. Even if substitution possibilities at the level of waste treatment are limited, introducing a carbon price would contribute to internalize the externality. Since it will, at least to some extent, be passed on to consumers, the carbon price will incentivize the reduction of the amount of waste and increased recycling of materials before incinerating the remaining waste for production of electricity and heat.

Non-energy related CO_2 emissions, originating from the incineration of waste, could thus be subject to a carbon price integrated into the current environmental incineration taxes. These environmental taxes could be converted into carbon equivalent taxes. If the carbon price trajectory is higher, the level of these environmental taxes would be raised by the corresponding gap. The main advantage of such an option is that its administration is based on an existing system that fully integrates any cross-border shopping effects as the tax is applicable to all waste from Belgian origin. Introducing carbon pricing through voluntary agreements (cf. Switzerland) is not considered as an option here as emission reduction possibilities at the source level are particularly limited.

Other sources of GHG emissions from the waste sector are projected to decline very significantly in a business-as-usual scenario. Still, the activities responsible for those emissions are not particularly exposed to international competition. Pricing those emissions could therefore be envisaged, which would then be passed on to the consumers and therefore foster alternatives, including reduced waste. As proposed for the incineration of waste, the carbon price could also here be potentially included into existing environmental taxes provided that these taxes have been decided with the purpose to reduce the amount of waste.

Price trajectory

As a main option, it is proposed that the carbon price follows the default trajectory A, B or C as described in Section 3.2.2.

Use of carbon revenues

Besides general purposes examined in Section 3.2.3[117], a first option is to devote revenues stemming from carbon pricing in the agriculture and waste sectors to **specific programs** for the (energy) transition of these sectors. Existing funds might be appropriate to serve as a vehicle for the financing of such programs. Examples include the Vlaams Landbouwinvesteringsfonds (VLIF) and the Visserijfonds.

A second option is a **lump-sum transfer** to farmers. A basis needs to be determined for such transfers. Possibilities include the cultivated surface or the workforce, with a potential differentiation according to the subsectors[118].

Finally, revenues from the implementation of a carbon price in the waste sector could be used to support measures promoting a **circular economy**.

Policy alignment

Policies to foster changes towards the consumption of agricultural products with a low(er) carbon impact are required for the agricultural sector to significantly decrease its emissions. The impacts and the feasibility of a price on the non-CO_2 GHG content of agricultural products (at product market level) could be analysed.

Agriculture has a potentially important role in maintaining carbon stocks, developing carbon sequestration and in contributing to reaching net-zero emissions trajectories. Specific policies could thus be developed in this area, including at the European level under the current reform of the common agricultural policy.

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[117] Some actors consider that the use of public carbon revenues to reduce electricity prices would not result in the same reduction of electricity prices than the price increases of gasoil and natural gas resulting from the introduction of a carbon price.

[118] Payments on the basis of cultivated surfaces could for instance differentiate open air from greenhouses cultures.

Summary

Agriculture

Emissions in 2016	12,2 $MtCO_2e$ (of which 2,3 $MtCO_2e$ from combustion of fossil fuels) 16% total non-ETS
Scope	All fossil fuel emissions; biogas, non-CO_2 emissions excluded Via component of energy taxes; if risks of carbon leakage (stationary sources), same as for non-ETS industry
Price	Trajectory A, B or C (*) Variant: ETS price or price based on benchmark energy prices with respect to neighbours in case of risks of leakage (to be assessed)
Public carbon revenues (uses)	General tax shift away from labour and/or electricity Lump-sum transfer to farmers Specific programmes for the transition, incl. existing funds (VLIF, Visserijfonds, …)
Max. expected annual revenues (trajectory B)	2020: 23 M€ 2030: 122 M€
Policy alignment	Feasibility of tax on agricultural products on basis of non-CO_2 emissions to be analysed; other consumption-oriented policies Role of the CAP in enhancing carbon sequestration in soils

(*) From 10€/tCO_2e in 2020 to 40, 70 or 100 €/tCO_2e in 2030

Waste

Emissions in 2016	3,8 $MtCO_2e$ 5% total non-ETS
Scope	CO_2 emissions from waste incineration, with a possible integration into existing environmental taxes, and non-CO_2 emissions from other sources under the waste category, with a possible integration into existing environmental taxes
Price	Trajectory A, B or C (*)
Public carbon revenues (uses)	General tax shift away from labour and/or electricity Supporting circular economy measures
Max. expected annual revenues (trajectory B)	2020: 20 M€ 2030: 106 M€
Policy alignment	Circular economy policies and waste strategies

(*) From 10€/tCO_2e in 2020 to 40, 70 or 100 €/tCO_2e in 2030

8 Fluorinated gases

The implications of setting a price on emitted fluorinated gases (F gases) are discussed in this Section. The context of the sector is first described, in terms of emissions, policy context and key characteristics. Second, the evolution of F gas prices is briefly analysed and the F gas tax schemes implemented in European countries are outlined. Finally, key implementation options are described on the basis of all these analyses and the discussions held with key actors.

8.1 CONTEXT

KEY MESSAGES

Total emissions of F gases almost reached 3 $MtCO_2e$ in Belgium in 2016.

Current legislation at international and EU levels has been adopted with the objective to progressively phase out F gases.

The largest (weighted) share of F gases is used for air conditioning and refrigeration.

Fluorinated gases (F gases) are man-made gases produced by the chemical industry. It therefore concerns chemicals that are purely synthetic and produced as a good that has a commercial value, and that can be recovered from installations for the purpose of reuse, recycling, reclamation and even destruction (RRRD). This means that these gases retain a commercial value throughout their lifetime.

They are also specific in the sense that their Global Warming Potential (GWP) ranges from 12 up to 22 800, which makes them the most powerful GHG. Still, the advantage is that they are mainly used in closed circuits, making them easier to recover.

They are usually used in refrigeration, air-conditioning and heat pumps applications, but also as fire extinguisher, solvent, or as foaming agent. HFCs were first developed as replacement refrigerant for substances controlled by the Montreal Protocol (CFCs and HCFCs). Moreover, HFCs and PFCs (and SF_6) are also substances that are integrated in the scope of the UNFCCC through which their emissions are controlled, imposing Parties to collect data about their emissions in the atmosphere. Recently, the predominant HFCs have been included in the scope of the Montreal Protocol via its Kigali amendment that will soon start with a phase-down in order to eliminate them as much as possible.

In this given international context, technologies are evolving rapidly (under the impulse of EU regulation or the Kigali Amendment) towards either new F gases with much lower GWP, Natural refrigerants or Not-in-Kind technologies. This is translated in a dramatic increase of solutions, equipment, installations relying on those innovative technologies.

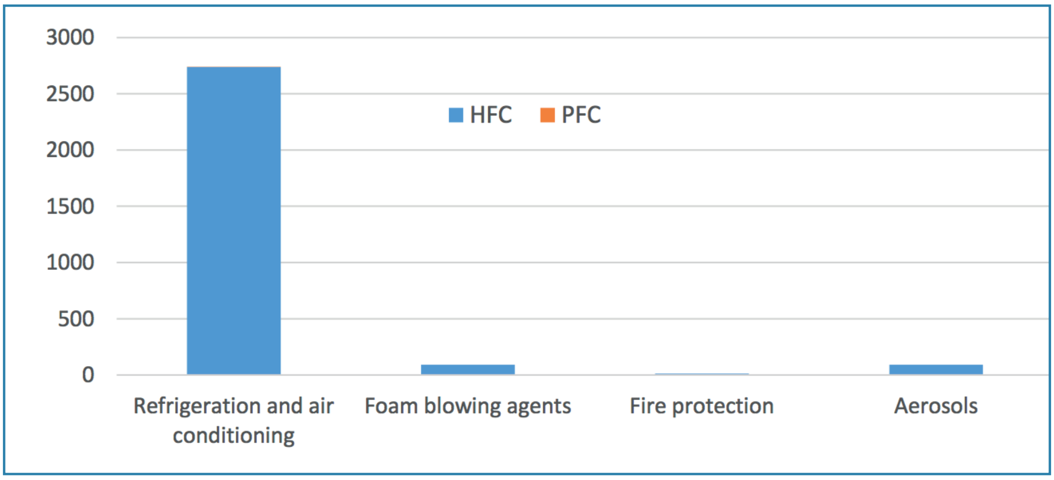
8.1.1 Emissions

As a preliminary remark, it should be stressed that while the Montreal Protocol covers F gases at the level of their production and consumption (i.e. when the substance is used), emissions of F gases are accounted for under the UNFCCC. In this context, it should be clear that gases "consumed" in applications are often not emitted at the same time, meaning that there are stocks that may last for a long time, but that could also be released at any time.

Currently, emissions of F gases represent around 2-3% of the global GHG emissions. Nevertheless, these levels are rising rapidly due to the improving standards of living and wealth of population worldwide. In that context, estimates show that emissions of F gases could reach up to 20% of global GHG emissions in 2050 if no measures are taken on F gases and the other GHG are reduced or contained.

In 2016, as can be seen in Figure 86, total emissions of F gases almost reached 3 MtCO_2e in Belgium[119]. The main sectors emitting F gases are the Refrigeration, Air Conditioning and Heat Pumps (RACHP) sector, foams and aerosols.

Figure 86: F gases emissions in Belgium, ktCO_2e, 2016



Source: NIR 2018

8.1.2 Policy context

The recent Kigali Amendment (KA) foresees a phase down of consumption and production of F gases up to 2047 (see Figure 87) as well as a licensing system (imports-exports) in 2019, prohibitions of trade with non-Parties and specific schedules and support for developing countries.

In the European Union, there is a Regulation (EU) N° 517/2014, a directive for Mobile AC (Dir 2006/40/CE) and a set of implementing acts that have foreseen a stricter phase-down going up to 2030 (see Figure 87), have a broader scope (HFCs, PFCs, SF_6), impose containment and recovery, training and certification of persons handling those gases, labelling, control the amounts through a quota system, ban different uses and prevent emissions.

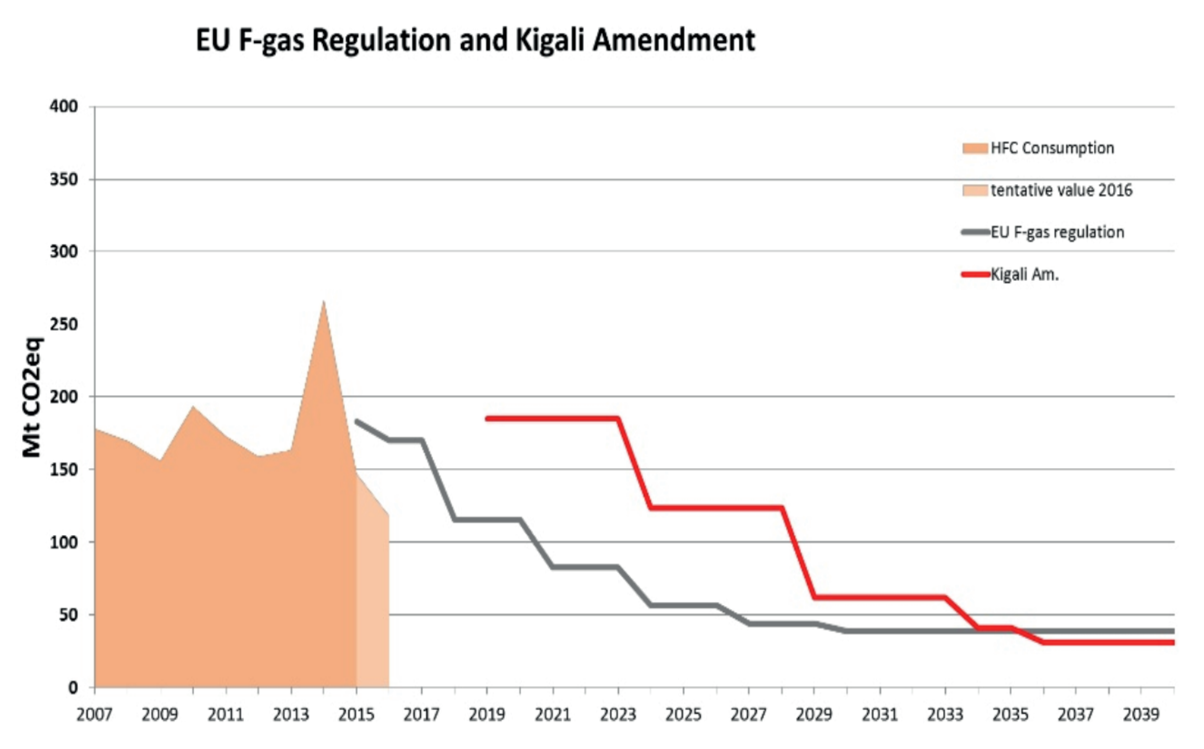
The regulation is also evolving either to adapt to the KA or to adjust the regulation to be in line with the 2050 objectives (and beyond). There are also many bans that are or will be set in place progressively, making the regulation an evolving tool.

The intention is to allow a foreseeable timetable for the industry to adapt, improve and develop alternatives, either with new fluorinated chemicals (blends and/or HFOs) or by using alternative refrigerants and technologies (like natural refrigerants such as Ammonia (NH3), Carbon dioxide (CO_2) or Hydrocarbons (HC)).

The path forward would be a mix of development of new fluorinated chemicals with a low GWP as well as the switch to the so-called "Natural refrigerants" (CO_2, NH_3 and Hydrocarbons). However, further challenges arise from these alternatives, such as a price increase of substances, bans, risks management linked to flammability or toxicity, etc.

[119] Emissions taken into account here only concern emissions from product uses as substitutes for ODS. Process emissions from industry are dealt with under the 'non-ETS industry' section.

Figure 87: Projected evolution of emissions under the EU F gas Regulation and the Kigali Amendment



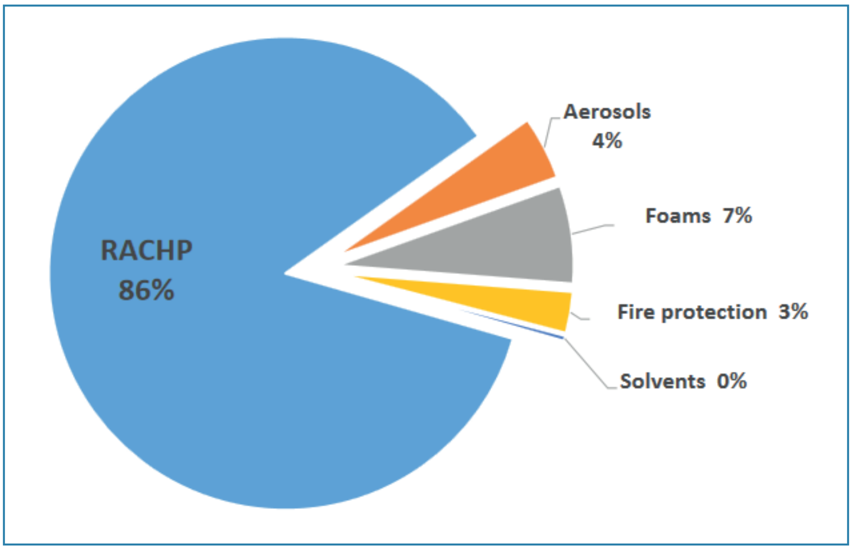
Source: F Gas Consultation Forum from the EU Commission (06/03/2018)

8.1.3 Key indicators

A specificity of F gases is that they are emitted in very specific locations: production facility, during manufacturing or installation of equipment, during operation or maintenance and finally at decommissioning or final disposal. Moreover, due to the value of the gas, it can be recovered and either recycled, reclaimed or destroyed. However, the consequence of this specificity is that it keeps a value until the end of life and could not be vented to the atmosphere depending on the will or legal context.

The use of F gases can be sorted by 'markets' of main use. Regarding HFCs, these are mainly RACHP, foam blowing, fire protection, electronics industrial cleaning and the chemical industry, as can be seen in Figure 88.

Figure 88: Markets using HFCs at global level, % of tonnes CO_2, 2012



Source: Kigali Fact Sheet 2, Ozon Action (UNEP)

As can be seen under Section 8.1.1, emissions in Belgium mainly stem from the RACHP sector. Since this sector represents such a large share of HFC use, it is important to understand the way HFC consumption is split between different sub-sectors.

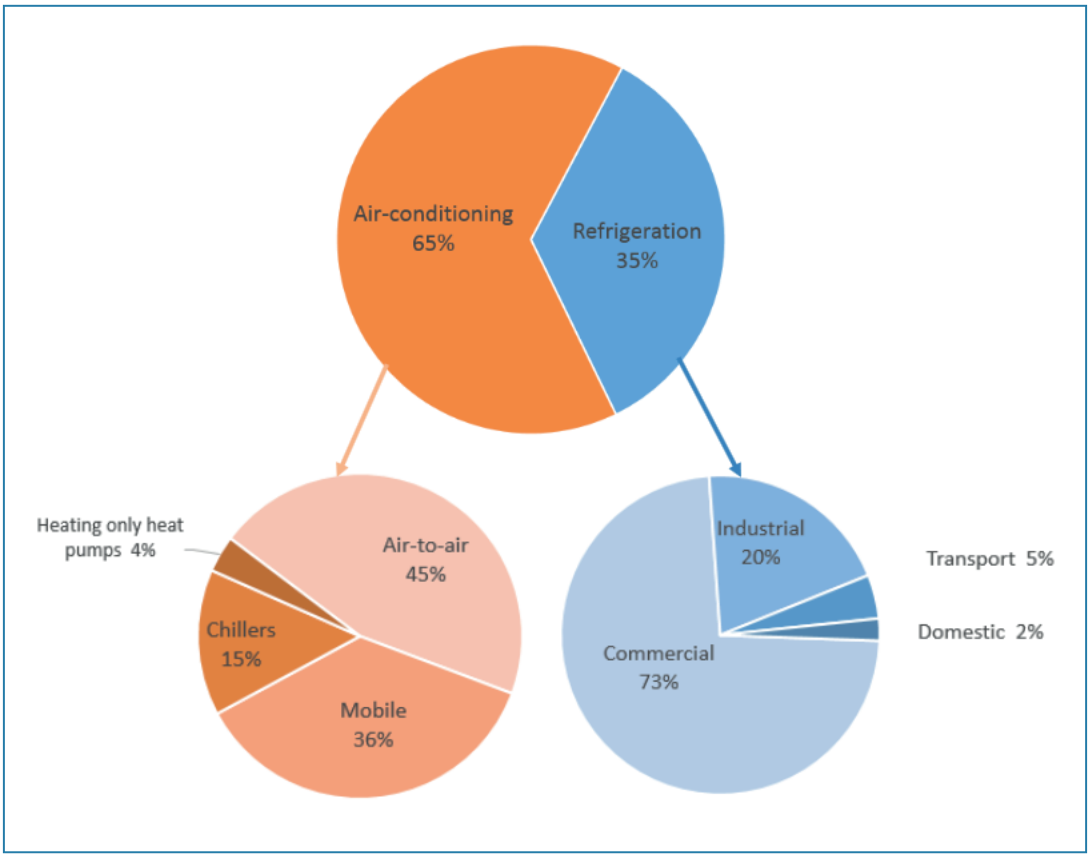
Figure 89 shows that an estimated 65% of the global GWP weighted HFC consumption in the whole RACHP market is for air conditioning, while 35% is for refrigeration.

The RACHP market can be sub-divided into four refrigeration sub-sectors and four air conditioning / heat pump sub-sectors, as illustrated in the same Figure 89 below.

Air to air conditioning systems and mobile air conditioning systems dominate the use of HFCs in air conditioning, representing around 80% of the total. The air to air sector includes a significant proportion of reversible units that operate both as air conditioners and air source heat pumps.

Commercial and industrial refrigeration systems dominate the use of HFCs in refrigeration, representing over 90% of the total.

Figure 89: HFC use in RACHP sectors (GWP-weighted), 2012



Source: Kigali Fact Sheet 2, Ozon Action (UNEP)

8.2 PRICES AND TAXES

KEY MESSAGES

Following the Montreal Protocol and its Kigali Amendment, prices of 'old' F gases tend to rise significantly.

Six European countries have implemented or are in the process of implementing a tax on F gases with diverse modalities.

8.2.1 Prices of gases

Prices of F gases are currently evolving upwards very rapidly. Several reasons that may explain these price increases have been identified.

The first element is the impact of the Montreal Protocol (phasing-out of uses and bans) on the ODS (Ozone Depleting Substances: CFC and HCFC). It has driven the production market and the manufacturing of equipment markets relying on those gases towards a switch to the so-called F gases (HFCs and PFCs).

More recently, under the Kigali Amendment (KA), the Montreal Protocol has been extended to also cover the HFCs, incentivizing the industry to leapfrog "old" HFCs and develop newer technologies relying on either HFOs or using Natural Refrigerants.

As a consequence, several recent market studies are showing a strong price increase of the "old" F gases such as R-404A, R-507 and R-410A and R-134a. The same trend is observed for HCFC-22, the main gas used in RAC sectors. As those gases are already banned or controlled in industrialized countries, sometimes through taxes based on the climate forcing potential, they are replaced by new fluorinated substances or blends with a lower GWP.

8.2.2 Lessons learned from existing F gas taxes

Six European countries have implemented or are in the process of implementing F gas taxes.

Denmark

Denmark has a tax on importation of CFC, HCFC and HFC, in bulk or in equipment/products, amounting to 150 DKK/tCO_2e (± 20 €) with a maximum of 600DKK. A refund is possible upon export. Starting in 2001, this measure had an immediate effect (huge effect on foam, less on refrigeration, imports dropped rapidly).

Spain

A tax on HFCs, PFCs and SF_6 is perceived at the end of the supply chain (i.e. at the moment filling-in equipment/products by certified technicians). It is a progressive tax that started in 2014 from 6 €/tCO_2e and that will rise up to 20€. Some limited exemptions are foreseen and the tax can be reimbursed at the end of life. The results are currently showing a reduction of 40% of the emissions, and the tax induces an increase of retrofitting of equipment and installations.

Poland

Poland has introduced a tax on HFCs, PFCs and SF_6 (as well as HCFCs and CFCs) to be paid at the time of placing on the market (0.0007 €) and in case of emissions (7.15 €). All the revenues are directed towards the Polish Environmental Protection Agency for the management of F gases.

Norway

Norway has a tax that covers the import and production of HFCs and PFCs, based on the GWP. It has been increased to 400 NOK (42 €) in 2018. Some limited exemptions exist for export and a refund is possible if the gas is destroyed.

Slovenia

The country a tax level linked to the climate impact of the gases, focusing on HFCs although other F gases are covered as well. However, following a change in the political landscape, the level of the tax has been drastically reduced since its introduction in 2013, from 16€/tCO_2e to only 0,003456€/tCO_2e, which has virtually cancelled the effect of the tax on this market.

France

France will introduce a new tax in 2019 on import and production of HFCs. This will be collected at the placing on the market and will also be based on the environmental impact. It will be introduced progressively starting from 40€/tCO_2e to reach 100 €/tCO_2e in 2030. This is expected to encourage recovery, recycling and reclamation as well as a technological switch to natural refrigerants. In order to support the latter, France is considering a compensation scheme (a tax credit of 25% is currently under discussion) in the case of investments in low or zero-GWP alternatives.

8.3 KEY IMPLEMENTATION ISSUES AND OPTIONS

Different options for the implementation modalities emerge from the previous analyses and from discussions with key actors. These options are summarised at the end of the Section.

Preliminary remarks

Given that F gases are most often not emitted at the time they are "consumed" in applications, stocks of these gases may last for a long time before being emitted. Any measure taken in this area should then consistently be applied for a long period in order to be effective and further action can be taken in order to deal with those stocks and avoid any release in the atmosphere.

The policy context described just above shows that important measures are taken at the international and especially at the EU level to progressively phase out F gases and that these measures have already a significant impact on the price of such gases. Motives for potentially introducing a price on emissions of F gases include the further support of alternatives in order to speed up the transition and the application of the polluters-pay principle.

Scope

In terms of scope, several options can be envisaged that all require further investigation before being concretely implemented. Based on experiences abroad, a GHG price could be applied on imported gases depending on the source of the substance (virgin, recycled, reclaimed) and may depend on the location of its use (Belgium, other EU Member State, non-EU Member State). Another, complementary option is to take into consideration a support for the destruction of a given amount of F gas. Anyway, the situation in Belgium (i.e. very export-oriented at the level of cooling systems, very limited production of F gases) tends to be considerably different than in the countries having introduced or currently developing a tax on F gases, including France. This should be taken into account when developing more concrete options for implementing a GHG price on F gases.

In any case, attention should be paid on avoiding traffic as well as loopholes or development of a black market.

SF_6, as a special fluorinated gas used in Medium and High Voltage Switchgear and controlled within a specific legal framework, may follow a differentiated pathway depending on the availability of alternatives.

Price trajectory

The price would be set at a level corresponding to the carbon price trajectory in the other sectors. Reduced rates could be envisaged depending on the source of the substance, for instance.

Use of carbon revenues

The revenues may be used either for general purposes or for supporting alternatives. Obviously, any refund scheme that may be set for re-export would require financing, for which the revenues could play a role.

Summary

Emissions in 2016	2,9 $MtCO_2e$. 4% total non-ETS
Scope	Possibly import of F-gases, possibly refund for destruction (to be assessed)
Price	Trajectory A, B or C (*) Reduced rates
Public carbon revenues (uses)	General tax shift away from labour and/or electricity Supporting transition towards alternatives
Max. expected annual revenues (trajectory B)	/
Policy alignment	EU Regulation on F gases

(*) From 10€/tCO_2e in 2020 to 40, 70 or 100 €/tCO_2e in 2030.

9 Transversal aspects

Preliminary insights on three transversal aspects are provided in this Section. The first of these aspects is the link between carbon pricing and air pollution, as it has already been alluded to in several sectoral analyses. The second transversal aspect has to do with the practical implementation of a carbon pricing scheme in Belgium. The last transversal aspect relates to the communication to the public.

9.1 AIR POLLUTION

Air pollution and climate change are two of the most pressing environmental challenges we face today. Furthermore, they are closely interlinked: the main sources of CO_2 emissions – the extraction and burning of fossil fuels – are not only key drivers of climate change, but also major sources of air pollutants.

Belgium is no exception. In addition to the many health and economic impacts linked to air pollution, the European Environmental Agency (EEA) estimates that exposure to air pollution caused at least 10 400 premature deaths in Belgium in 2014[120]. In addition to that, Belgium also stands to suffer from the effects of climate change, including sea-level rise and an increase in extreme weather events[121].

At the national and regional levels, a number of policy processes linked to climate change are affecting and will affect the concentration of air pollutants in Belgium and beyond. Investigating these interlinkages is therefore important, in order to provide policy makers with a window of opportunity to mitigate and reduce climate change and air pollution at the same time.

By affecting the use of fossil fuels in Belgium, the implementation of a carbon price in the non-ETS sector will undoubtedly (positively or negatively) impact the emissions of air pollutants in Belgium. Investigating the extent of this impact and its mechanisms is therefore important, in order to maximize the benefits of the measure and avoid its potential negative effects on air quality.

In this Section, we first describe the EU limit values and the World Health Organization (WHO) target values on air quality. We also analyse the Belgian context in terms of emissions of air pollutants in the main sectors, including the sectors that are not part of the EU ETS. Finally, the link between GHG emitting sectors and the emissions of air pollutants is briefly analysed.

9.1.1 Air quality objectives

KEY MESSAGES

The WHO has developed guideline values for a series of air pollutants. Today, the EU values are much less stringent than those of the WHO, but the Union aims to bring its values in line with the WHO recommendations by 2050.

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[120] EEA (2017) Air quality in Europe — 2017 report, European Environment Agency, pp.57-58. Available online on: https://www.eea.europa.eu/publications/air-quality-in-europe-2017.

[121] For more information about the impacts of climate change on Belgium, see: http://www.climat.be/fr-be/changements-climatiques/en-belgique/impacts.

European air pollution policy has a long history. In December 2013, the European Commission published its latest policy package aiming at improving air quality in Europe: the Clean Air Policy Package[122]. This set of policies includes:

- A "Clean Air Programme for Europe" with new air quality objectives up to 2030, aiming at limiting locally the concentration of the air pollutants most harmful to health.
- A revised "National Emission Ceilings Directive" with stricter national emission ceilings for the six main pollutants, aiming at pushing down background concentrations and limit transboundary air pollution.
- A proposal for a new Directive to reduce pollution from medium-sized combustion installations.

The purpose of the EU limit and target values is to identify how the best possible air quality offering maximum protection to the population in all EU-28 member states can be achieved in the most cost-effective way. In the medium term, the Commission's objective is to reduce the number of premature deaths resulting from excessively high concentrations of PM or O_3 and the surface area of ecosystems exceeding the critical values by 52% and 35% respectively by 2030, compared with 2005.

For its part, and based on a synthesis of information from scientific papers on the health impact of air pollution, the WHO developed guideline values for a series of air pollutants. These values were published for the first time in 1987 and were reviewed in 2005.

Today, the EU values are less stringent than the health protection guideline values of the WHO (see Table 15). However, the EU aims to bring its values in line with the WHO recommendations by 2050[123].

Table 15: EU limit and target values for pollutants vs WHO air quality guideline values

Limit and target values for pollutants according to Directive 2008/50/EC			
Pollutant	**Averaging period**	**Maximum number of exceedances**	**Value**
PM_{10}	1 day (starting in 2005) Year (starting in 2005)	35	50 µg/m³ 40 µg/m³
$PM_{2.5}$	Year (starting in 2015) Year (starting in 2020)		25 µg/m³ 20 µg/m³
NO_2	1 hour (starting in 2010) Year (starting in 2010)	18	200 µg/m³ 40 µg/m³
SO_2	1 hour (starting in 2005) 1 day (starting in 2005)	24 3	350 µg/m³ 125 µg/m³
Air quality guideline values of the World Health Organisation			
Pollutant	**Averaging period**	**Maximum number of exceedances**	**Value**
PM_{10}	1 day year	3	50 µg/m³ 20 µg/m³
$PM_{2.5}$	1 day year	3	25 µg/m³ 10 µg/m³
NO_2	1 day year	0	200 µg/m³ 40 µg/m³
O_3	8 hours	0	100 µg/m³
SO_2	10 minutes 1 day	0	500 µg/m³ 20 µg/m³

122 More information on this can be found on http://ec.europa.eu/environment/air/clean_air/index.htm.
123 Annual Report 2016 of the Belgian Interregional Environment Agency (IRCEL-CELINE).

Given the long-term horizon of this debate and the public policy relevance of these limit value levels, it was decided to systematically refer to both of them throughout this document.

9.1.2 Belgian context

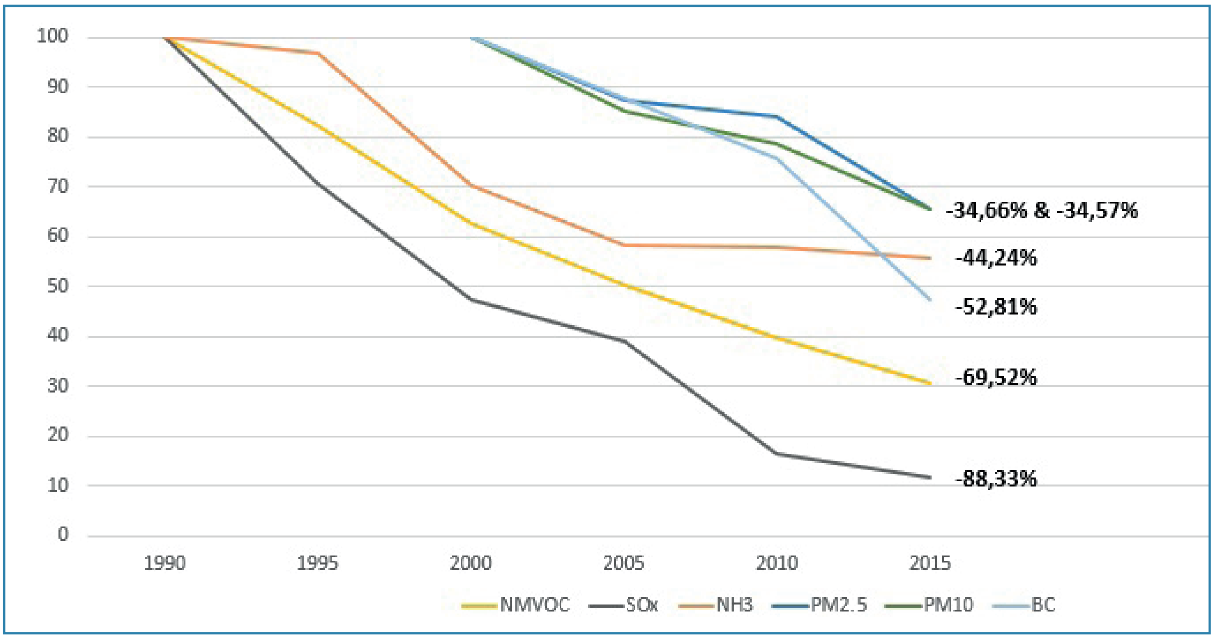
KEY MESSAGES

The transport sector is a large emitter of NOx, especially due to the high proportion of diesel cars on the Belgian roads. Emissions of particulate matter in this sector are not only linked to the burning of fossil fuels: non-exhaust emissions from tyres, brakes and road abrasion are also significant sources of pollution.

The buildings sector is a significant source of PM2.5, PM10 and black carbon. This is mainly due to the incorrect use of biomass for domestic heating.

Over the past couple of years, air quality measurements measured through the telemetry networks of the Flemish, Walloon and Brussels-capital region show a regular decrease in the concentrations of all air pollutants, in comparison with the year 1990 or 2000 (see Figure 90). In Belgium, the situation is therefore undeniably improving and, today, most European standards are respected in our country.

Figure 90: Emissions of air pollutants in Belgium (from 1990 or 2000, in %)



Source: NEC 2017

However, while air pollution remains most of the time below the levels prescribed in the EU air quality legislation, their concentration also exceeds most of the more stringent, health-related, levels set by the World Health Organization (see Figure 91). Respecting EU standards can therefore not be the end objective, especially if the goal is to protect human health. In light of this, and given the significant estimated adverse health impact that air pollution has in our country, substantial efforts still need to be made in this regard.

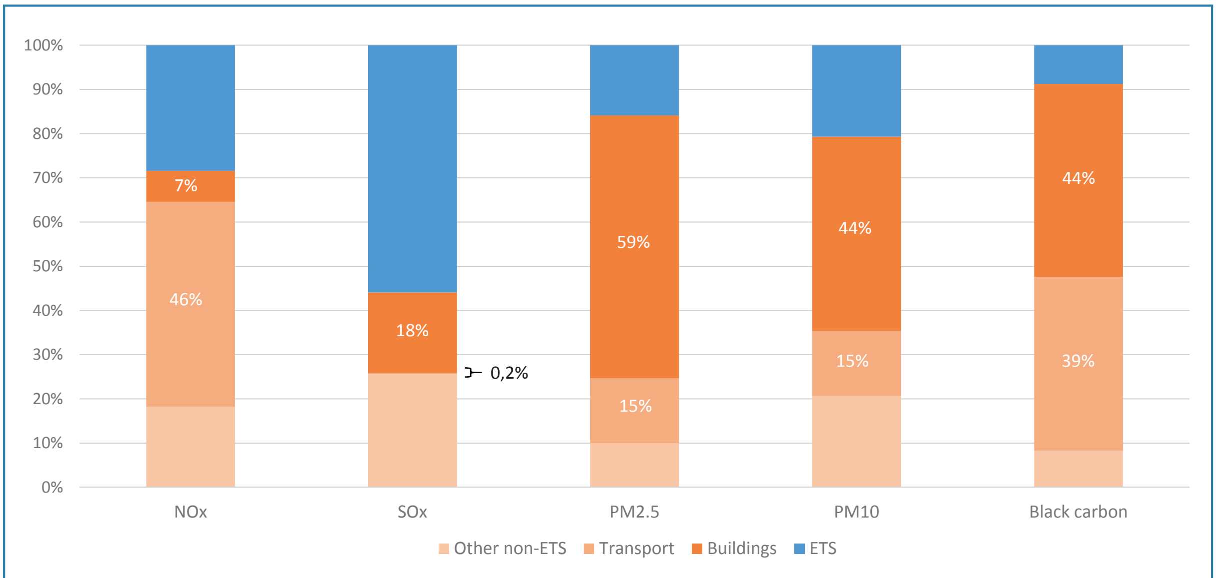
Figure 91: Respect of the EU limits and WHO target values on air pollution in Belgium[124]

Average time	1-hour		Max 8-hour		24-hour		Year	
	EU	WHO	EU	WHO	EU	WHO	EU	WHO
SO_2	☺	☺			☺	☹		
NO_2	☺						☹	☹
PM_{10}					☺	☹	☺	☹
$PM_{2.5}$						☹	☺	☹
O_3			😐	☹		☹		

Source : IRCEL/CELINE

According to the latest EU reporting exercises published by Belgium[125], the non-ETS sectors are major emitters of air pollutants in Belgium. As such, the shares of NOx, PM2.5, PM.10 and black carbon emitted by the non-ETS sectors are all above 70% of the total emissions (respectively 71,5%, 84,1%, 79,3% and 91,2%), while SOx remains in majority emitted by sectors already covered by the EU ETS. The transport and building sectors, in particular, are important sectors of emissions. Together, they represent more than half of the Belgian emissions for most air pollutants (see Figure 92).

Figure 92: Source of emissions of air pollutants in Belgium, 2015



Source: NEC 2017

It is, however, important to note that while reducing emissions of air pollutants in Belgium will have a positive impact on their concentration, the effect will not be linear. Air pollution in our country is indeed also impacted by transboundary sources, meteorological conditions and various complex atmospheric reactions[126].

124 In this table, a green smiley means that concentration in Belgium are currently below the limits/target value and will also be respected in the future. A blue smiley means that most of the concentrations measured in Belgium are below the target values, except during years with unfavorable meteorological conditions, and that it is unclear yet whether the limits/target values will be respected in the future. A red smiley means that concentrations in Belgium are above the limits/target values and will not be respected without additional emission reduction measures.

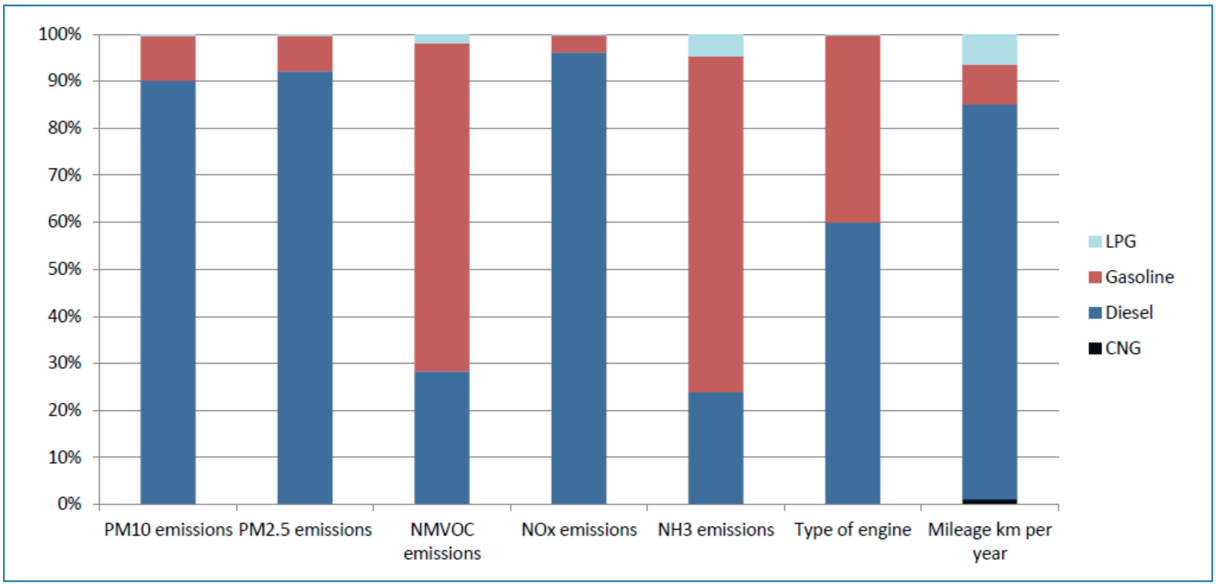
125 See: http://cdr.eionet.europa.eu/be/eu/nec_revised/inventories/.

126 Belgian Interregional Environment Agency – IRCEL/CELINE (2016) Annual Report. Available online: http://www.irceline.be/fr/documentation/publications/annual-reports.

Sectoral analysis: transport sector

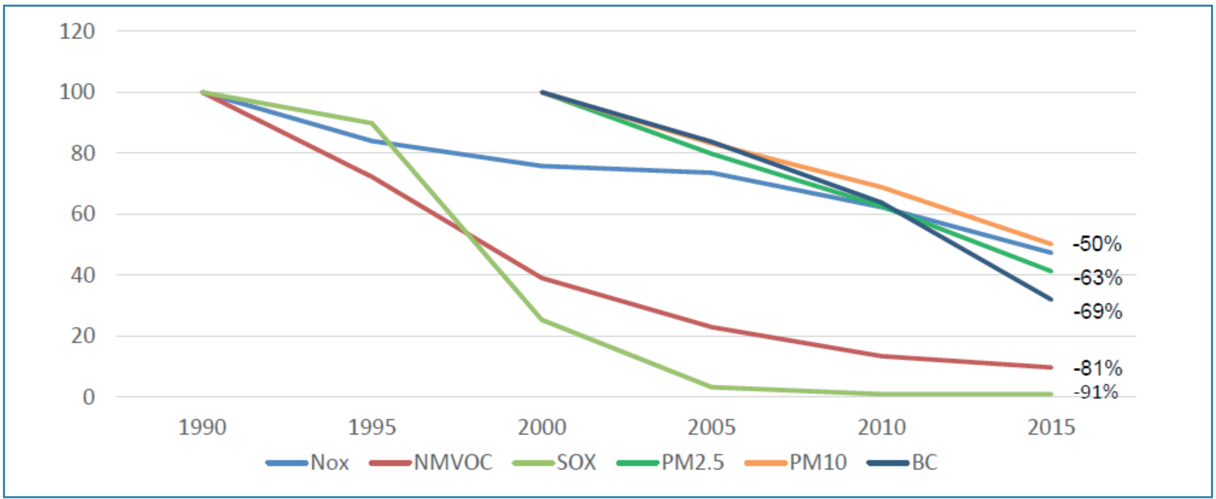
Today, the transport sector is a significant source of NOx (46,4%) and black carbon (39,2%) pollution. While approximately 60% of the vehicles in Belgium are diesel-powered, this fuel technology is the source of more than 90% of particulate matter emissions and of 95% of NOx emissions in the road transport sector (see Figure 93). This is linked both to the higher number of kilometres that these vehicles drive every year and to the technology itself.

Figure 93: Share of fuels in road transport emissions in Belgium



Source: NEC 2017

Figure 94: Evolution of the emissions from the road transport sector (from 1990 or 2000, in %)

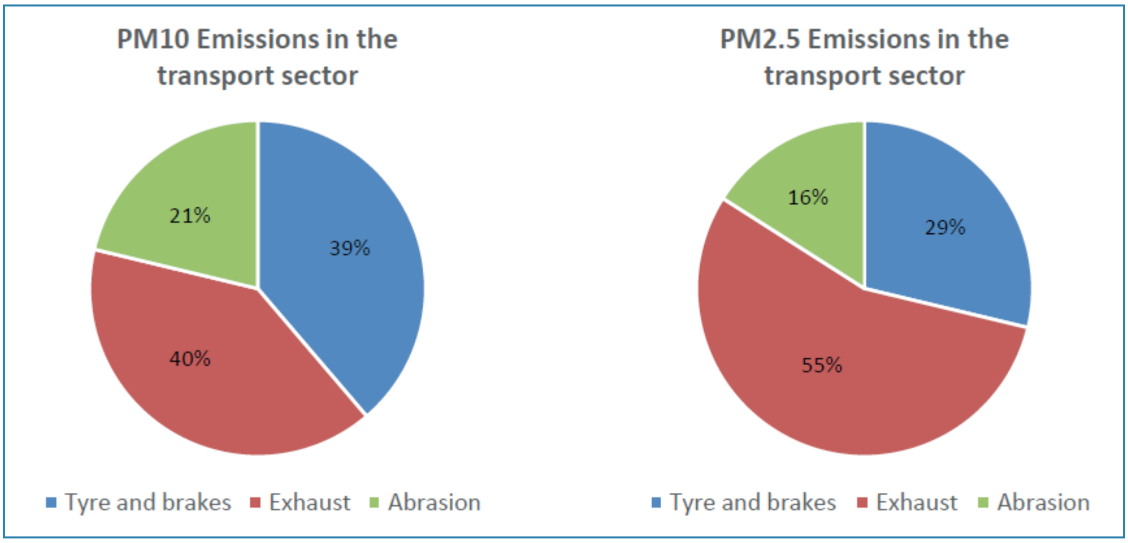


Source: NEC 2017

Similarly as in other sectors, emissions of air pollutants originating from the transport sector have diminished over the past couple of years (see Figure 94), mainly due to the implementation and adoption of new measures and technologies (fuels with low sulphur content, unleaded petrol, catalytic converters, particulate filters, Euro standards,…). However, while the observed decrease of PM emissions can be linked to the introduction of diesel particulate filters (since Euro 5/6), it is important to note that the NOx emissions in this sector did not decrease as much as expected.

Moreover, the emissions of particulate matter in the transport sector are not only linked to the burning of fossil fuels. Non-exhaust emissions from tyre, brakes and road abrasion are also significant contributors (see Figure 95). Technological changes such as switching to electric vehicles will therefore not completely solve the issue of particulate matter emissions in the transport sector, and modal change measures aiming at reducing traffic volumes should therefore seriously be considered in this regard.

Figure 95: Origin of emissions of particulate matter in the transport sector

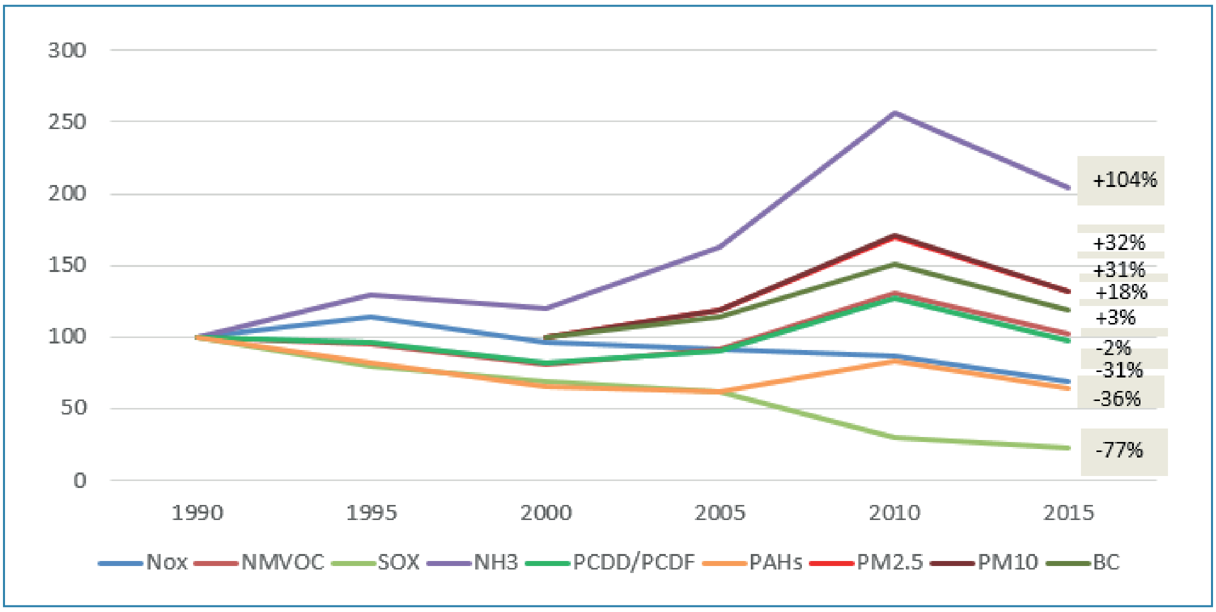


Source: NEC 2017

Sectoral analysis: buildings sector

Today, the buildings sector is a significant source of PM2.5 (59,4%), PM10 (43,9%) and black carbon (43,6%) pollution in Belgium. Unlike other sectors, the emissions of all pollutants in this sector do not follow a clear downward trend (see Figure 96): while the emissions of some pollutants (SO_2) are diminishing, other pollutants are stable or increasing (PM2.5, PM10, black carbon). It is, however, important to note that the emissions in this sector are closely related to weather conditions and can vary from one year to the other.

Figure 96: Evolution of the emissions from the buildings sector (from 1990 or 2000, in %)

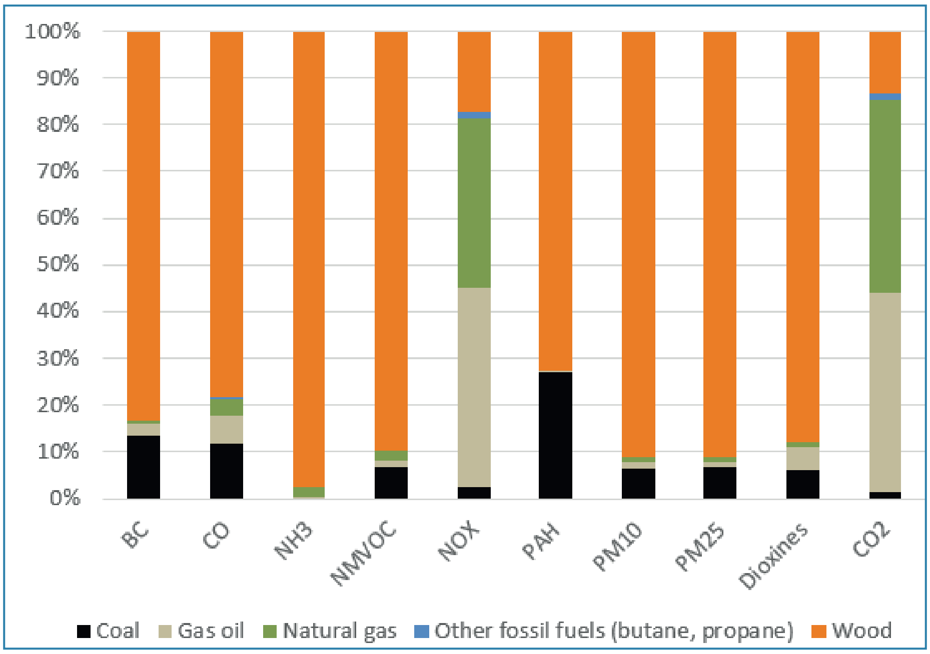


Source: NEC 2017

The emissions of air pollutants from domestic heating strongly depend on the combustion technology used. As shown in Figure 97, the incorrect use of biomass in the residential sector is the main source of pollution for most pollutants considered.

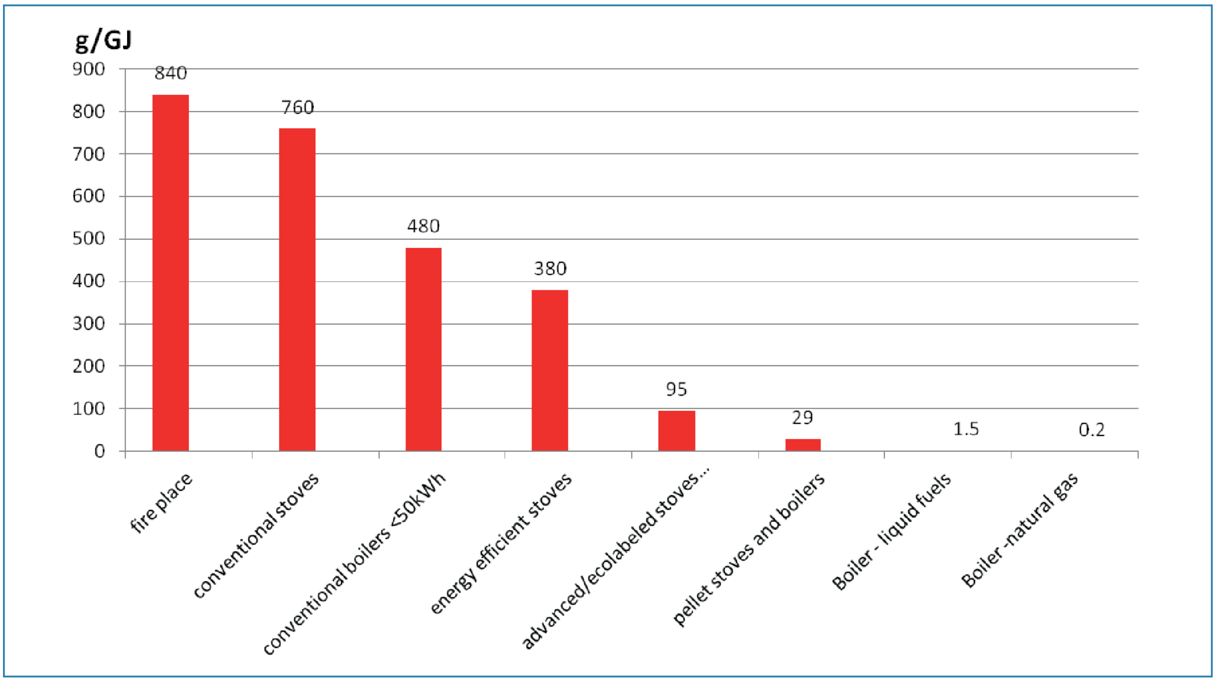
Therefore, if it leads to an increase of the incorrect use of biomass for domestic heating (for instance the untreated use of wood in fire places or conventional stoves/boilers), the implementation of a carbon price could increase the emissions of some air pollutants stemming the Belgian residential combustion sector (see Figure 98), and would have a negative health impact, especially in cities. This constitutes a major point of attention that any public authority engaged in the design of a carbon pricing mechanism in this sector should take into account.

Figure 97: Share of fuels in residential combustion emissions in Belgium



Source: NEC 2017

Figure 98: Emission factors PM10 per combustion technology



Source : EMEP/EEA air pollutant emission inventory guidebook (2016)

9.1.3 Expected impact of the low carbon transition on air pollution

KEY MESSAGES

Climate change and air pollution are two closely interlinked issues. Studying the impact of climate change mitigation measures on air pollution is therefore extremely relevant. It is also necessary to ensure full coherence between air pollution control and climate mitigation policies.

While most low-carbon measures will have a positive impact on air pollution by reducing the amount of fossil fuel burned, this relationship is not always linear. For example, while the transition towards more active, shared and electric means of transportation might potentially have a positive impact on air quality, analyses made in the context of this debate show that if it leads to an increase of biomass used for domestic heating, measures aimed to spur the low-carbon transition in the buildings sector could potentially have a negative impact on the emissions of several air pollutants in Belgium.

Further studies therefore need to be made on the links between the low-carbon transition and its overall impact on air quality, in order to identify the many positive co-benefits connected to specific mitigation measures, but also to identify the sectors where particular attention points have to be kept in mind. This might, given the growing importance that citizens and policy makers have attributed to air quality over the past couple of years, increase the acceptability by the Belgian population of implementing low-carbon measures, including a carbon pricing mechanism.

9.2 PRACTICAL IMPLEMENTATION

KEY MESSAGES

Practical implementation issues mainly relate to the scope of carbon pricing and to the use of its revenues.

One of these issues is how carbon pricing revenues generated at the federal level might be transferred to the regional authorities. Exploratory analyses suggest that different avenues can be followed.

These issues have neither been analysed nor discussed in detail. Therefore, this section only intends to provide a few preliminary thoughts on these issues.

A first type of practical implementation issues is of administrative nature and relates to the practical implementation of the carbon price. For the sectors where carbon pricing would be implemented through a component of current excise duties, only few practical arrangements would probably be necessary. In the transport sector, if and when the carbon price is implemented via a road pricing system, it should be foreseen that the latter already integrates the necessary practical aspects such as, for instance, the link between the carbon price and the estimated consumption of the different vehicles. In the non-ETS industrial sectors, the concrete implementation of the price requires to either define and concretely assess criteria to determine the extent to which a sector is at risk of carbon leakage (and the collection of the required data at a sufficiently detailed level), or to establish the most appropriate way to introduce the carbon price into potentially new voluntary agreements. As for the other sectors, in particular the waste sector and the F gases, further research is required to determine in practice the most appropriate manner to set the carbon price on the corresponding sources of emissions.

In terms of the allocation of revenues from carbon pricing, practical implementation issues will also depend on the options retained. In the case of a reduction of the cost of labour, a natural candidate is the rate of social security contributions. Practical arrangements are needed to determine whether contributions from employers, employees or both should be reduced, and, more fundamentally if such reductions should be targeting specific groups (less qualified workers, for instance), and if so, on the basis of which criteria. In the case of a reduction of the electricity price, the appropriate charges and levies to be reduced need to be determined and potential links with existing uses of the proceeds from these charges and levies need to be made.

As to the important aspect of allocating part of the carbon revenues to account for (increased) energy poverty, different avenues have been suggested. For the implementation of energy vouchers for instance, it needs to be examined to what extent existing institutions would be able to administer the system or if a new agency needs to be created. Any lump-sum redistribution to households also requires further analyses, for instance the possibility to make use of personal income taxation for that purpose.

Finally, several options foresee the use of the proceeds to support specific sectors or domains of the energy transition (support to SMEs, investment in transport infrastructures, renovation programmes, etc.). The retained options will all raise practical implementation questions that will often require co-ordination between different political levels.

All of this raises the question of how (part of the) carbon pricing revenues generated at the federal level might be transferred to the regional authorities whenever the situation requires it. Exploratory analyses included in Box 1 below suggest that different avenues can be followed.

Box 1: Preliminary analysis on the possible avenues to transfer carbon pricing revenues generated at the federal level to the regional authorities

An important, transversal aspect related to the imbrication of policies and measures at different levels deserves particular attention. Indeed, several options envisage the implementation of the carbon price via the introduction of a carbon component in excise duties, which falls under the competences of the federal authority. At the same time, many options foresee the allocation of at least part of the revenues from carbon pricing to the financing of specific transition policies, a number of which are within the competences of the Regions. This raises the question of how carbon pricing revenues generated at the federal level might be transferred to the regional authorities.

A thorough analysis of this issue could not been performed. Yet, preliminary investigations show that several avenues can be followed.

The most straightforward legal solution lies in a modification of the Special Financing Act (LSF-BFW) which organises the financing of the Communities and Regions. The federal authority could raise a tax on the basis of its competencies and the LSF-BFW could provide for the allocation of a portion of revenues to the regional authorities. Amending the LSF-BFW would require a qualified majority in parliament (2/3 of the voices and majority in each language group).

Another option might be the conclusion of a co-operation agreement between the Federal State and the regions on the basis of Article 92a, §1, para. 1 of the LSRI-BWHI, which states that "[t] he State, [...] and the Regions may enter into co-operation agreements which include, inter alia, [a] joint establishment and management of joint services and institutions, [b] the joint exercise of own competences, or [c] on the development of joint initiatives ". It is therefore on the basis of 92 bis, §1 LSRI-BWHI that a cooperation agreement could be concluded between the federal State and the Regions. At first glance, pending in-depth examination, the wording of this provision and more specifically the possibility of undertaking "joint initiatives" suggests that the collection of the tax would be ensured by the federal government, and that the use of revenues would support low-carbon initiatives in areas of regional competence.

According to Article 92bis, §1, paragraph 2 of the LSRI-BWHI, the agreement will a priori be subject to the assent of the federal legislator, since the imposition of a tax falls within the competence of the legislator. It might also be subject to the approval by regional decree / ordinance, to the extent that the Regions would also mobilize competences of the regional legislator. In both cases, a cooperation agreement would be subject to approval by simple majority approval in federal and regional legislative assemblies.

The development of such a cooperation agreement would thus require the definition of the competences mobilized within the federal state (e.g. taxation on fuels) and within the Regions (e.g. rational use of energy), and the definition of the structure of the agreement .

Precedents for organizing the collection of the federal tax and redistributing to the regions in such a manner exist.

One can also envision the creation of a common institution governed by detailed rules of governance, operation, financing and control . It is also important to note that such a 'voluntary' cooperation agreement, based on Article 92a, §1 LSRI-BWHI, is subject to the possibility of unilateral amendment, unless the co-operation agreement expressly provides for the creation of a co-operative jurisdiction, which is capable of rendering ineffective any unilateral norm which would modify the content of the agreement. Article 92 bis, §5 of the LSRI-BWHI provides for the creation of such jurisdictions..

To conclude, several avenues could in principle be followed to implement the redistribution of proceeds perceived at the Federal level to the Regions. They, however, deserve further investigation as they are relatively novel.

9.3 COMMUNICATION TO THE PUBLIC

KEY MESSAGE

An appropriate communication strategy towards the public, that starts even before the implementation of a carbon price and that is regularly ensured following its implementation and periodic assessment, is perceived by many actors as critical for the support of the measure and for it to deliver its full potential.

A growing field of interdisciplinary research including economics, political sciences and psychology, starts analysing the communication aspects of carbon pricing (Lachapelle, 2017). According to Carattini et al. (2017), the main reasons why individuals may dislike carbon taxes are:

"• Considering the burden of the tax, both personally and to the wider economy, to be too high and objecting to the more coercive nature of taxation, compared with subsidies.

• Concern about the regressive nature of carbon taxes – that is, their disproportionate negative impact on low-income households.

• Not believing that carbon taxes will be effective in reducing greenhouse gases.

• Distrusting government and viewing carbon taxes as a backdoor way of raising government revenue, rather than as an incentive to reduce emissions. "

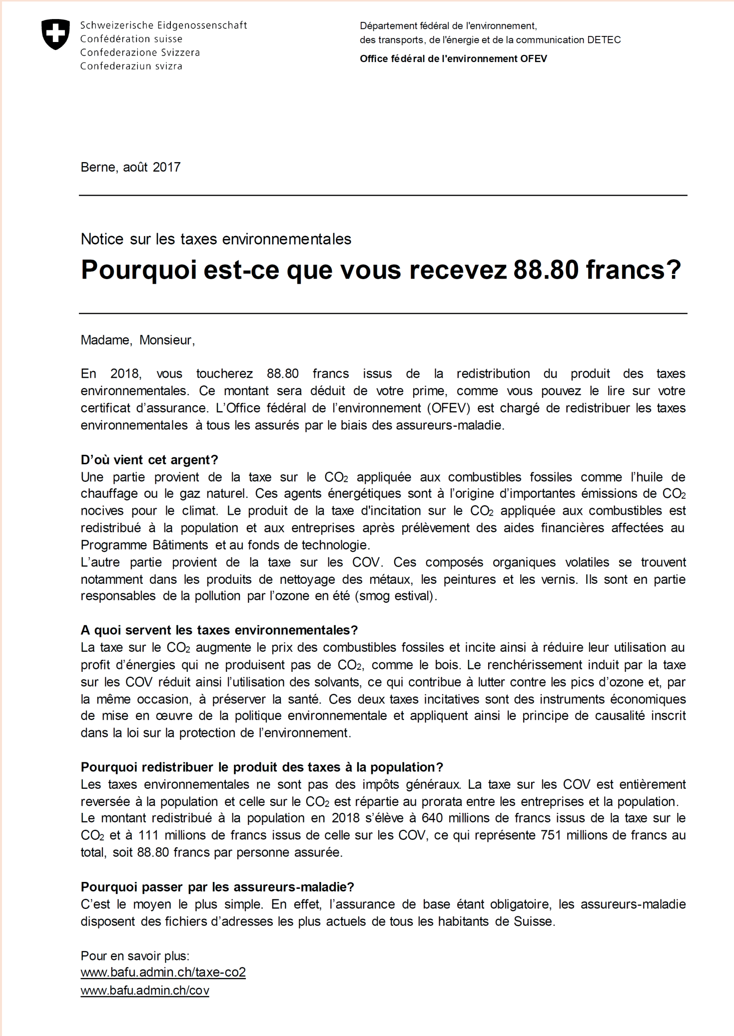
As we have seen, different options exist to implement a carbon price/carbon tax that can alleviate the potential regressivity concern, ensure its effectiveness and favour the earmarking of revenues, which would in principle increase the acceptability of a carbon price in Belgium.

Moreover, several countries have decided to set a whole trajectory for their carbon tax in advance (see Section 3.2.2), which can prove to be an essential element for the carbon price to play its role in guiding low carbon investments. Political credibility of such long term commitment can be increased by setting the most appropriate framework and by clearly communicating on it to the public.

An appropriate communication strategy on these aspects is seen as an important success factor. In particular, communication on the impacts at the level of individuals (such as average impact on energy bill and impact on low income households) is essential, as is communication on the compensation measures and on low carbon alternatives.

Box 2. Communication in the context of the Swiss carbon tax.

As mentioned in Section 4.2.2, Switzerland redistributes a large share of its carbon tax revenues directly back to the citizens. A fixed amount of money is transferred on the social account of each citizen. On that occasion, each person receives an official letter explaining why they receive that amount and what the role of the carbon tax is.



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Département fédéral de l'environnement,
des transports, de l'énergie et de la communication DETEC
Office fédéral de l'environnement OFEV

Berne, août 2017

Notice sur les taxes environnementales

Pourquoi est-ce que vous recevez 88.80 francs?

Madame, Monsieur,

En 2018, vous toucherez 88.80 francs issus de la redistribution du produit des taxes environnementales. Ce montant sera déduit de votre prime, comme vous pouvez le lire sur votre certificat d'assurance. L'Office fédéral de l'environnement (OFEV) est chargé de redistribuer les taxes environnementales à tous les assurés par le biais des assureurs-maladie.

D'où vient cet argent?
Une partie provient de la taxe sur le CO_2 appliquée aux combustibles fossiles comme l'huile de chauffage ou le gaz naturel. Ces agents énergétiques sont à l'origine d'importantes émissions de CO_2 nocives pour le climat. Le produit de la taxe d'incitation sur le CO_2 appliquée aux combustibles est redistribué à la population et aux entreprises après prélèvement des aides financières affectées au Programme Bâtiments et au fonds de technologie.
L'autre partie provient de la taxe sur les COV. Ces composés organiques volatiles se trouvent notamment dans les produits de nettoyage des métaux, les peintures et les vernis. Ils sont en partie responsables de la pollution par l'ozone en été (smog estival).

A quoi servent les taxes environnementales?
La taxe sur le CO_2 augmente le prix des combustibles fossiles et incite ainsi à réduire leur utilisation au profit d'énergies qui ne produisent pas de CO_2, comme le bois. Le renchérissement induit par la taxe sur les COV réduit ainsi l'utilisation des solvants, ce qui contribue à lutter contre les pics d'ozone et, par la même occasion, à préserver la santé. Ces deux taxes incitatives sont des instruments économiques de mise en œuvre de la politique environnementale et appliquent ainsi le principe de causalité inscrit dans la loi sur la protection de l'environnement.

Pourquoi redistribuer le produit des taxes à la population?
Les taxes environnementales ne sont pas des impôts généraux. La taxe sur les COV est entièrement reversée à la population et celle sur le CO_2 est répartie au prorata entre les entreprises et la population.
Le montant redistribué à la population en 2018 s'élève à 640 millions de francs issus de la taxe sur le CO_2 et à 111 millions de francs issus de celle sur les COV, ce qui représente 751 millions de francs au total, soit 88.80 francs par personne assurée.

Pourquoi passer par les assureurs-maladie?
C'est le moyen le plus simple. En effet, l'assurance de base étant obligatoire, les assureurs-maladie disposent des fichiers d'adresses les plus actuels de tous les habitants de Suisse.

Pour en savoir plus:
www.bafu.admin.ch/taxe-co2
www.bafu.admin.ch/cov

The communication should start already before the implementation of the measure. According to Carattini et al. (2017):

"As soon as policymakers start considering the design of a carbon tax, they should simulate its effects on a wide range of social and economic outcomes, and use the information from these simulations to navigate the process of public consultations, and to pre-emptively address voter concerns about the carbon tax. This disclosure should occur before voters are called to ballot, and before lawmakers consider a bill. Providing these modelled results through different, trusted, information channels and devices may ensure that the public debate about the effects of a carbon tax is based on the best available evidence."

Finally, once implemented, the measure should be regularly assessed and such assessment should be largely communicated, including on the use of revenues, for the perception of the carbon price to improve over time. A good example of large communication on the carbon tax and its use of revenues is Switzerland, as can be seen in Box 2.

10 Summary of the options and perspectives

In 2015, by adopting the Paris Agreement, its signatories committed to holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. In order to meet this ambition, it is urgent to take the necessary steps to significantly reduce, and ultimately phase out, greenhouse gas emissions. A series of strong, coordinated policies and measures at different levels needs to be implemented. The pricing of carbon or GHG emissions is one such potential measure that is regarded by most academics and policy experts as an efficient measure, central to any effective climate policy package, and is therefore currently being adopted by an increasing number of countries around the world. Leading experts consider that the appropriate carbon price lies in the range of at least 40-80 US$/t$CO_2$e in 2020 and 50-100 US$/tCO_2e in 2030.

The national debate shows that implementing, in the short term, a carbon price in Belgium in the sectors that are not part of the EU ETS could be a key policy to gradually drive our economy towards low carbon alternatives. It also shows that, beyond the principle of pricing greenhouse gas emissions, the modalities of implementation are essential for the success of the measure and for its support by most if not all actors.

In particular, the following principles should be taken into account when looking at the different implementation modalities of a carbon price. First of all, the long term perspective should be considered from the outset. The purpose of implementing a carbon price should not be to penalize and impose a burden on actors in the short term, but rather to set a credible price signal to progressively orient the decisions of citizens, companies and institutions towards low carbon behaviours and investments. Secondly, the notion of budget neutrality should be taken into account when the substantial amount of public revenues that can be raised by the instrument are considered. The results of the debate clearly show that the use of those revenues for specific and well-defined purposes, rather than to support the general budget for instance, is a key success factor for the concrete implementation of carbon pricing. Finally, any successful pricing of carbon emissions requires the concomitant implementation of many specific measures at different levels. The coordination of those measures and of their financing, in particular between the federal and regional authorities, is also essential.

Key carbon pricing implementation options have been drawn for each sector on the basis of those principles, sectoral analyses and thorough discussions with stakeholders. Table 16 below summarises these options.

The analysis of the way other countries have implemented carbon taxes reveals that most of them have opted for an increasing carbon price trajectory and the progressive broadening of its scope. Almost all of them do cover the two main emission sectors, buildings and transport, while the other sectors are currently diversely covered.

In the buildings and transport sectors, the comparison of final energy prices in Belgium with the neighbouring countries shows that, except for (non-professional) diesel, fossil fuel prices are in general relatively lower, often due to lower taxes, while electricity prices are higher. The main options identified for the implementation of a carbon pricing in Belgium in these sectors are limited and rather clear-cut. The analyses show that, for the options identified, the impact of carbon pricing is manageable, especially when carbon pricing revenues can be used to compensate for its potential adverse impacts and to finance complementary measures. Only few practical implementation issues remain open and lessons from practical implementations abroad can be inspiring in this respect. Policy alignment, including on air pollution measures, will have to be duly considered and ensured.

Table 16: Summary of the key implementation options

	Emissions in 2016	Scope	Price	Public carbon revenues (uses)	Max. expected annual revenues (trajectory B)	Policy alignment
Buildings	23,0 $MtCO_2e$ 31% Tot nETS	All fossil fuel emissions (oil, gas, coal), biomass excluded Via component of energy taxes	Trajectory A, B or C (1)	General tax shift away from labour and/or electricity Lump-sum transfers to and financing of targeted policies for people at risk of energy poverty Lump-sum transfers to all citizens Renovation programmes Support to SMEs	2020: 220 M€ 2030: 939 M€	Renovation strategies, incl. policies targeting people at risk of energy poverty Air pollution policies (incl. biomass) Specific fiscal reforms, including: ➤ removing exemptions/ reduced rates on fossil fuels ➤ reforming the Revenu Cadastral/Kadastraal Inkomen and the Onroerende voorheffing/ Précompte Immobilier, ➤ reform of VAT level (new built, renovation) ➤ reform of Registratierechten/ droits d'enregistrement
Transport	26,3 $MtCO_2e$ 35% Tot nETS	All fossil fuel emissions (petrol, diesel, gas) Via (Option 1) component of energy taxes and, for freight transport, potentially via road pricing for the part of the carbon price above benchmark with neighbouring countries or (Option 2) road pricing if/when fully implemented;	Trajectory A, B or C (1) Variant: initial carbon price level implemented within current taxation levels	General tax shift away from labour and/or electricity Passenger transport revenues: ➤ Lump-sum transfers to all households ➤ Infrastructure investments ➤ Promotion of low carbon transport modes (incl. electric mobility, public transport and 'soft modes' like walking and bicycle) Freight transport revenues: ➤ Infrastructure investments (incl. multi-modality) ➤ Fund for technological innovation and deployment (all modes)	2020: 289 M€ 2030: 1146 M€	Road pricing for cars, potential extension of current road pricing for freight Company cars fiscal treatment Air pollution policies Other transport taxes and subsidies

	Emissions in 2016	Scope	Price	Public carbon revenues (uses)	Max. expected annual revenues (trajectory B)	Policy alignment
Agriculture	12,2 $MtCO_2e$ 16% Tot nETS	All fossil fuel emissions; biogas, non-CO_2 emissions excluded Via component of energy taxes; if risks of carbon leakage (stationary sources), same as for non-ETS industry	Trajectory A, B or C (1) Variant: ETS price or price based on benchmark energy prices with respect to neighbours in case of risks of leakage (to be assessed)	General tax shift away from labour and/or electricity Lump-sum transfer to farmers Specific programmes for the transition, incl. existing funds (VLIF, Visserijfonds, …)	2020: 23 M€ 2030: 122 M€	Feasibility of tax on agricultural products on basis of non-CO_2 emissions to be analysed; other consumption-oriented policies Role of the CAP in enhancing carbon sequestration in soils
Industry	5,4 $MtCO_2e$ 8% Tot nETS	All fossil fuel emissions Via (Option 1) component of energy taxes with special treatment for sectors at risk of carbon leakage (to be assessed) or (Option 2) carbon price in projects to be implemented under voluntary agreements Process emissions: specific treatment (incl. benchmark and/or voluntary agreement)	Trajectory A, B or C (1) Price capped at level corresponding to fossil fuel price benchmark for sectors at risk of carbon leakage (under scope Option 1 only) Variant 1: ETS price instead of trajectory A, B or C (under both scope Options) Variant 2: initial carbon price level implemented within current taxation levels (under scope Option 1 only)	General tax shift away from labour and/or electricity Fund for innovation in industries and support to SMEs	2020: 55 M€ (2) 2030: 286 M€ (2)	Voluntary agreements reform SMEs policy support
Waste	3,8 $MtCO_2e$ 5% Tot nETS	CO_2 emissions from waste incineration, with a possible integration into existing environmental taxes, and non-CO_2 emissions from other sources under the waste category, with a possible integration into existing environmental taxes	Trajectory A, B or C (1)	General tax shift away from labour and/or electricity Supporting circular economy measures	2020: 20 M€ 2030: 106 M€	Circular economy policies and waste strategies
F gases	2,9 $MtCO_2e$ 4% Tot nETS	Possibly import of F gases, possibly refund for destruction (to be assessed)	Trajectory A, B or C (1) Reduced rates	General tax shift away from labour and/or electricity Supporting transition towards alternatives	Not assessed	EU regulation on F-gases
Other	0,8 $MtCO_2e$ 1% Tot nETS	Not analysed (3)	Not analysed (3)	Not analysed (3)	Not analysed (3)	Not analysed (3)
Total	**74,5 $MtCO_2e$** **100%**				**2020: 607 M€** **2030: 2599 M€**	

(1) From 10€/tCO_2e in 2020 to 40, 70 or 100 €/tCO_2e in 2030
(2) Theoretical maximum; depends on actual scope and price trajectory
(3) These sources are diverse and priority has been given to the analysis of the main sources

Experiences abroad also show that pricing greenhouse gas emissions in most of the other sectors is possible provided that their specificities are adequately accounted for. Again, benchmark analyses on energy prices show that fossil fuels prices are relatively low while electricity prices are relatively high. In these other sectors, several implementation options will, however, require further investigation, either because potential competitiveness issues need to be accurately assessed or because emission factors do not necessarily accurately reflect actual emissions.

Finally, the current climate and energy policy context, in particular the necessity to develop, at the national level, measures towards mid-term and long-term goals, is a great opportunity to implement such an overarching and transversal measure as carbon pricing. The introduction of carbon pricing and the use of its revenues will necessarily require a high degree of coordination between the different authorities to ensure the highest degree of policy coherence. Policy coherence and the alignment of all policy frameworks with the reality of the low carbon transition is essential for the measure to deliver its full potential to contribute to mitigate climate change and to grasp the many opportunities of the transition.

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12 Appendices

APPENDIX 1 PROJECT TEAM, PARTICIPANTS TO THE TECHNICAL WORKSHOPS, PRESENTATIONS MADE DURING THE WORKSHOPS, AND PROCESS OF THE DEBATE

Project team

Samuel Buys (Climate Change Service), Lucas Demuelenaere (Climate Change Service), Luc Dries (Climate Change Service), Quentin Jossen (Climact), Koen Meeus (Climate Change Service), Julien Pestiaux (Climact), Frédéric Souchon (PwC Belgium), Vincent van Steenberghe (Climate Change Service), Luc Vercruyssen (PwC Belgium), Pascal Vermeulen (Climact), Peter Wittoeck (Climate Change Service), Luc Wittebolle (SuMa Consulting), Sébastien Yasse (PwC Belgium).

Participants to the workshops include

Thomas Bernheim (EU Commission), Antoine Bertrand (UCM), Mathias Bienstman (BBL), Annemie Bollen (SERV), Thierry Bréchet (UCL), Joke Brecx (FPS Economie), Marie Collard (FPS Finance), Nicolas Coomans (FEB – VBO), Bérénice Crabs (CREG), Alexis D'Allasta (CFDD – FRDO), Bert De Wel (CSC – ACV), Pieterjan Debergh (FEB – VBO), Patricia Debrigode (CREG), Leen De Cort (BV-OECO / AB-REOC), Philippe Degraef (FEBETRA), Laurens De Meyer (BBL), Laurent Demilie (FPS Mobility), Marc Depoortere (CFDD – FRDO), Bart Dewaele (CREG), Johan Eyckmans (KUL), Ilse Forrez (Essencia), Karen Geens (FPS Economy), Frank Gérard (EDORA), Ana Granados (FWA), Dominique Gusbin (Federal Planning Bureau), Paul Hegge (LINEAS), Koenraad Holmstock (LV Vlaanderen), Frederic Keymeulen (TLV), Ruth Lambrechts (AGORIA), Noémie Laumont (EDORA), Noé Lecocq (IEW), Jean-Pierre Libaert (Confédération construction), Michel Martens (FEBIAC), Xavier May (ULB), Celine Mouffe (CCE - CRB), Sylvie Myngheer (FEBEG), Klaas Nijs (VOKA), Aurélie Noiret (FWA), Carl Maschietto (SPW), Michèle Pans (CCECRB), Didier Paquot (UWE), Dominique Perrin (AWAC), Nilufer Polat (CGSLB - ACLVB), Tom Quintelier (FEVIA), Cynthia Ragoen (CESW), Laura Rebreanu (BECI), Joris Recko (VEA), François Sana (CSC – ACV), Diane Schoonhoven (Boerenbond), Kristof Schreurs (FEBEG), Sandra Sliwa (Minaraad), Laurien Spruyt (BBL), Sébastien Storme (FGTB – ABVV), Christian Valenduc (FPS Finance), Klaas Vancauwenberg (MOW), Thierry Vancouwenberg (SPW), Olivier Van der Maren (FEB – VBO), Frank Vandermarliere (AGORIA), Pascale Van der Plancke (BIM), Piet Vanden Abeele (UNIZO), Julie Vandenberghe (WWF), Jean-Pierre Van Dijk (FPB – BPF), Els Van Hover (LNE), Christine Vanoppen (LINEAS), Charlotte Vanpoucke (IRCELINE), Alex Van Steenbergen (BFP-FPB), Roel Vermeiren (VEA), Charlie Verthe (CESRBC – CBCES), Alain Wilmart (FPS ENV), Tania Zgajewski (CCECRB).

Presentations

1. Transversal issues

   Thomas Bernheim (EU Commission): "Overview of recent and forthcoming European strategies and key messages"

   Thierry Bréchet (UCL): "Key implementation issues of a carbon pricing mechanism"

   Johan Eyckmans (KUL): "Contribution to the national debate on carbon pricing"

   Dominique Perrin (AWAC): "Overview of recent and forthcoming regional strategies and key measures Walloon Region"

   Pascale Van der Plancke (BIM): "Overview of recent and forthcoming regional strategies and key measures – Brussels capital Region"

   Els Van Hover (LNE): "Overview of recent and forthcoming regional strategies and key measures Flemish Region"

2. Buildings sector

   Sandrine Meyer (ULB): "Carbon tax and stakes of redistribution: considerations on energy poverty and split incentives"

   Thierry Vancouwenberg (SPW): "Contribution to the national debate on carbon pricing: the building sector in the Walloon Region"

   Christian Valenduc (FPS Finance): "Politique fiscale et environnement, quid pour le résidentiel ?"

   Charlotte Vanpoucke (IRCELINE): "Air quality in Belgium – focus on the building sector"

   Pascale Van der Plancke (BIM): "Stratégie bruxelloise de rénovation et précarité énergétique"

   Roel Vermeiren (VEA): "The Flemish Renovation Pact"

3. Transport sector

   Xavier May (ULB): "Analyse du régime actuel des voitures de société"

   Dominique Perrin (AWAC): "Overview of the Walloon measures in the transport sector" (powerpoint unavailable)

   Charlotte Vanpoucke (IRCELINE): "Air quality in Belgium – focus on the transport sector"

   Pascale Van der Plancke (BIM): "Politiques environnementale et de mobilité en matière de transport en RBC »

   Els Van Hover (LNE): "Overview of the Flemish measures in the transport sector"

   Alex Van Steenbergen (BFP-FPB): "De federale fiscaliteit in transport: aangepast aan de uitdaging?"

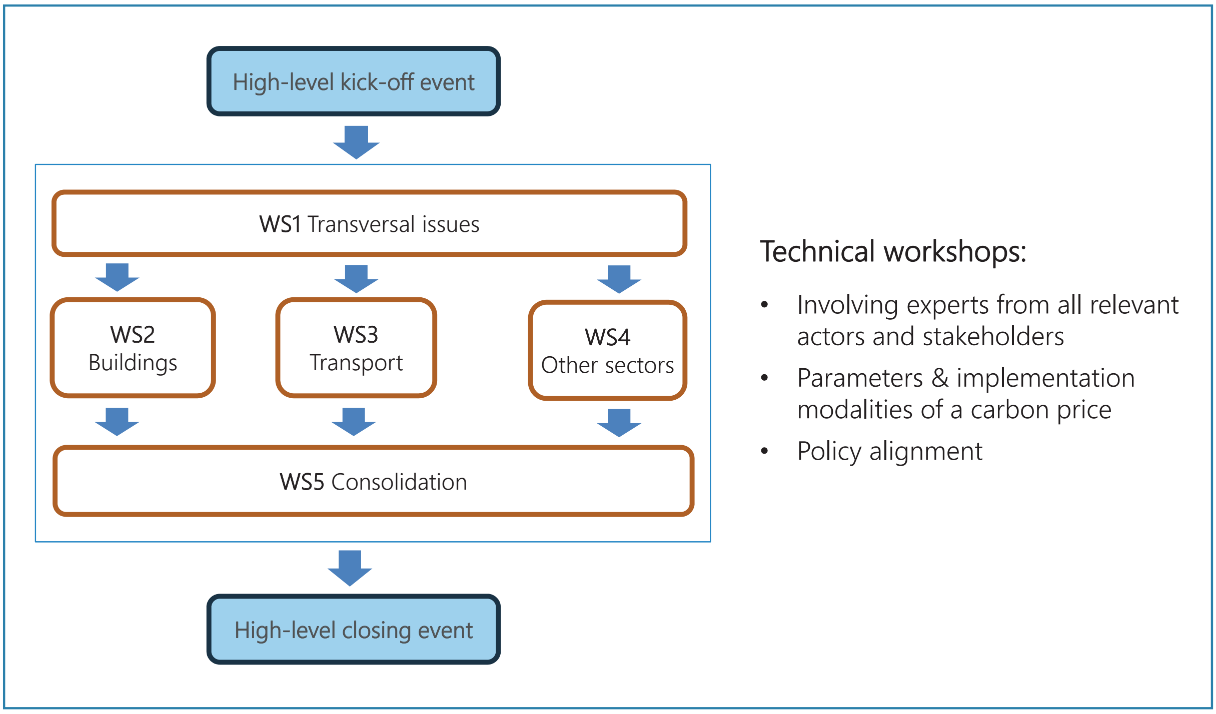
4. Other sectors (non-ETS industry, agriculture and waste, fluorinated gases)

   Carl Maschietto (SPW): "Groupe de travail tarification carbone – les accords de branche wallons"

   Joris Recko (VEA): "EBO voor de niet VER-industrie"

   Alain Wilmart (FPS ENV): "Contribution to the national debate on carbon pricing – the F gases sector"

A.1.1: Overview of the process of the Belgian carbon pricing national debate

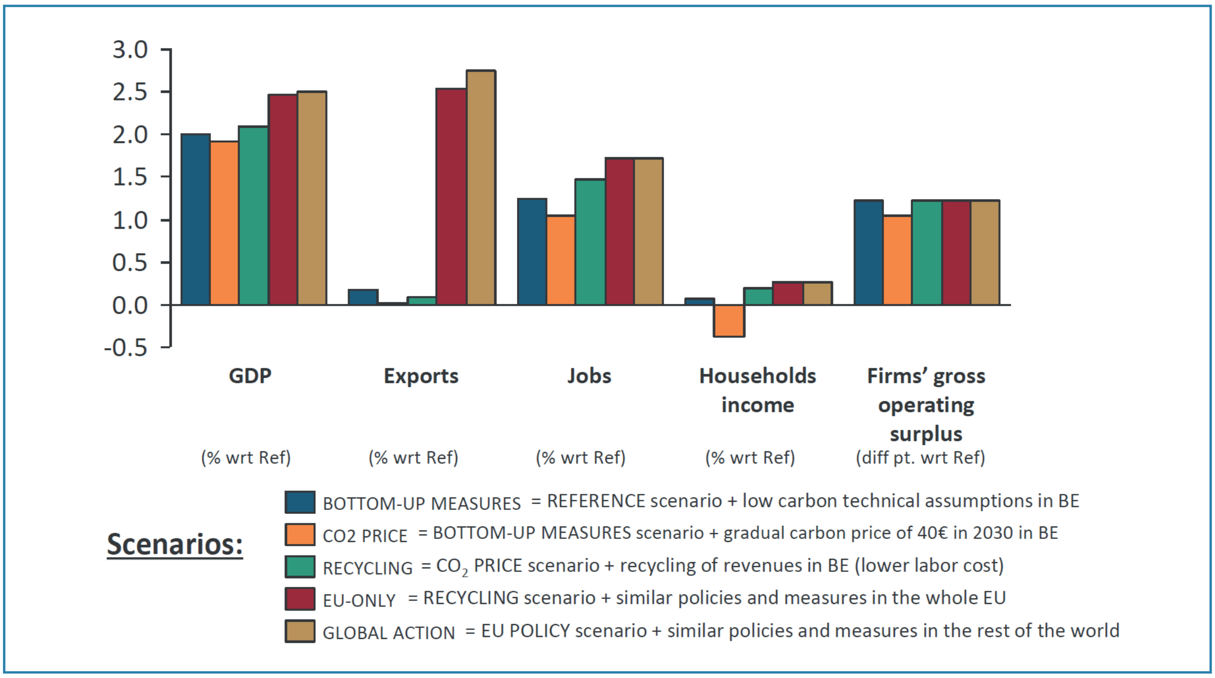


APPENDIX 2 MACROECONOMIC IMPACTS (DETAILED RESULTS) AND POSSIBLE ENERGY PRICE TRAJECTORIES

1. On the macroeconomic impacts of the low carbon transition in Belgium (detailed results)

Figure A2.1 shows the impact of the CORE scenario on GDP, net exports, employment, households income and firms' gross operating surplus in 2030 with respect to the reference scenario. In the first case ('bottom-up measures'), investments required along the CORE scenario are leading to additional growth and job creation while not reducing households income and firm's gross operating surplus.

A.2.1: Impact of the CORE scenario on a selection of indicators in 2030 according to different cases regarding the implementation of carbon pricing and international participation (in % w.r.t. Reference scenario in 2030)



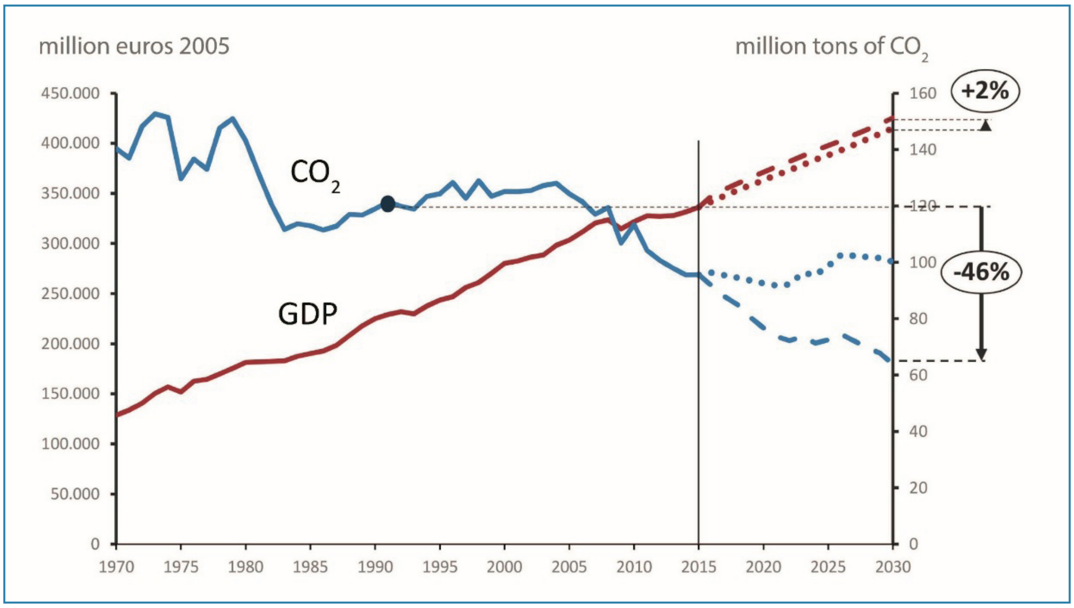
Source: Climact, Federal Planning Bureau and Bréchet (2016)

In the second case, a carbon price of 40€/tCO_2 is implemented in the non-ETS sectors. In the ETS sectors, an additional price of 5€/tCO_2 is introduced, above the 35€/tCO_2 already assumed in the Reference scenario. In this case, public revenues from carbon pricing, which amount to about 3,5 billons euros in the year 2030, are not recycled back to the economy. The GHG emissions are then further reduced compared with the first case, by about 2 percentage points given the assumed elasticities. All indicators are only marginally affected, with the noticeable exception of households disposable income given that the significant public revenues are not reinjected into the economy.

The third case takes those revenues into account by assuming that they are used to lower social security contributions. This leads to a visible, although moderate, positive impact on GDP, jobs and income.

Finally, cases four and five account for the implementation of similar policies (low carbon investments and carbon pricing) in, respectively, the EU and whole world. Such a context has a strong and positive impact on the trade balance and, as explained above, further stimulates growth, with a GDP level at almost 2,5% above its level in the Reference scenario in 2030. The 'global action' case is illustrated in Figure A.2.2 with a long term historical perspective.

A.2.2: Impact of the CORE low carbon scenario on emissions and GDP in Belgium (1970-2030)
(carbon price of 40 €/tCO_2, recycling in lower labour cost, world low carbon transition)



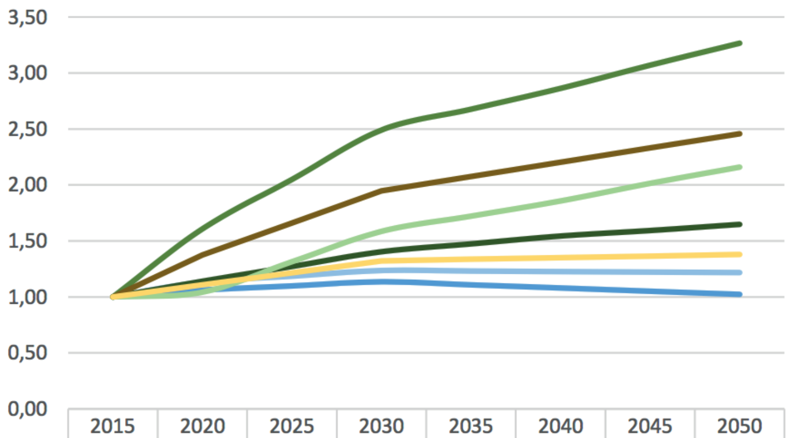
Source: Climact, Federal Planning Bureau and Bréchet (2016)

2. Possible energy price trajectories (cf. section 3.3 of the report)

The levels of energy prices, in particular their relative evolutions, play an important role in the assessment of the impact of carbon pricing. For clarity purposes, analyses are performed under the working assumption of constant energy prices, while sensitivity of the results to energy price evolutions are provided as well.

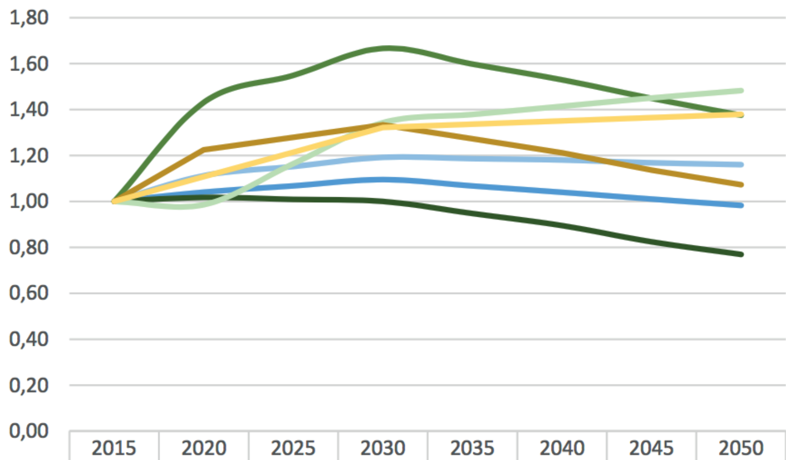
The figures below summarize our assumptions on the relative evolution of energy prices used in these sensitivity analyses for the costs of the BaU scenario (Figure A.2.3) and the Low-Carbon scenario (Figure A.2.4). These assumptions are coherent with the "scenarios for a low-carbon Belgium" analyses and rely primarily on modelling work by the International Energy Agency. More precisely, the cost evolutions suggested in the "Current Policies Scenario" of the World Energy Outlook 2016 are considered for the BaU scenario, and the ones suggested in the "450 scenario" are associated to the Low-Carbon scenario.

A.2.3: Evolution of energy prices considered in the sensitivity analysis of costs of the BaU scenario (base 1.00 = 2015)



	2015	2020	2025	2030	2035	2040	2045	2050
Electricity Residential	1,00	1,06	1,10	1,14	1,11	1,08	1,05	1,02
Electricity Commercial	1,00	1,13	1,18	1,24	1,23	1,23	1,22	1,22
Solid hydrocarbons	1,00	1,14	1,27	1,40	1,47	1,54	1,59	1,65
Liquid hydrocarbons	1,00	1,61	2,05	2,49	2,68	2,86	3,07	3,27
Gaseous hydrocarbons	1,00	1,04	1,31	1,59	1,72	1,86	2,01	2,16
Bioenergy	1,00	1,37	1,66	1,95	2,08	2,20	2,33	2,46
Heat transport	1,00	1,11	1,21	1,32	1,34	1,35	1,36	1,38

A.2.4: Evolution of energy prices considered in the sensitivity analysis of costs of the Low-Carbon scenario (base 1.00 = 2015)



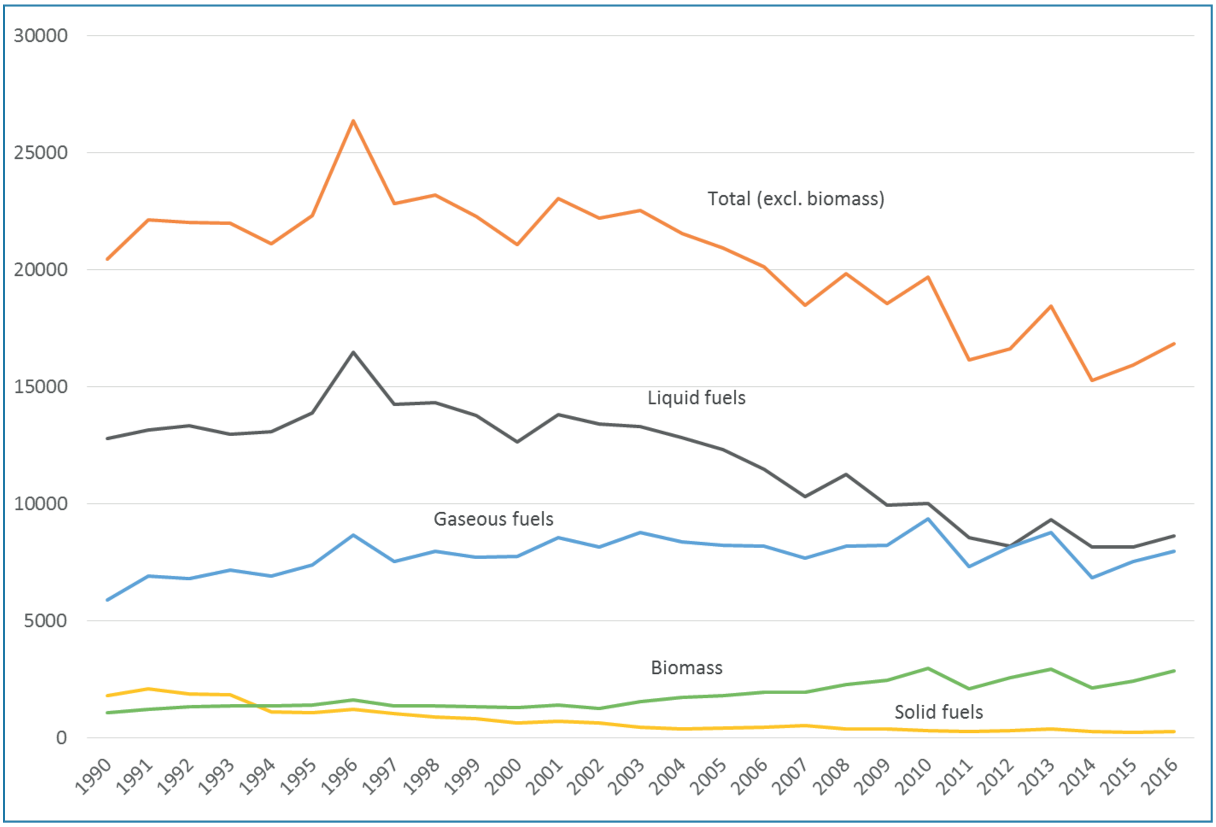
	2015	2020	2025	2030	2035	2040	2045	2050
Electricity Residential	1,00	1,04	1,07	1,10	1,07	1,04	1,01	0,98
Electricity Commercial	1,00	1,11	1,15	1,19	1,19	1,18	1,17	1,16
Solid hydrocarbons	1,00	1,02	1,01	1,00	0,95	0,89	0,82	0,77
Liquid hydrocarbons	1,00	1,43	1,55	1,67	1,60	1,53	1,45	1,38
Gaseous hydrocarbons	1,00	0,99	1,16	1,34	1,38	1,41	1,45	1,48
Bioenergy	1,00	1,22	1,28	1,33	1,27	1,21	1,14	1,07
Heat transport	1,00	1,11	1,21	1,32	1,34	1,35	1,36	1,38

Note that the relative price evolution of biomass is derived, as working assumption, from the average between solid and liquid hydrocarbons. In addition, heat transport costs are taken from the "Scenarios for a low-carbon Belgium" study without updates.

APPENDIX 3 ADDITIONAL INFORMATION ON THE BUILDINGS SECTOR

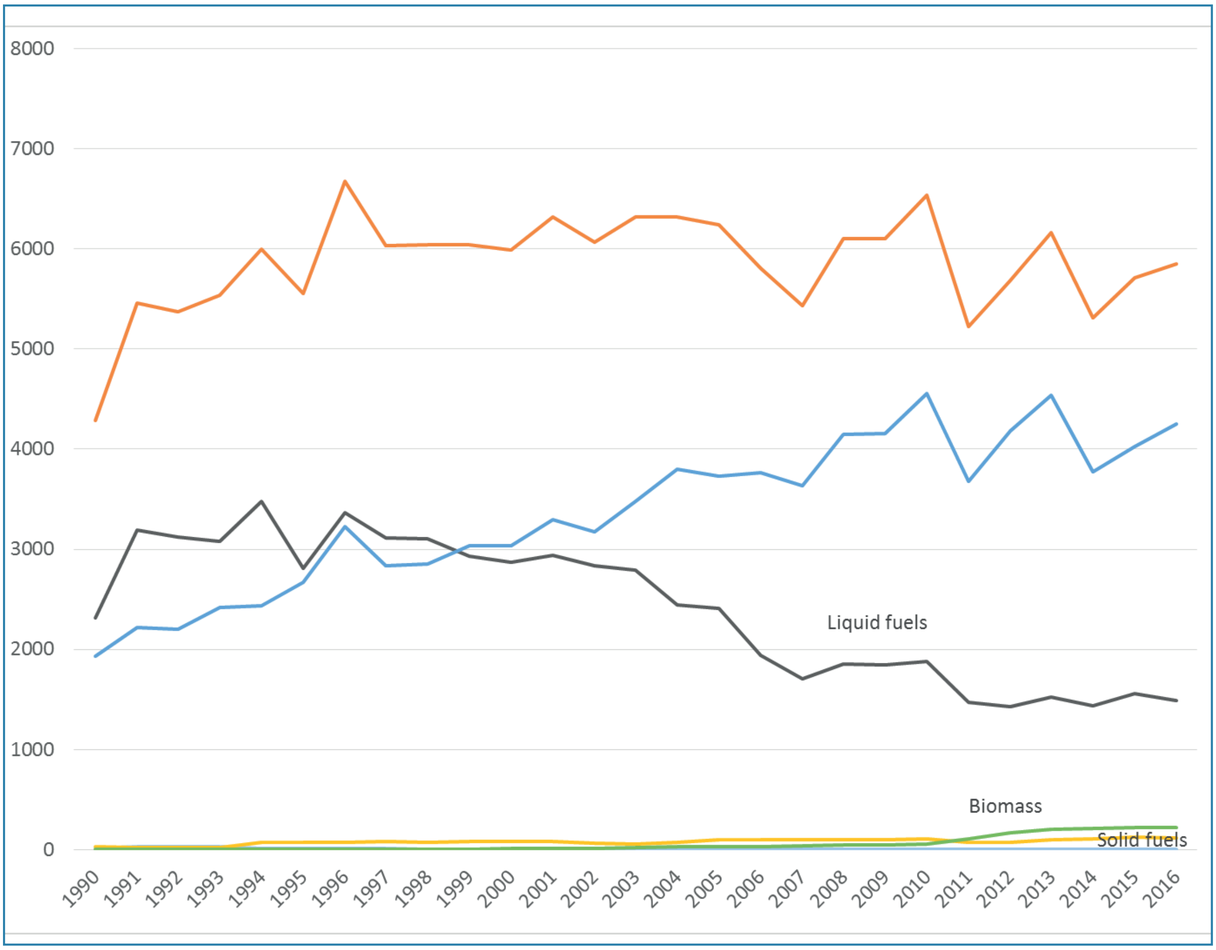
1. GHG emissions, key indicators / characteristics and low carbon scenario

A.3.1: Historical GHG emissions in the residential sector per energy source (in $ktCO_2$)



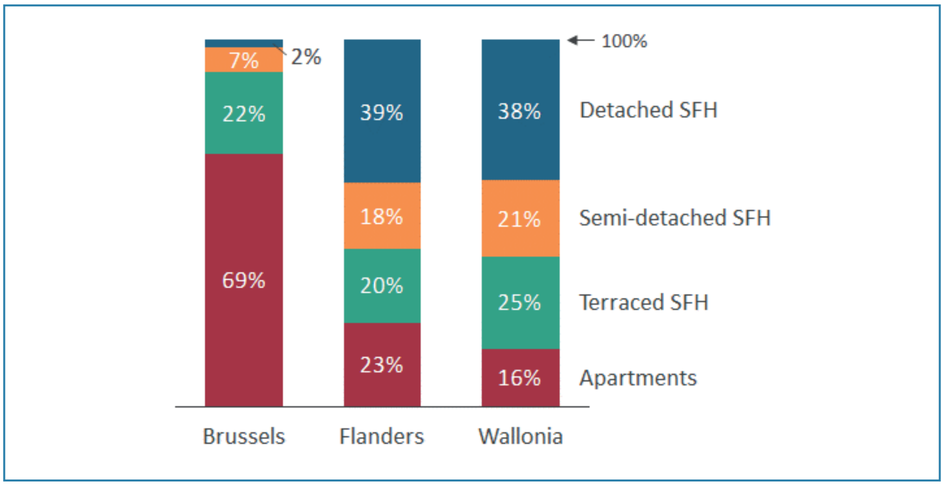
Source: NIR 2018

A.3.2: Historical GHG emissions in the non-residential sectors per energy source (in $ktCO_2$)



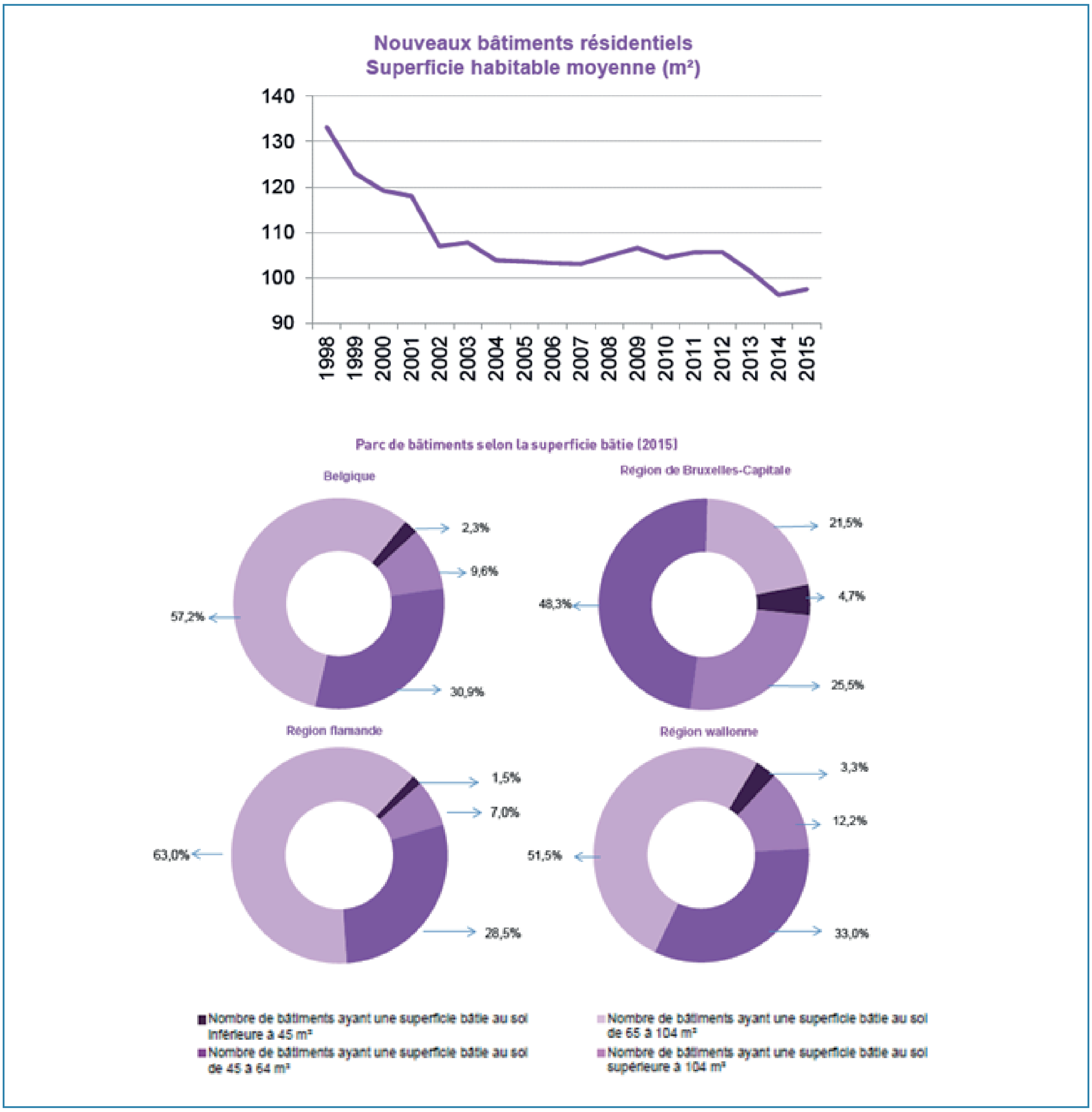
Source: NIR 2018

A.3.3: Distribution of building types by Region in Belgium (in % of total households)



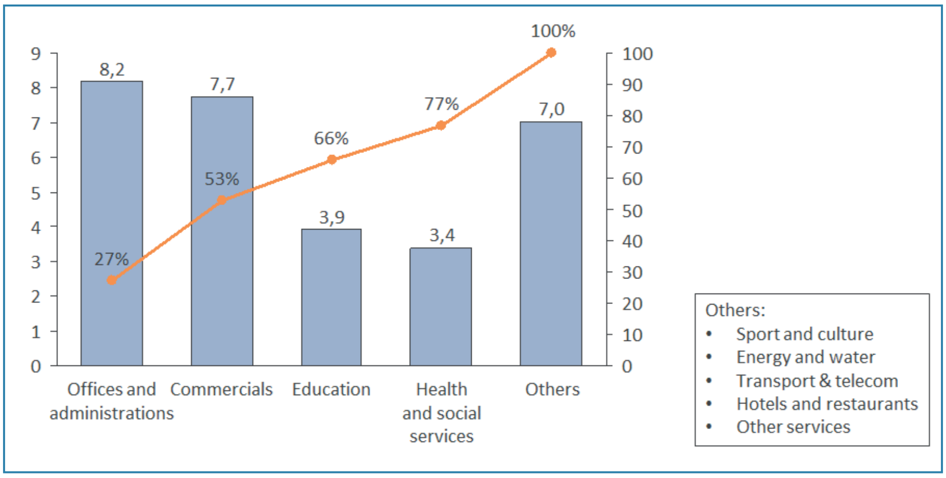
Source: Energy Consumption Survey for Belgian households

A.3.4: New residential buildings – average living surface (m^2)



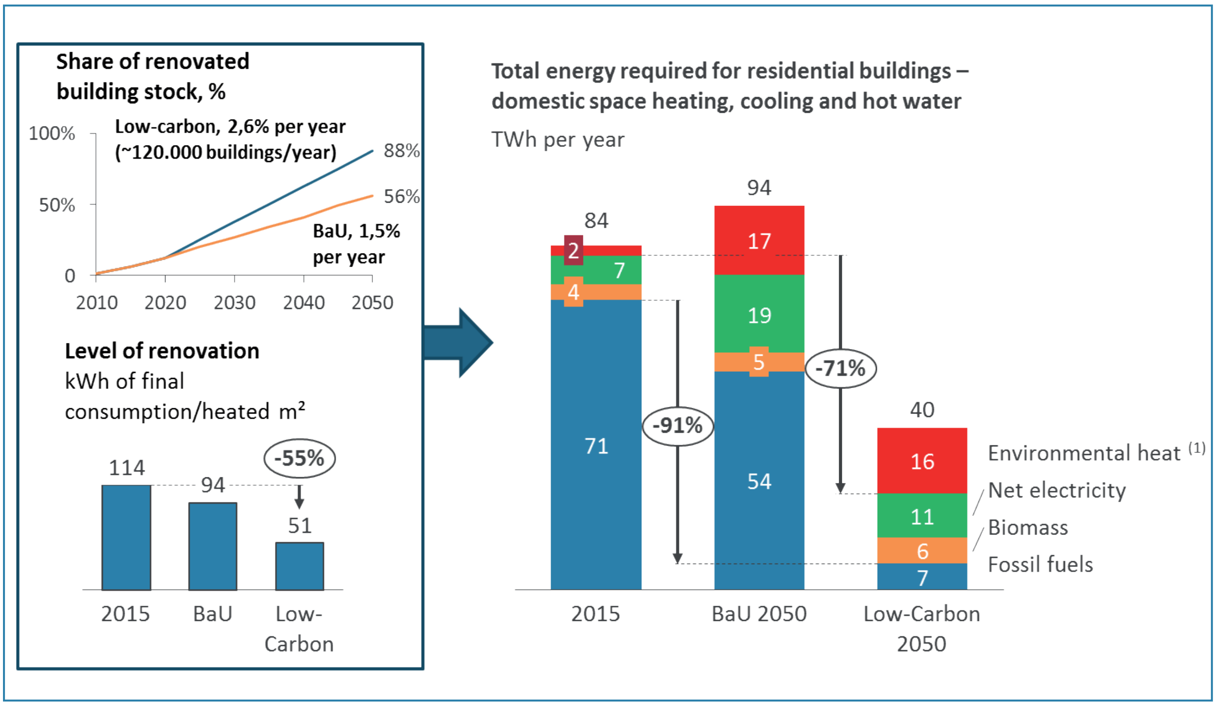
Source: SPF Economie 2016, Aperçu statistique de la Belgique

A.3.5: Energy consumptions in non-residential buildings, excluding electricity
(in TWh per year, left – Cumulated share %, right)

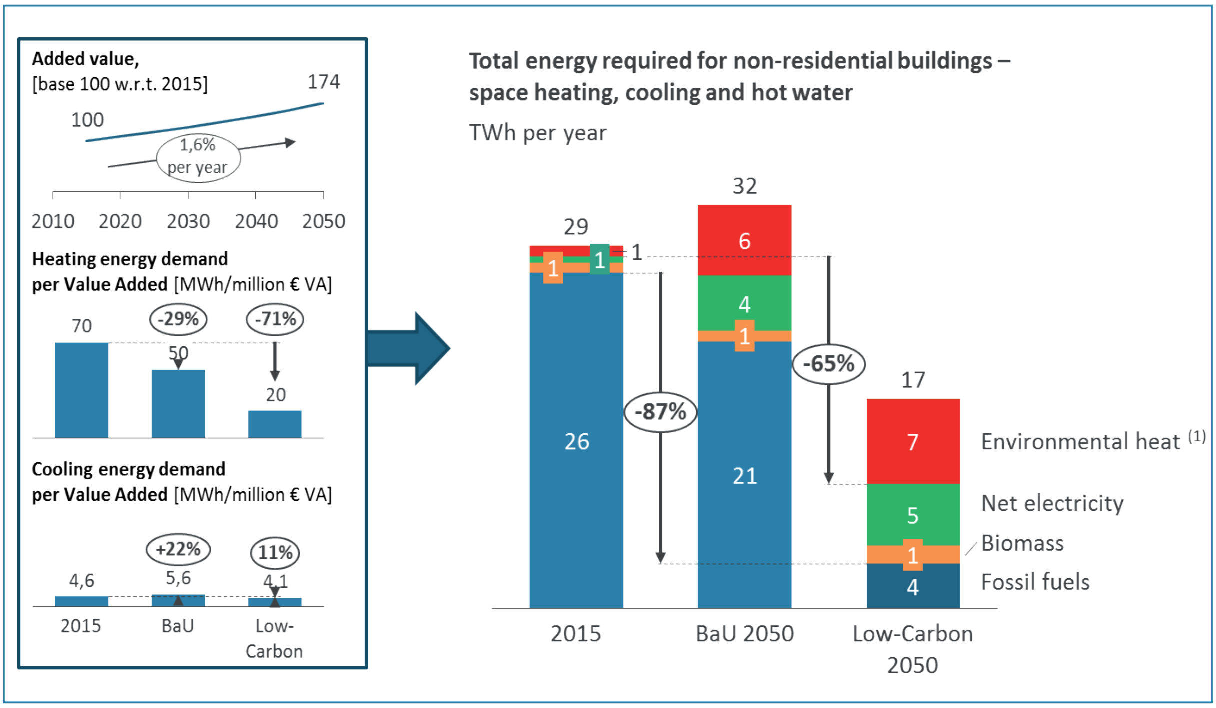


Source: CLIMACT, based on regional energy balances (data 2013)

A.3.6: Assumptions on the renovation rate and renovation depth in the BaU and the low-carbon scenario for residential buildings, and resulting energy consumptions



A.3.7: Assumptions on the energy intensity for heating and cooling in the non-residential buildings in the BaU and the low-carbon scenario, and resulting energy consumptions



2. Benchmark analysis of natural gas and heating gas oil

A.3.8: Benchmark analysis natural gas final prices and carbon prices needed to reach the same price levels

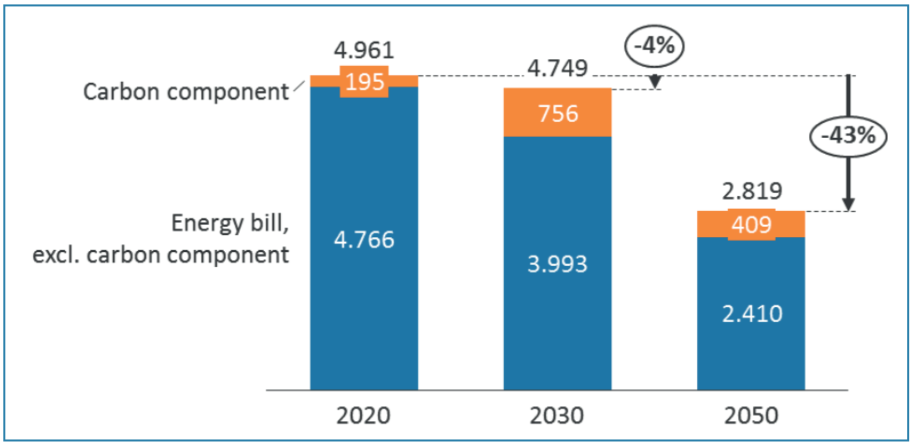
Natural gas prices - 1st semester 2017 D2 profile (EUR/MWh)								
	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Final prices (all taxes & levies included)	51,90	63,90	76,30	61,10	41,80	60,78	67,10	70,10
Difference with BE (abs)	0,00	-12,00	-24,40	-9,20	10,10	-8,87	-15,20	-18,20
Difference (%)	0%	-19%	-32%	-15%	24%	-15%	-23%	-26%
CP to close the gap	0,00	59,11	120,20	45,32	49,75	43,72	74,88	89,66

A.3.9: Benchmark analysis heating gasoil final prices and carbon prices needed to reach the same price levels

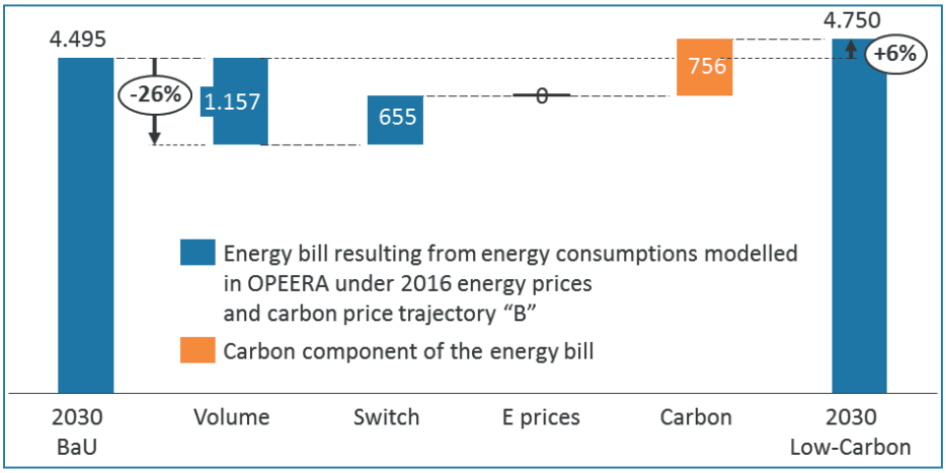
Heating gas oil prices - 2nd semester 2017 (EUR/1000 L)								
	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Final prices (all taxes & duties included)	558,87	724,58	1001,93	596,39	528,21	712,78	774,30	863,26
Difference with BE (abs)	0,00	-165,71	-443,06	-37,52	30,66	-153,91	-215,43	-304,39
Difference (%)	0%	-23%	-44%	-6%	6%	-22%	-28%	-35%
CP to close the gap	0,00	63,49	169,75	14,38	11,75	58,97	82,54	116,62

3. Evaluation of impacts on the average energy bill

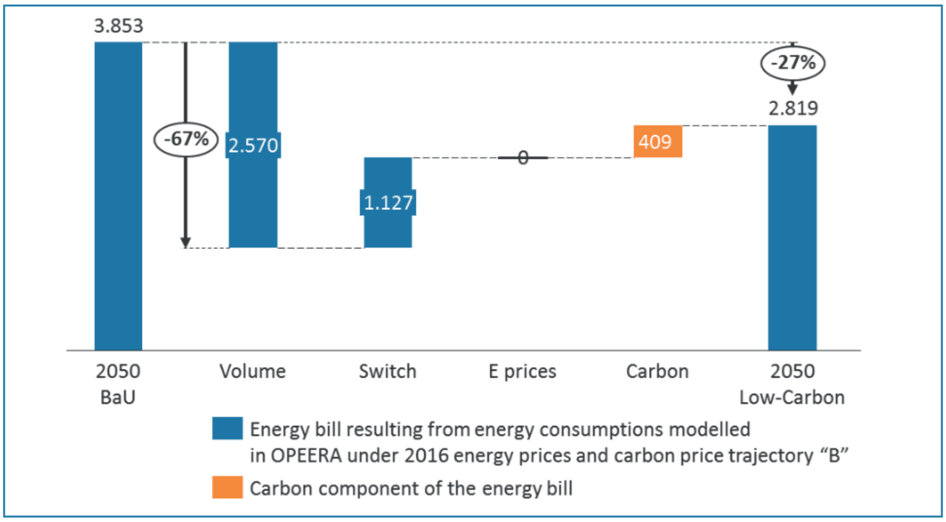
A.3.10: Evolution of the average annual energy bill for heating non-residential buildings, in the low-carbon scenario under Option B (in €/M€ added value/year)



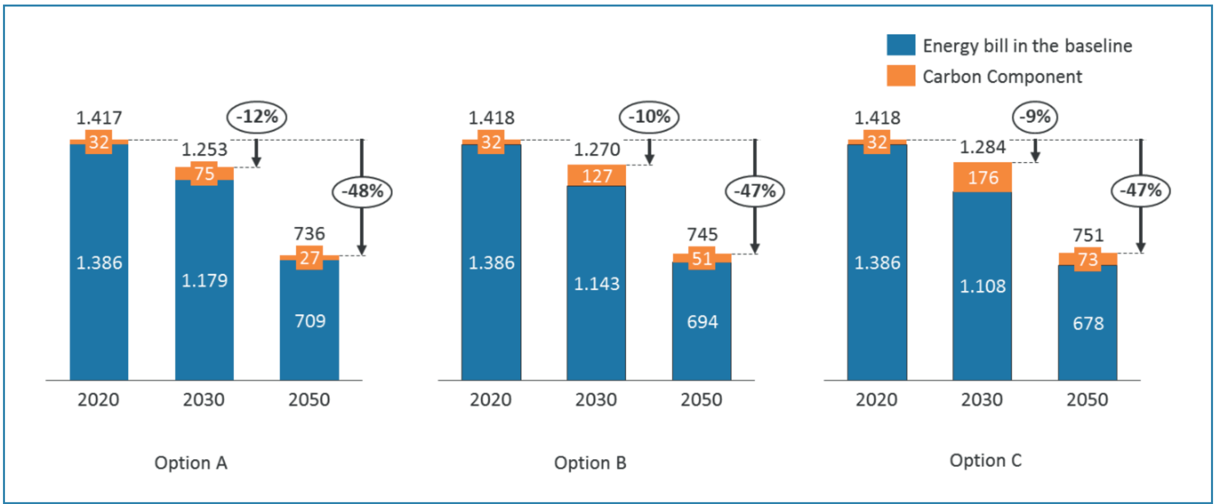
A.3.11: Average annual energy bill for heating non-residential buildings by 2030 in the BaU and the low-carbon scenario Waterfall highlighting the drivers of the difference (in €/M€ added value/year)



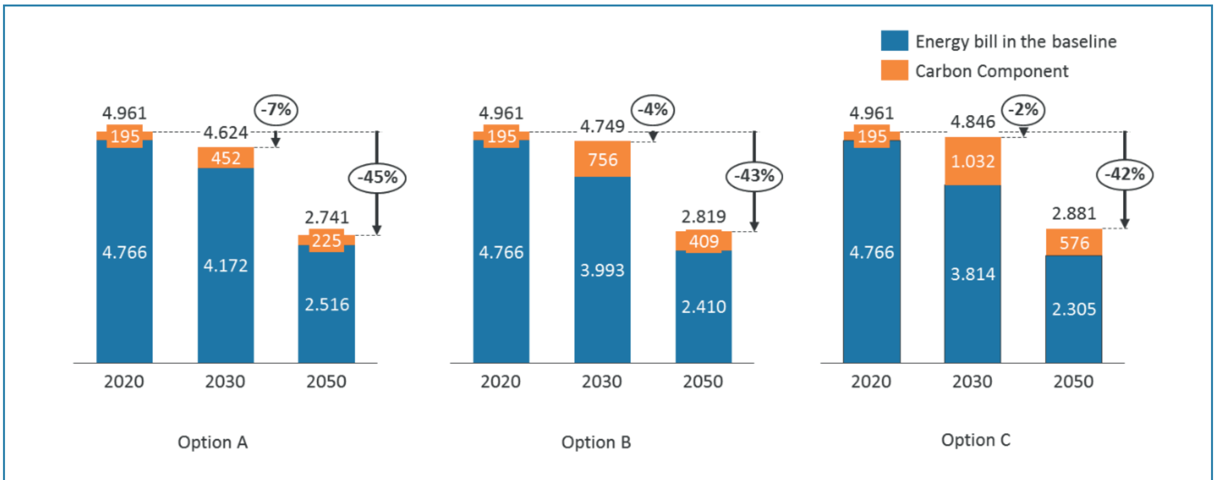
A.3.12: Average annual energy bill for heating non-residential buildings by 2050 in the BaU and the low-carbon scenario Waterfall highlighting the drivers of the difference (in €/M€ added value/year)



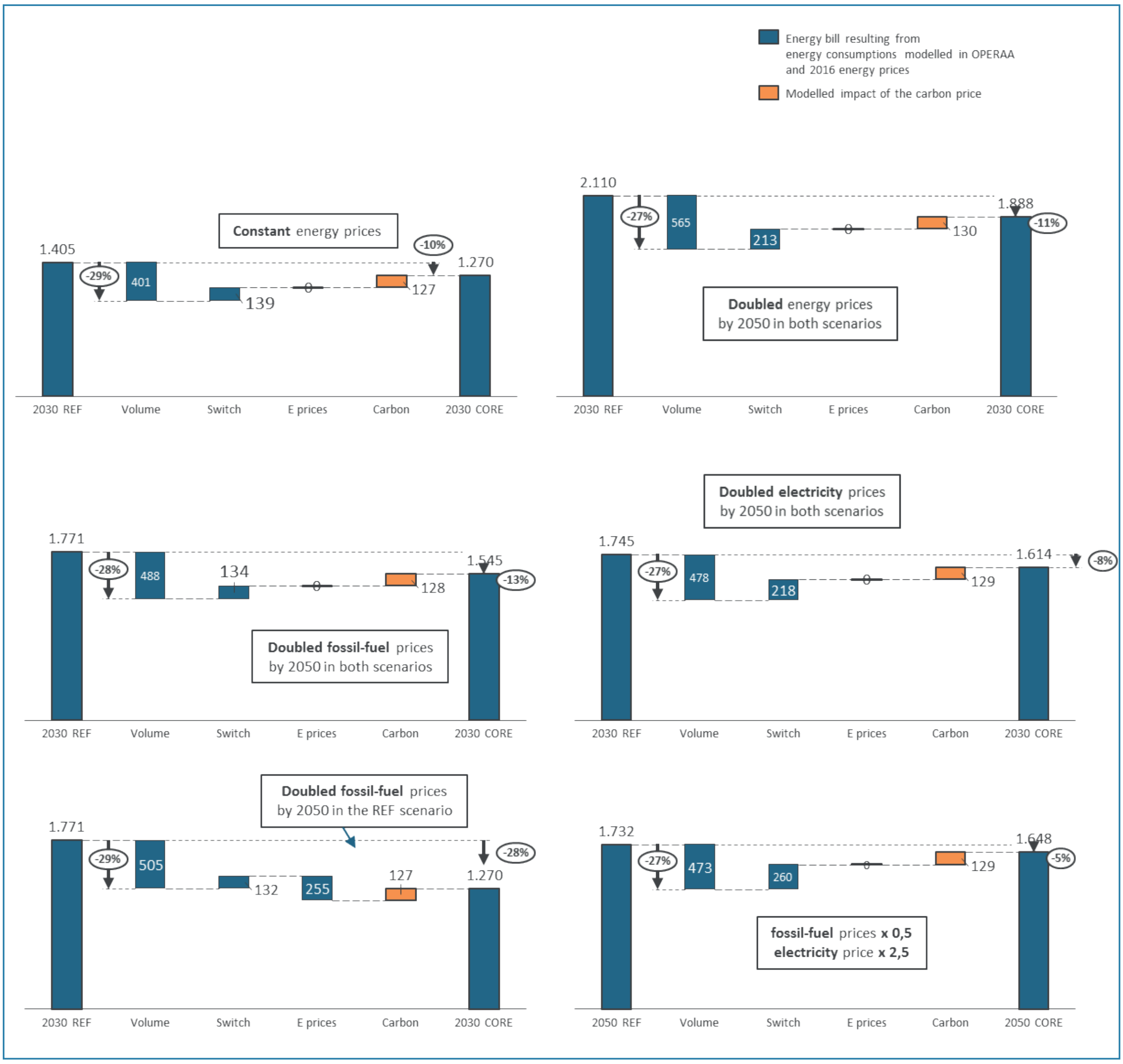
A.3.13: Evolution of the average annual energy bill for heating residential buildings, in the low-carbon scenario under the three carbon price trajectories (in €/household/year)



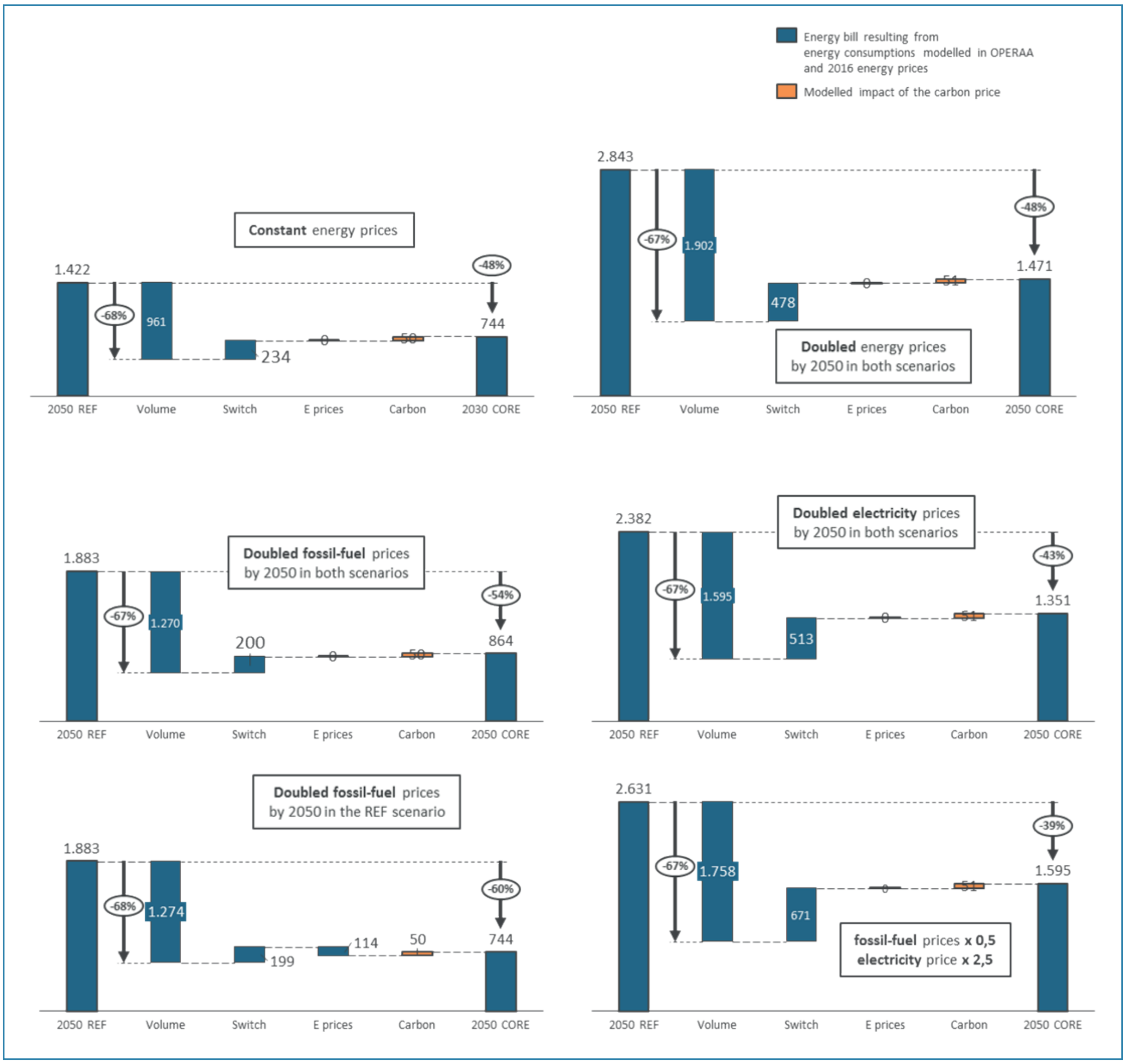
A.3.14: Evolution of the average annual energy bill for heating non-residential buildings, in the low-carbon scenario under the three carbon price trajectories (in €/M€ added value/year)



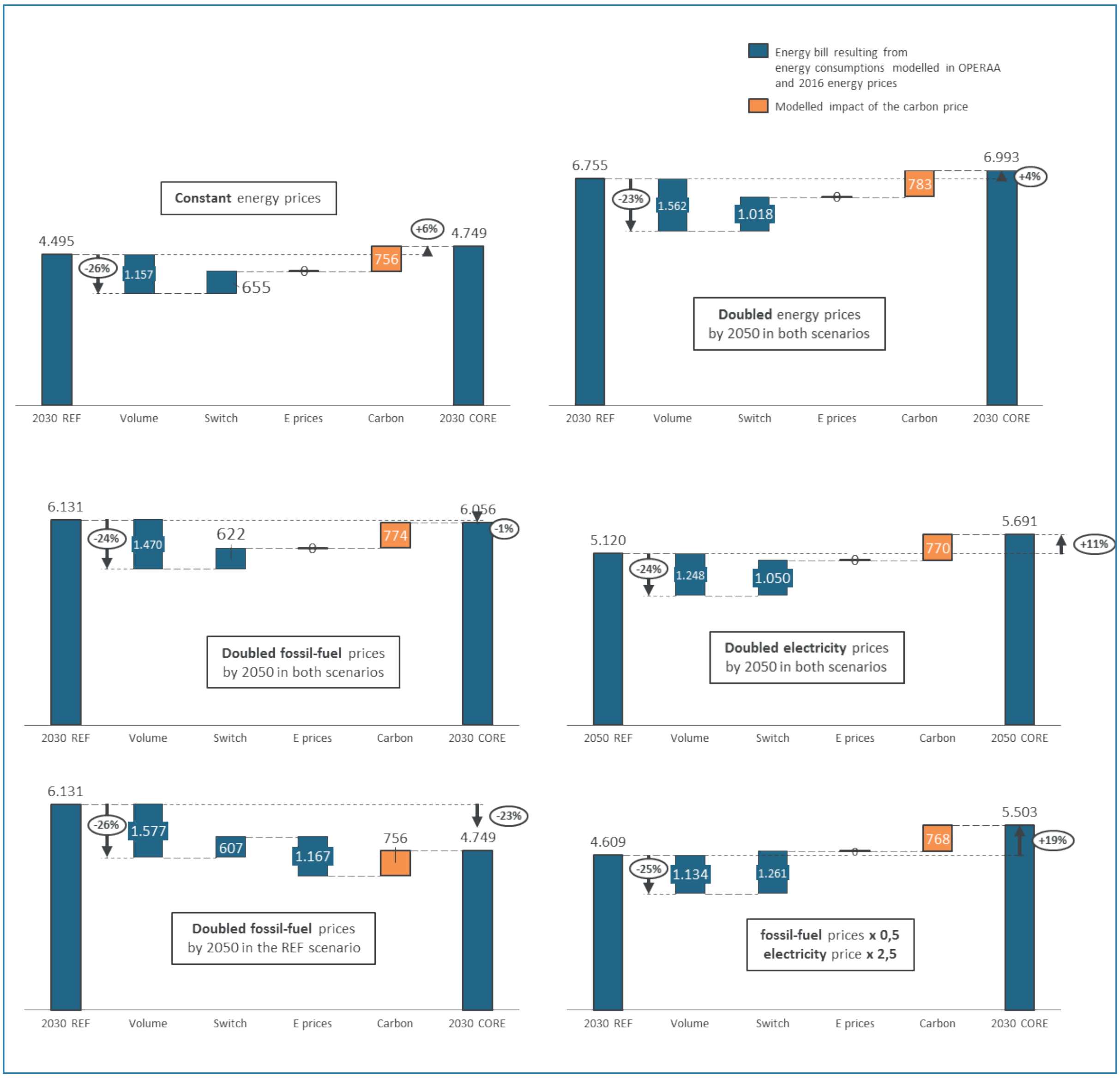
A.3.15: Annual energy bill for heating residential buildings by 2030 in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices [€/household/year]



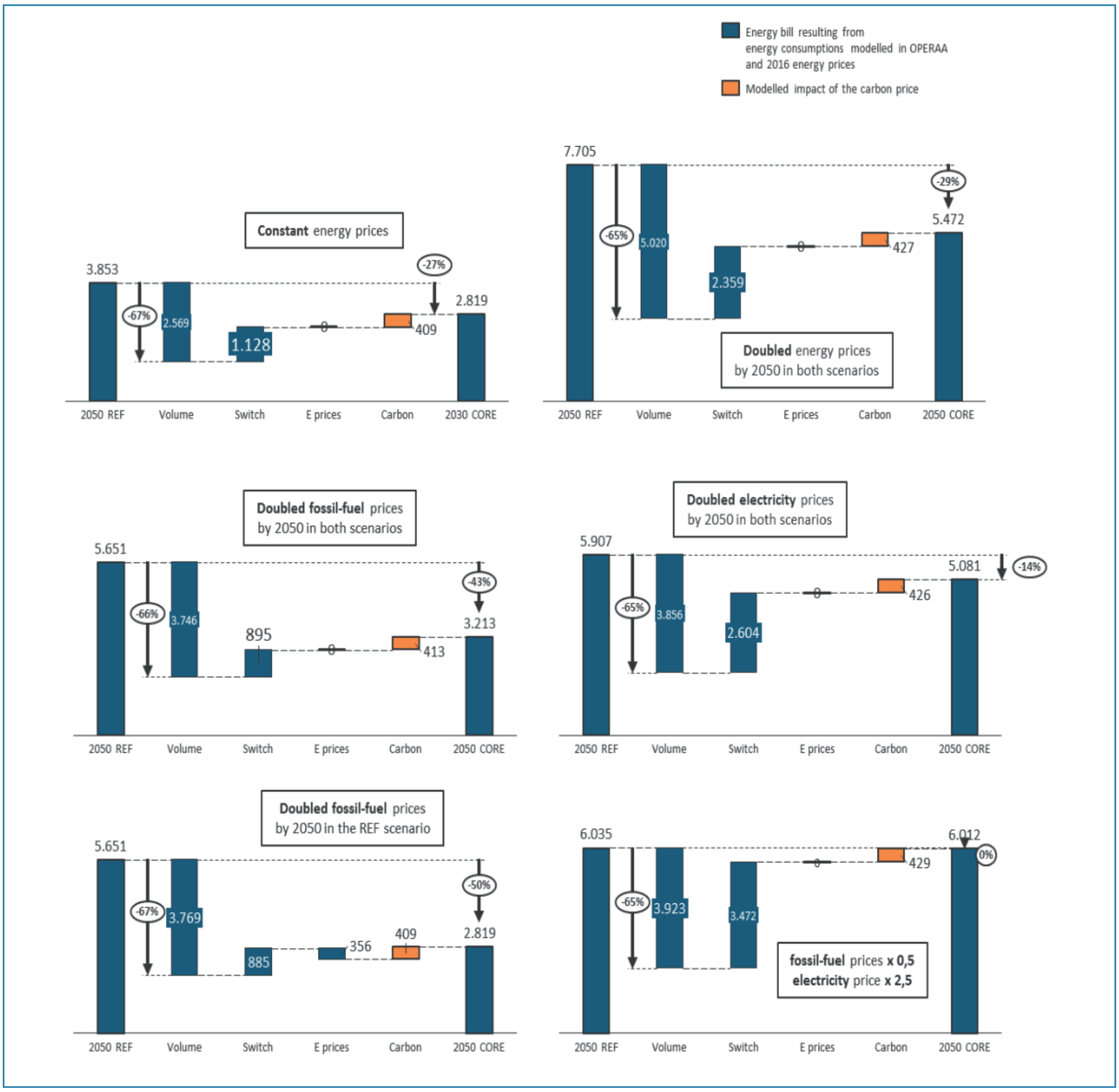
A.3.16: Annual energy bill for heating residential buildings by 2050
in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices
[€/household/year]



A.3.17: Annual energy bill for heating non-residential buildings by 2030 in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices [€/household/year]



A.3.18: Annual energy bill for heating non-residential buildings by 2050 in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices [€/household/year]



4. Evaluation of impacts on public carbon revenues

A.3.19: Evolution of the annual public revenues from a carbon price applied to energy consumptions in buildings under the three carbon price trajectories

Carbon price trajectories		2020	2025	2030	2035	2040	2045	2050
A	€/tCO_2e	10,0	23,3	40,0	55,0	70,0	85,0	100,0
B	€/tCO_2e	10,0	40,8	70,0	100,0	130,0	160,0	190,0
C	€/tCO_2e	10,0	58,3	100,0	145,0	190,0	235,0	280,0
Option A								
Buildings	M€	219,1	402,4	555,0	577,0	523,2	408,6	253,6
Residential	M€	159,3	286,0	393,6	402,0	356,4	268,5	153,8
Non-residential	M€	59,8	116,3	161,4	175,0	166,8	140,0	99,8
Option B								
Buildings	M€	219,1	693,0	938,5	1.006,7	931,6	740,9	467,8
Residential	M€	159,3	493,6	668,2	705,0	638,6	490,7	286,0
Non-residential	M€	59,8	199,3	270,3	301,7	292,9	250,2	181,7
Option C								
Buildings	M€	219,1	973,9	1.294,0	1.398,2	1.302,9	1.046,7	668,5
Residential	M€	159,3	695,2	925,2	984,8	899,5	698,9	412,4
Non-residential	M€	59,8	278,7	368,8	413,5	403,5	347,7	256,1

5. Profitability of investments - cost of renovation

A.3.20: CAPEX for retrofitting individual residential houses reported in the selected literature (in €/annually saved kWh)

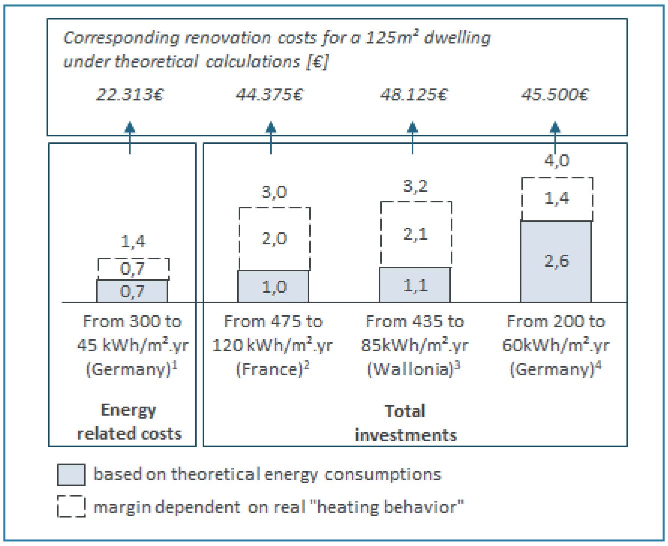


Figure A.3.20 shows the renovation investments relative to the annual energy saved (in €/annually saved kWh) obtained from the following selection of literature:

- Belgium (Wallonia): Climact (2017b), Analyses menées dans le cadre de la stratégie wallonne à long terme de rénovation énergétique des bâtiments

- France: Sia Partners (2017), *Etude économique – Coûts et bénéfices d'un plan de rénovation des Passoires énergétiques à l'horizon 2025*
- Germany: Ecofys (2011), Economics of deep renovation and Power & Zulauf (2011), *Cutting Carbon Costs: Learning from Germany's Energy Saving Program*

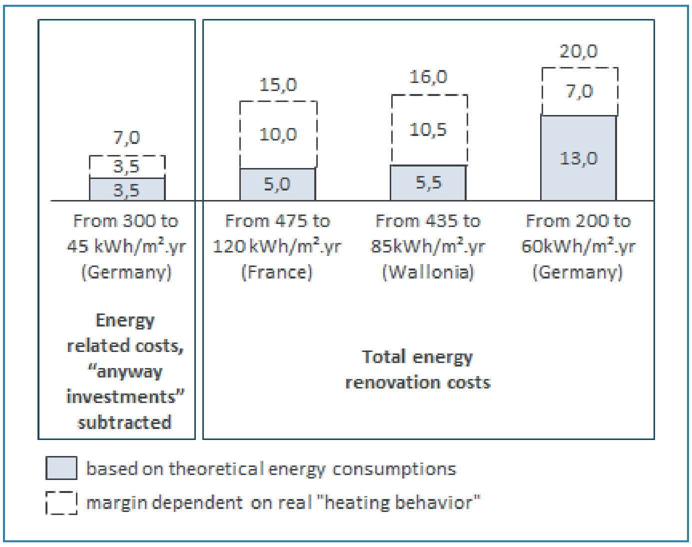
The figure shows:

- the specific energy consumption prior and after renovation (in kWh/m²/year),
- the investments expressed relative to the total energy saved annually (CAPEX divided by the product of the conditioned area and difference of specific energy consumption before and after renovation, in €/annually saved kWh),
- a correction of these investments if real consumptions differ from the theoretical ones by a factor 2,
- the total investment if these investments were applied to a 125m² dwelling.

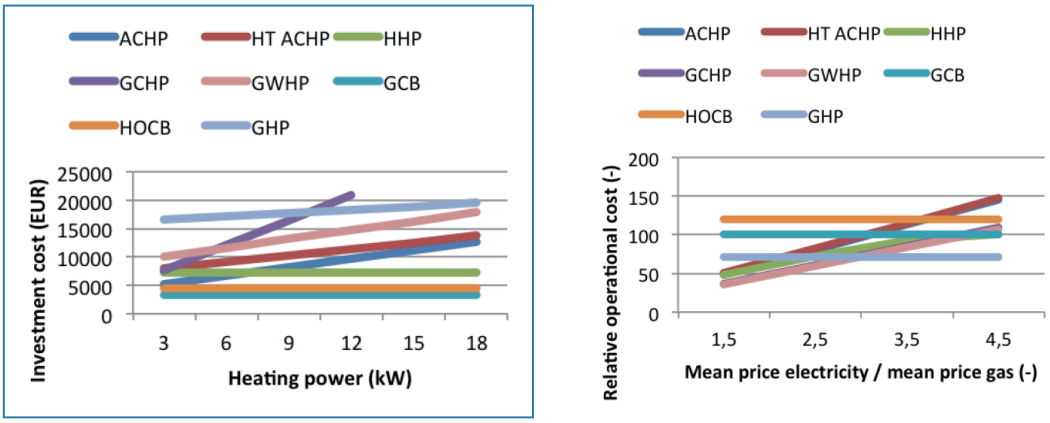
The corresponding costs of the saved energy are shown in Figure A.3.21, considering an average 20-year lifetime for the investments:

- The left-hand side gives energy related costs after subtraction of these "anyway investments" from the total investment in energy efficiency;
- Figures provided in the right-hand side consider that investments do not occur at the end of the life-time of the targeted buildings component.

A.3.21: Cost per saved kWh assuming a 20-year lifetime of investments (in c€/saved kWh) in GER, FR and Wallonia



A.3.22: Investment cost (left) and relative (with respect to a gas condensing boiler) operational cost (right) for various heating systems.



Source: KUL, 2015. Heat pumps fact sheet

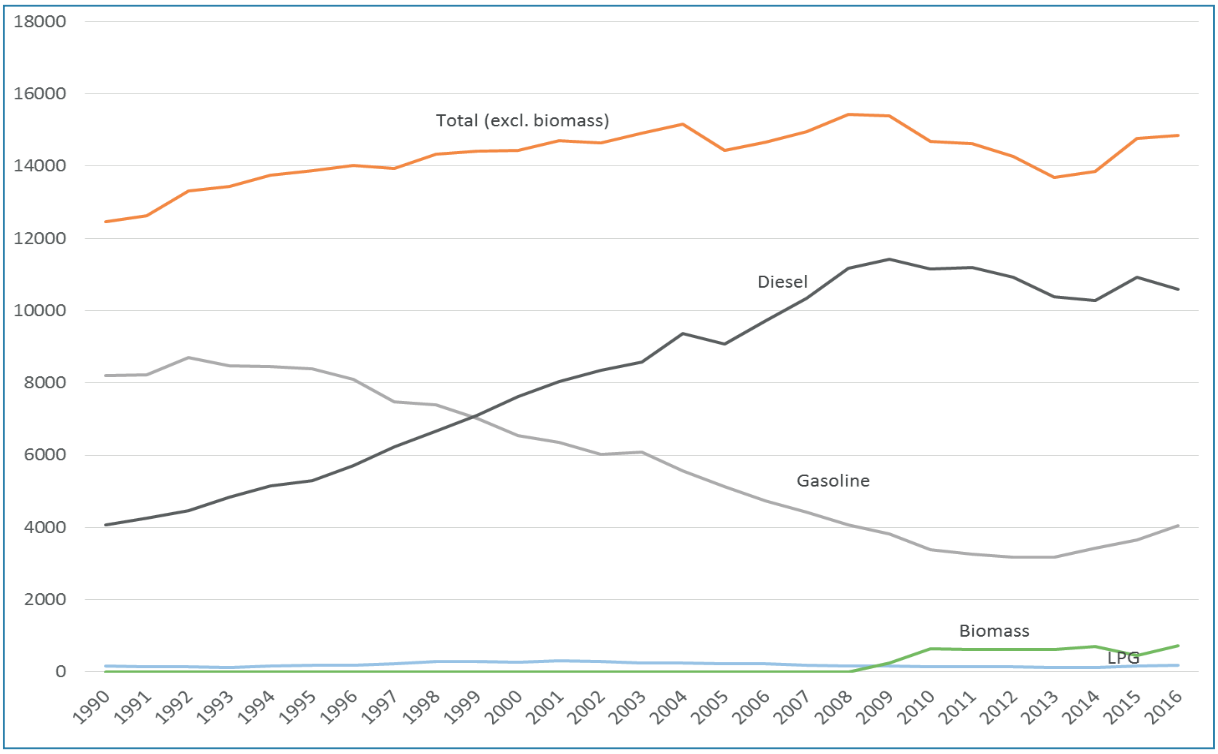
Same source: "There is a great variety in possibilities, each with its own specific investment and operational cost. Figure A.3.22 depicts a non-exhaustive list of choices: air coupled heat pump (ACHP), high temperature air coupled heat pump (HT ACHP), hybrid heat pump (HHP), ground coupled heat pump (GCHP), ground water heat pump (GWHP), gas condensing boiler (GCB), heating oil condensing boiler (HOCB) and gas heat pump (GHP). The choice of system depends on a lot of local boundary conditions, such as the heating power needed, the current and expected energy prices, the presence of a gas distribution network, the legal limitation on drilling depth for GCHP or GWHP and subsidies by local authorities.

For large buildings such as buildings in the commercial & service sector and apartment blocks, the choice of heating system is even more diverse. Given the large heat and/or cold demand, it becomes economically more favorable to combine multiple heat and/or cold production systems and use systems which benefit from an economy of scale, such as cogeneration."

APPENDIX 4 ADDITIONAL INFORMATION ON THE TRANSPORT SECTOR

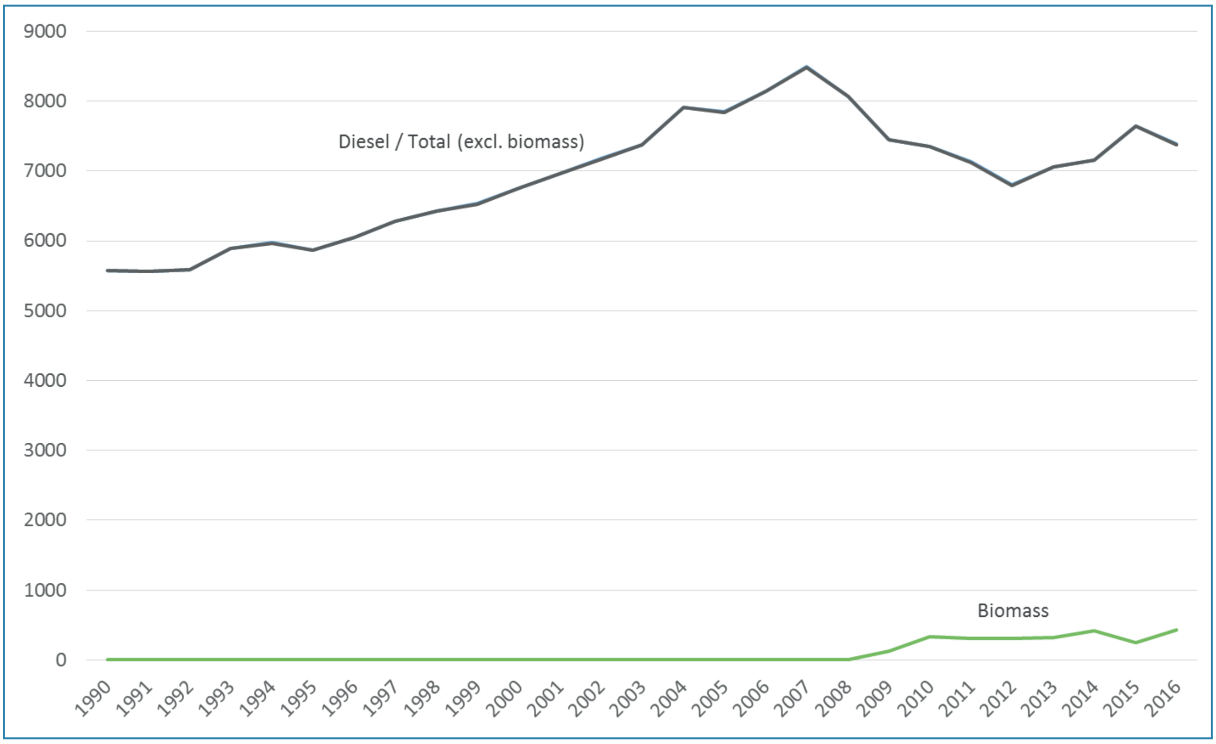
1. GHG emissions, key indicators / characteristics and low carbon scenario

A.4.1: Historical CO_2 emissions of cars per energy source (in $ktCO_2$)



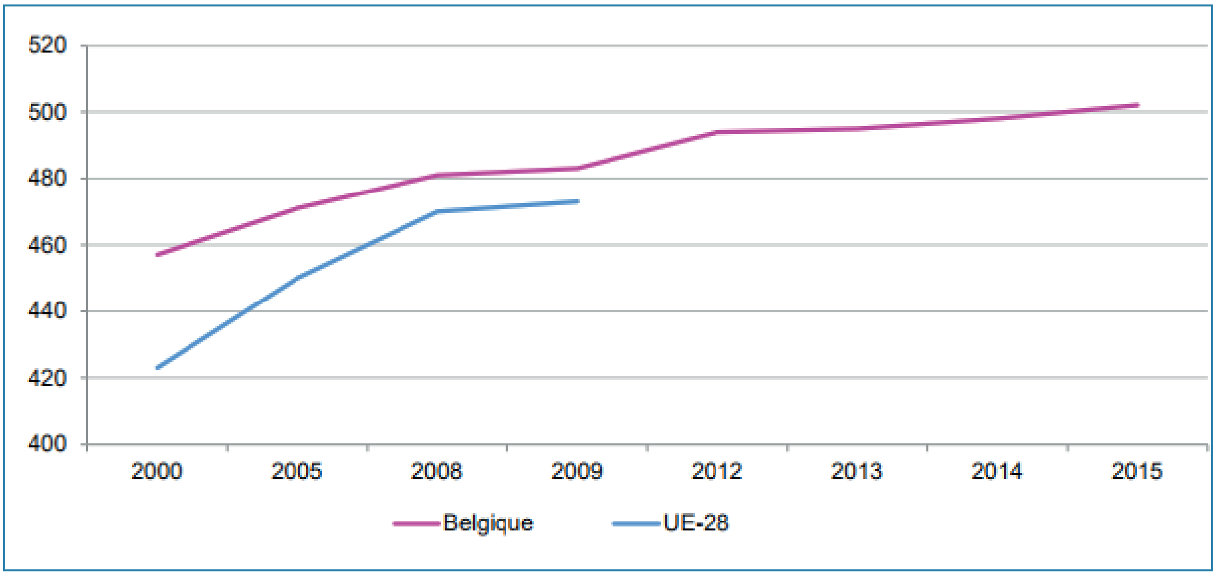
Source: NIR 2018

A.4.2: Historical CO_2 emissions of heavy duty trucks and buses per energy source (in $ktCO_2$)



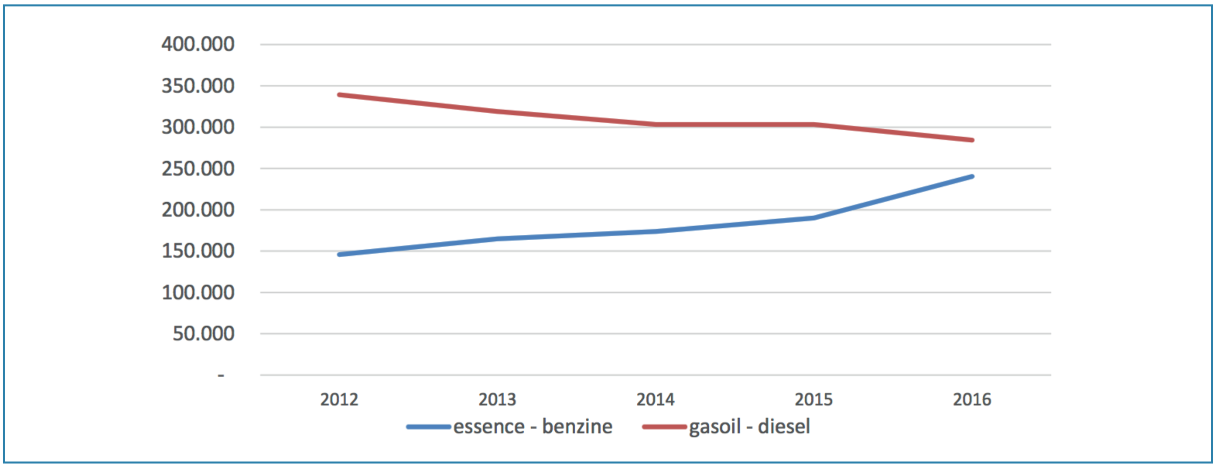
Source: NIR 2018

A.4.3: Car density (in number of cars for 1.000 inhabitants)



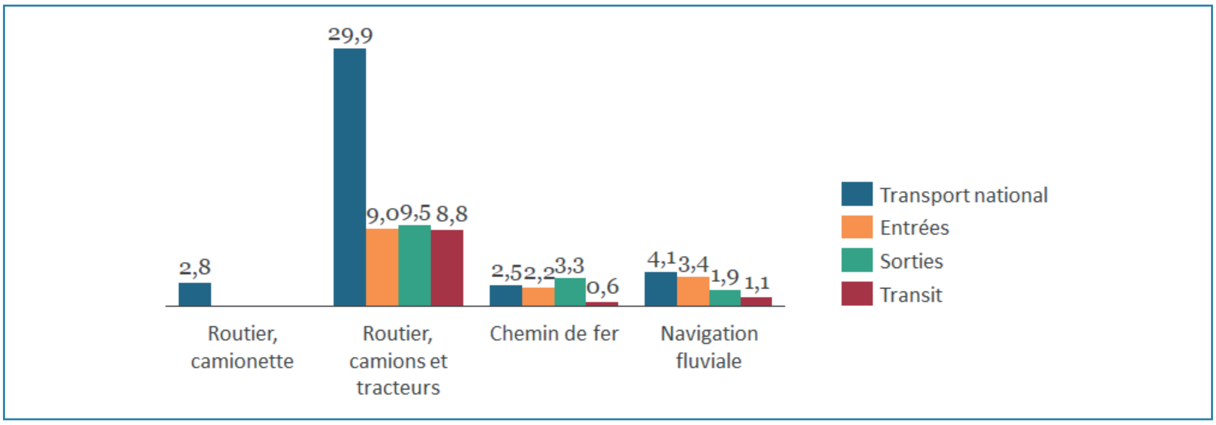
Source: FPS Economy

A.4.4: Annual registrations of new cars in Belgium (2012-2016)



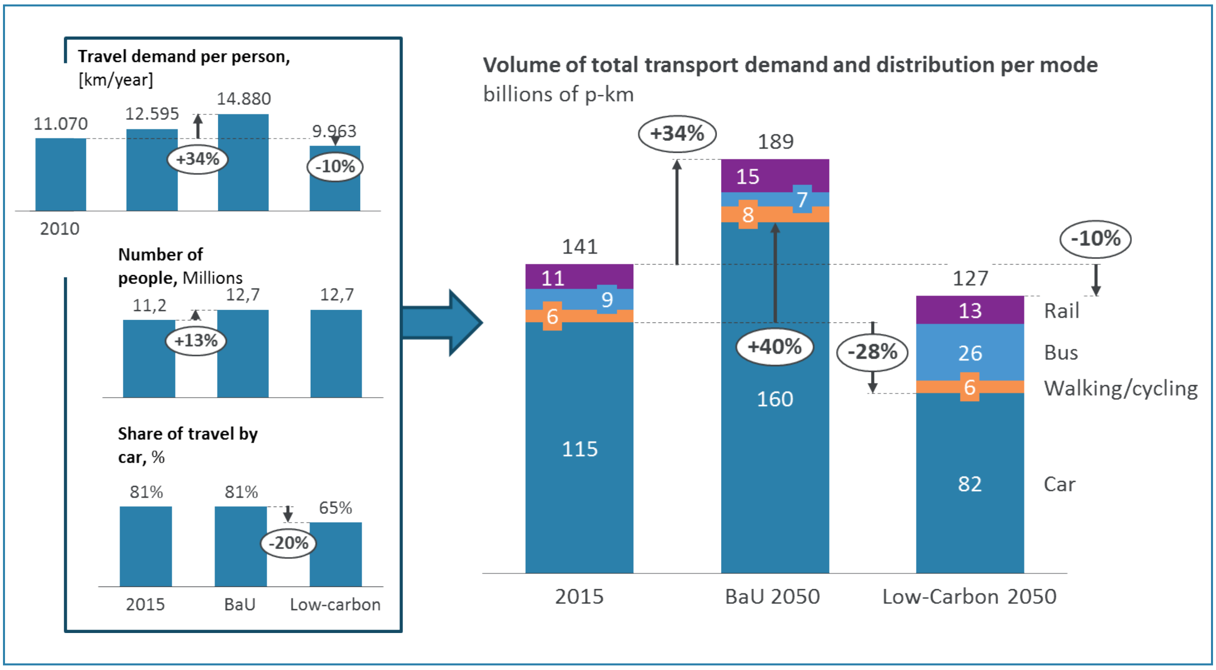
Source: FPS Economy

A.4.5: Freight transport by mode and activity in 2014 (in million t.km)

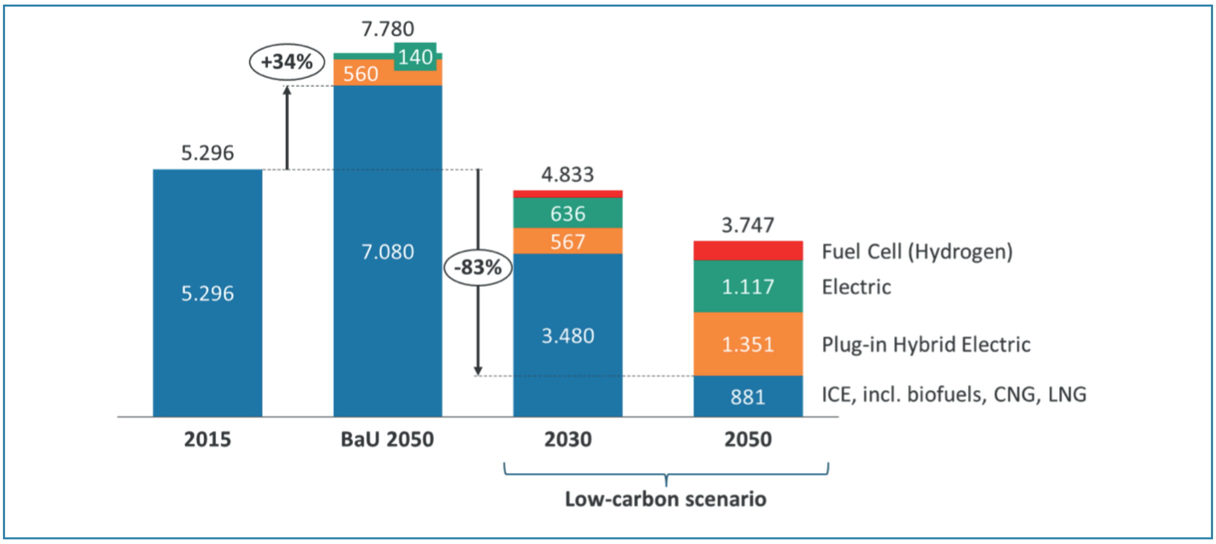


Source: Federal Planning Bureau

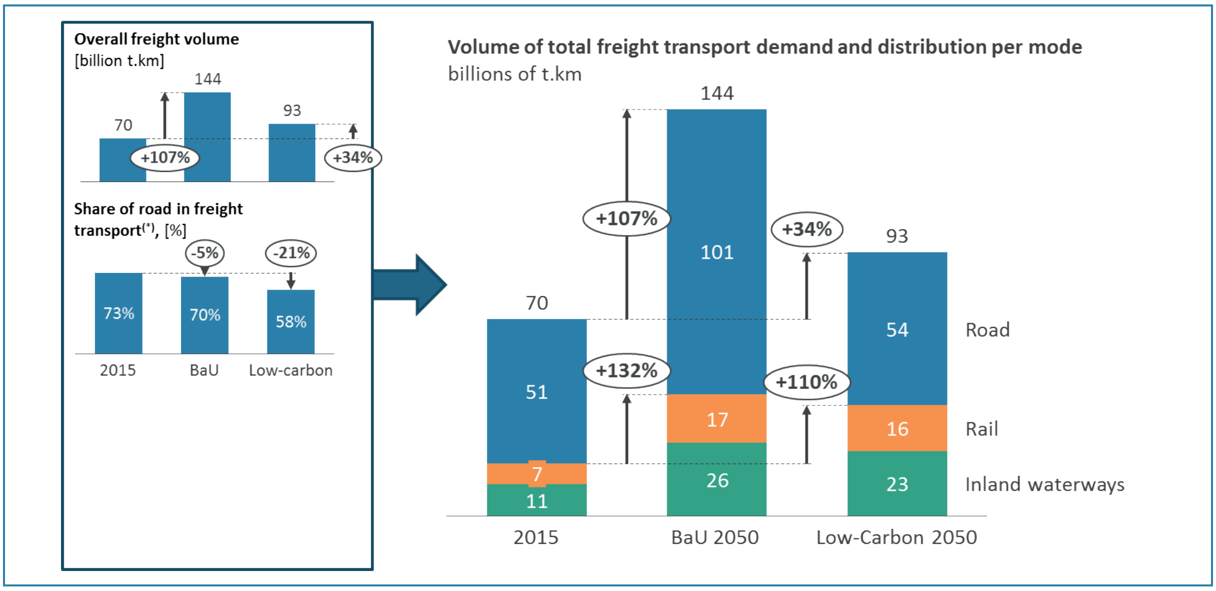
A.4.6: Assumptions driving the passenger transport demand in the BaU and the low-carbon scenario



A.4.7: Fleet of vehicles in the BaU and the low-carbon scenario (in thousands of units)

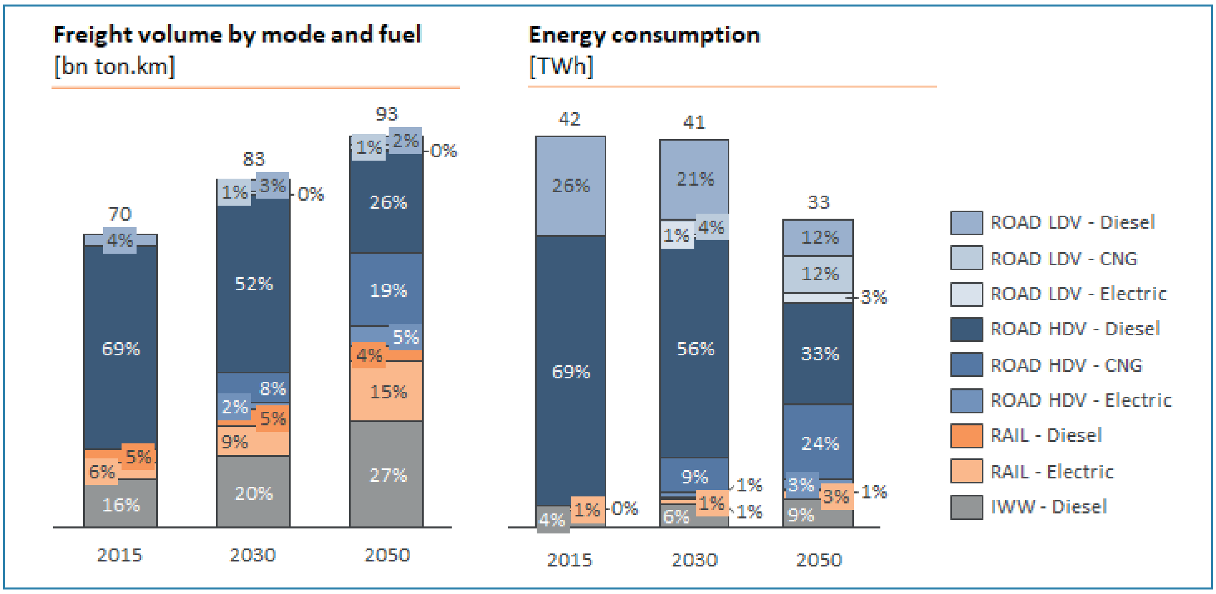


A.4.8: Assumptions driving the freight transport demand in the BaU and the low-carbon scenario

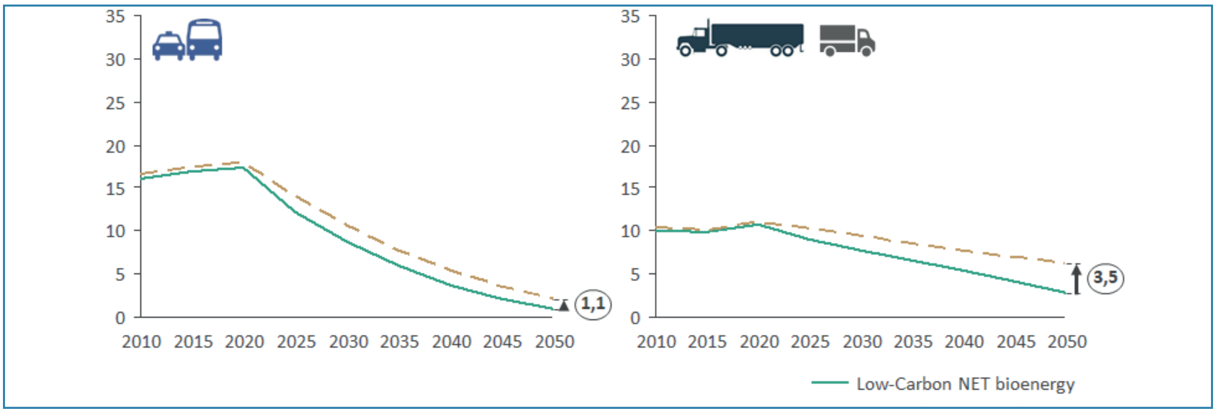


Emission reductions in freight transport rely on a decoupling of economic growth and transported volumes of goods (A.4.9) with lower ambition on road transport electrification w.r.t. passenger transport (A.4.11).

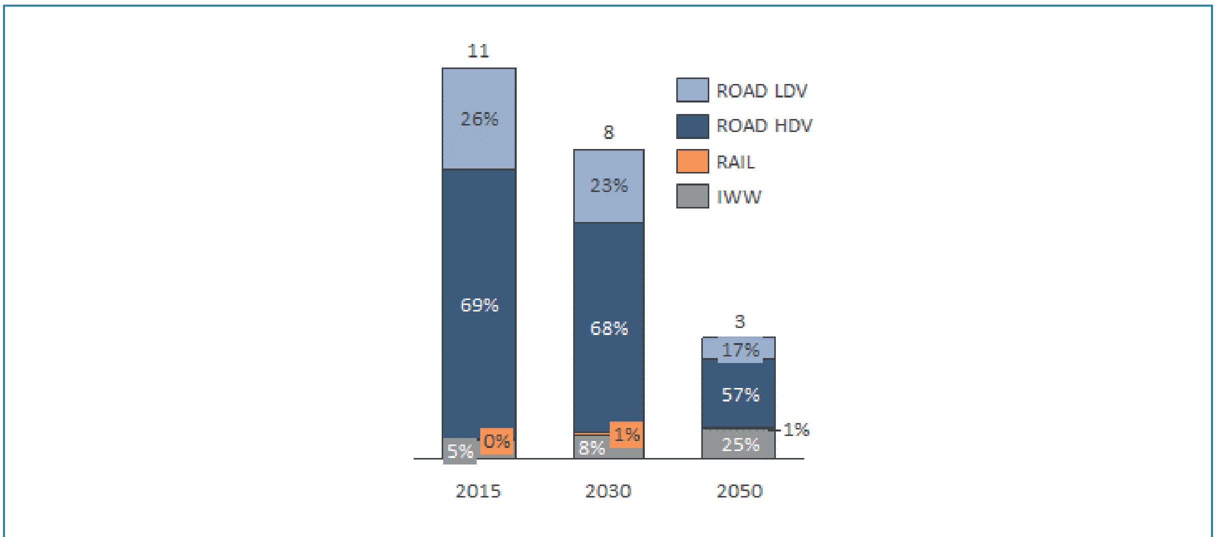
A.4.9: Evolution of freight transport volume and energy consumption in the low-carbon scenario



A.4.10: GHG emissions in passenger and freight transport, net and gross bioenergy in the low-carbon scenario (in $MtCO_2e$)

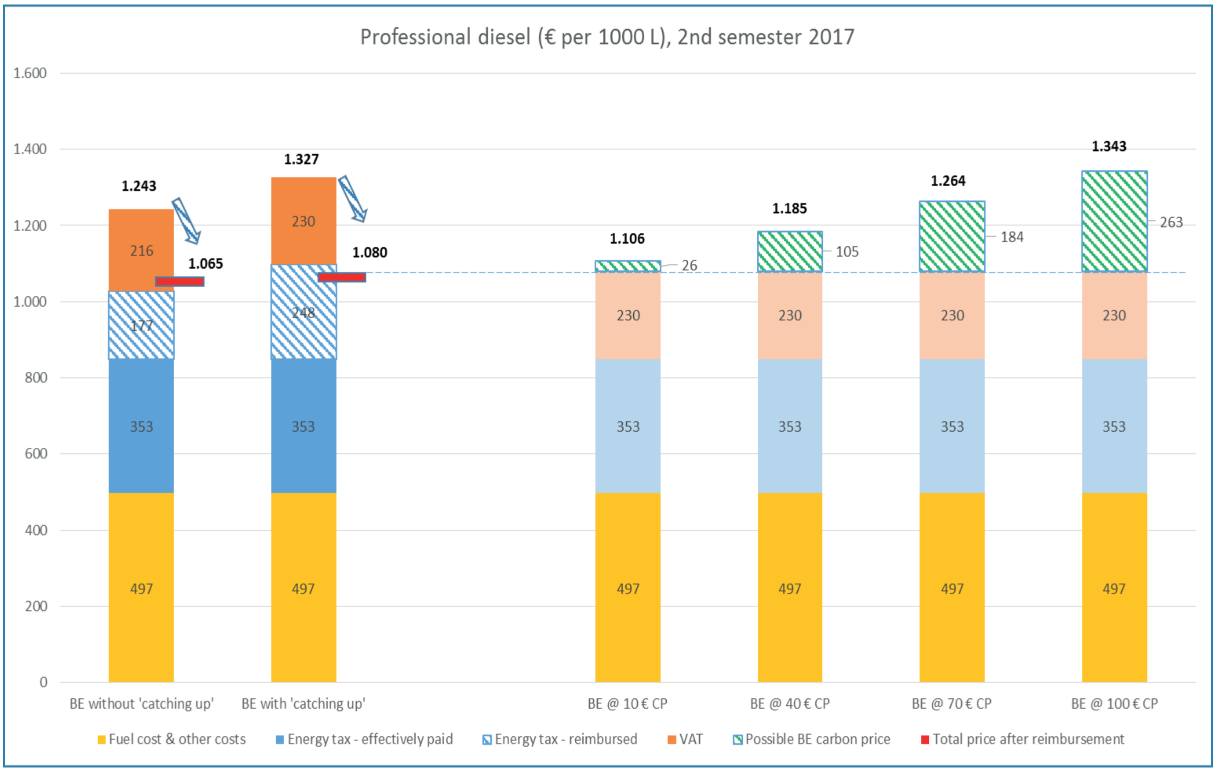


A.4.11: GHG emissions of freight transport by mode in the low-carbon scenario corresponding to the mode distribution shown in Figure A.4.9 (in $MtCO_2e$)

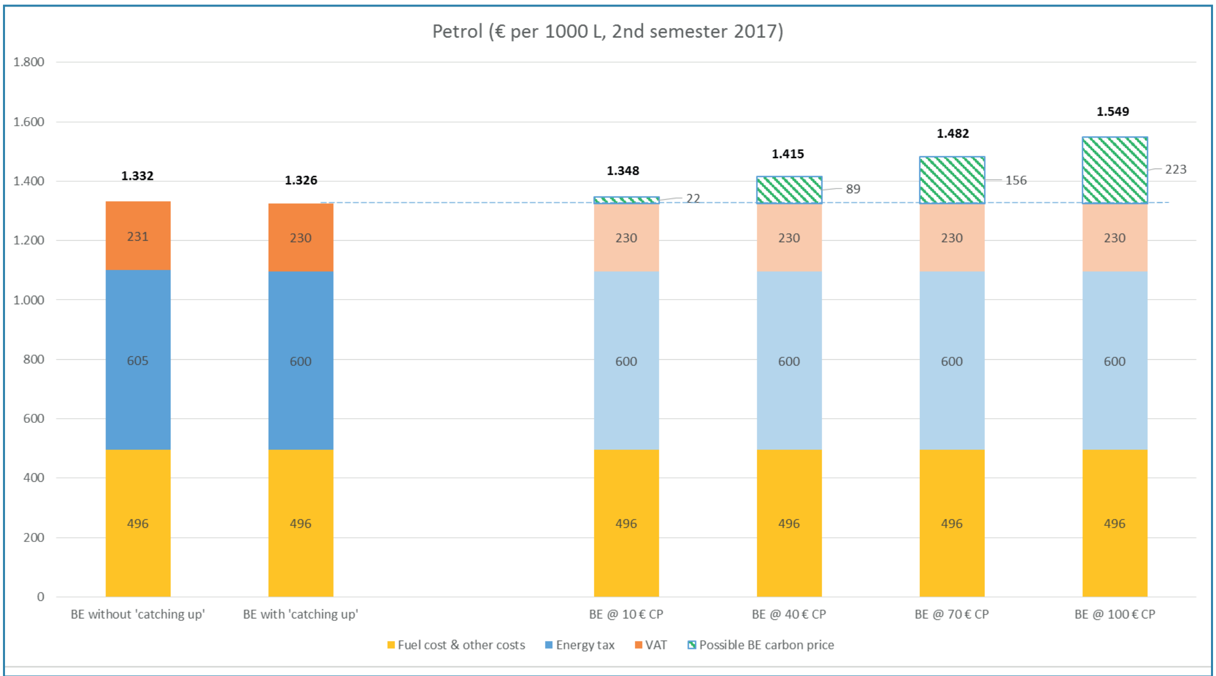


2. Expected prices of diesel and petrol in Belgium after the catching-up of excise duties[127]

A.4.12: Expected final price of professional diesel following the catching-up of excise duties



A.4.13: Expected final price of petrol following the catching-up of excise duties



127 Using the same sources and methodology as the other analyses. Assumption that all parameters other than the excise duties remain constant up till the end of 2018.

A.4.14: Benchmark analysis professional diesel

Professional diesel (EUR/1000 L)								
	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Situation as it is at the end of 2017								
Final prices (including reimbursements and diesel-petrol 'catch up' until the end of 2017)	1.065	1.105	1.214	1.155	987	1.116	1.158	1.160
Difference with BE (abs)	0	-40	-149	-90	78	-50	-93	-95
Difference (%)	0%	-4%	-12%	-8%	8%	-5%	-8%	-8%
CP to close the gap	0,00	15,35	56,77	34,23	29,54	19,20	35,45	36,06
Scenario at the beginning of 2019 (FR carbon tax at 55€/tCO_2), without BE CP								
Final prices	1.080	1.110	1.214	1.155	987	1.117	1.160	1.162
Difference (abs)	0	-31	-135	-75	92	-37	-80	-83
Difference (%)	0%	-3%	-11%	-7%	9%	-3%	-7%	-7%
Scenario at the beginning of 2019 (FR carbon tax at 55€/tCO_2), with 10€ BE CP								
Final prices	1.106	1.110	1.214	1.155	987	1.117	1.160	1.162
Difference (abs)	0	-4	-108	-49	119	-11	-54	-56
Difference (%)	0%	0%	-9%	-4%	12%	-1%	-5%	-5%
Scenario at the beginning of 2030 (FR carbon tax at 100€/tCO_2), with 70€ BE CP								
Final prices	1.264	1.119	1.214	1.155	987	1.119	1.163	1.167
Difference (abs)	0	145	50	109	277	145	101	97
Difference (%)	0%	13%	4%	9%	28%	13%	9%	8%

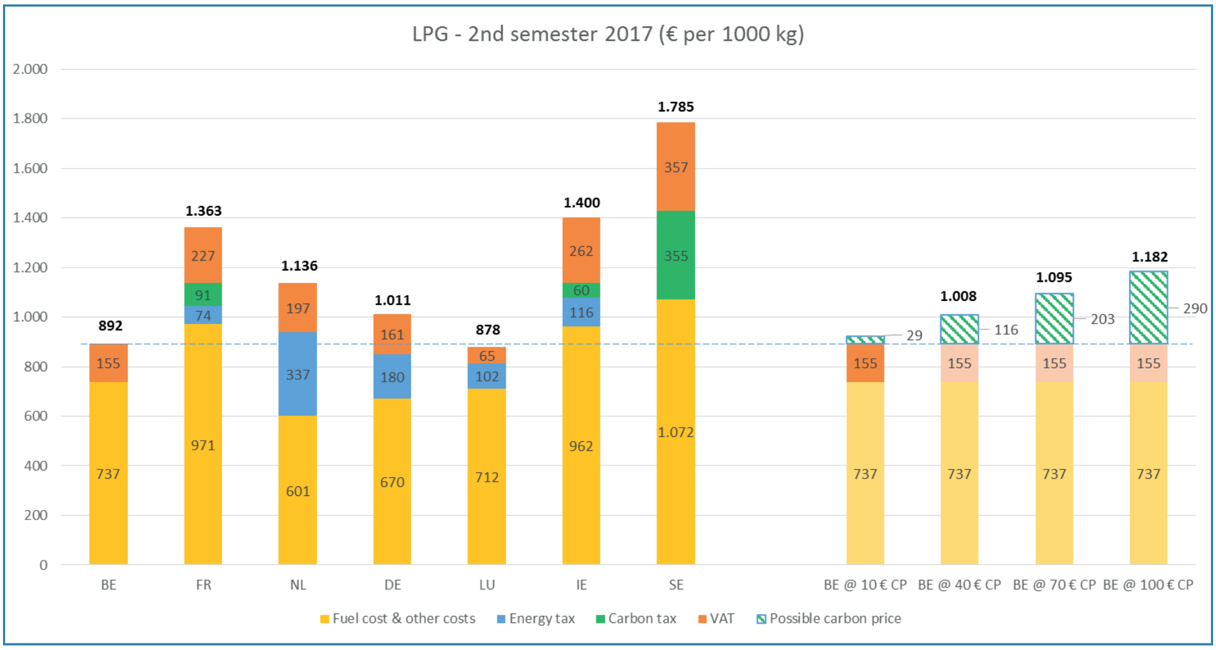
A.4.15: Benchmark analysis non-professional diesel

Non-professional diesel (EUR/1000 L)								
	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Situation as it is at the end of 2017								
Final prices (including diesel-petrol 'catch up' until the end of 2017)	1.243	1.220	1.214	1.155	987	1.144	1.196	1.217
Difference with BE (abs)	0	23	28	87	255	98	46	26
Difference (%)	0%	2%	2%	8%	26%	9%	4%	2%
CP to close the gap	0,00	8,70	10,70	33,23	97,01	37,41	17,54	9,70
Scenario at the beginning of 2019 (FR carbon tax at 55€/tCO_2), without BE CP								
Final prices	1.327	1.284	1.214	1.155	987	1.160	1.218	1.249
Difference (abs)	0	43	113	172	340	167	110	78
Difference (%)	0%	3%	9%	15%	34%	14%	9%	6%
Scenario at the beginning of 2019 (FR carbon tax at 55€/tCO_2), with 10€ BE CP								
Final prices	1.354	1.284	1.214	1.155	987	1.160	1.218	1.249
Difference (abs)	0	70	139	199	366	193	136	105
Difference (%)	0%	5%	11%	17%	37%	17%	11%	8%
Scenario at the beginning of 2030 (FR carbon tax at 100€/tCO_2), with 70€ BE CP								
Final prices	1.512	1.402	1.214	1.155	987	1.190	1.257	1.308
Difference (abs)	0	109	297	356	524	322	254	203
Difference (%)	0%	8%	24%	31%	53%	27%	20%	16%

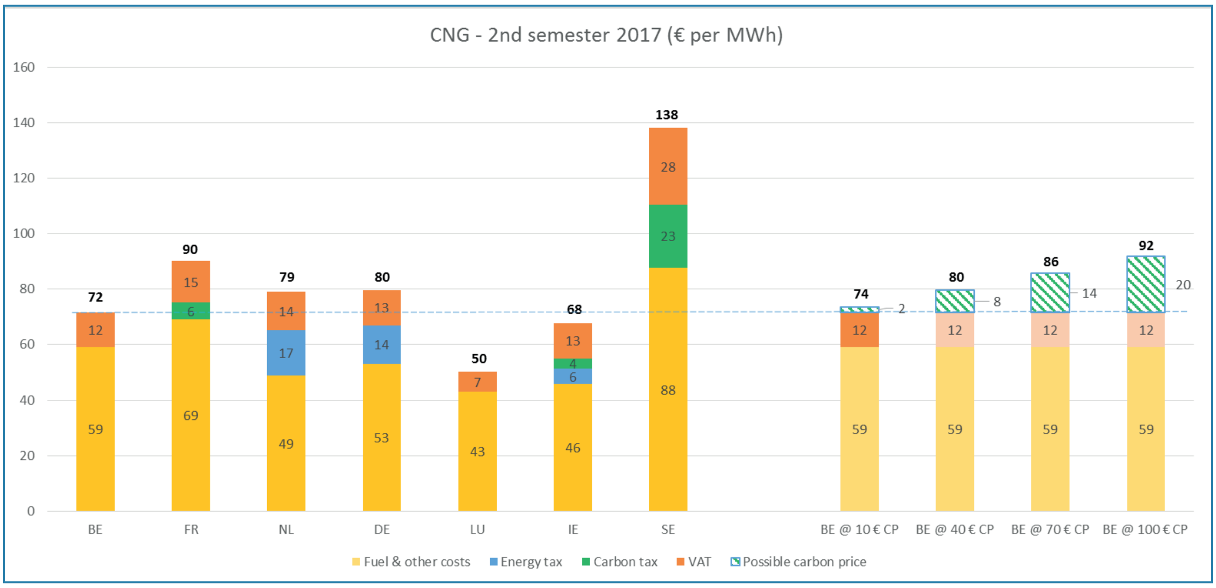
A.4.16: Benchmark analysis petrol

Petrol (EUR/1000L)								
	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Situation as it is at the end of 2017								
Final prices (including diesel-petrol 'catch up' until the end of 2017)	1.332	1.360	1.544	1.362	1.150	1.354	1.422	1.452
Difference with BE (abs)	0	-28	-212	-31	182	-22	-90	-120
Difference (%)	0%	-2%	-14%	-2%	16%	-2%	-6%	-8%
CP to close the gap	0,00	12,61	94,95	13,68	81,54	9,92	40,41	53,78
Scenario at the beginning of 2019 (FR carbon tax at 55€/tCO_2), without BE CP								
Final prices	1.326	1.415	1.544	1.362	1.150	1.368	1.440	1.479
Difference (abs)	0	-89	-218	-36	176	-42	-114	-153
Difference (%)	0%	-6%	-14%	-3%	15%	-3%	-8%	-10%
Scenario at the beginning of 2019 (FR carbon tax at 55€/tCO_2), with 10€ BE CP								
Final prices	1.348	1.415	1.544	1.362	1.150	1.368	1.440	1.479
Difference (abs)	0	-66	-195	-14	198	-19	-92	-131
Difference (%)	0%	-5%	-13%	-1%	17%	-1%	-6%	-9%
Scenario at the beginning of 2030 (FR carbon tax at 100€/tCO_2), with 70€ BE CP								
Final prices	1.482	1.515	1.544	1.362	1.150	1.393	1.474	1.529
Difference (abs)	0	-33	-62	120	332	89	8	-47
Difference (%)	0%	-2%	-4%	9%	29%	6%	1%	-3%

A.4.17: Comparison of final prices of LPG and impact of carbon price in Belgium



A.4.18: Comparison of final prices of CNG and impact of carbon price in Belgium



A.4.19: Benchmark analysis LPG

LPG (EUR/1000 kg)								
	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Situation as it is at the end of 2017								
Final prices	892	1.363	1.136	1.011	878	1.097	1.170	1.249
Difference with BE (abs)	0	-471	-244	-120	14	-205	-278	-358
Difference (%)	0%	-35%	-21%	-12%	2%	-19%	-24%	-29%
CP to close the gap	0,00	162,34	84,00	41,20	4,66	70,72	95,84	123,17
Scenario with 10€ BE CP								
Final prices	921	1.363	1.136	1.011	878	1.097	1.170	1.249
Difference (abs)	0	-442	-215	-91	43	-176	-249	-329
Difference (%)	0%	-32%	-19%	-9%	5%	-16%	-21%	-26%
Scenario with 70€ BE CP								
Final prices	1.095	1.363	1.136	1.011	878	1.097	1.170	1.249
Difference (abs)	0	-268	-41	84	217	-2	-75	-154
Difference (%)	0%	-20%	-4%	8%	25%	0%	-6%	-12%

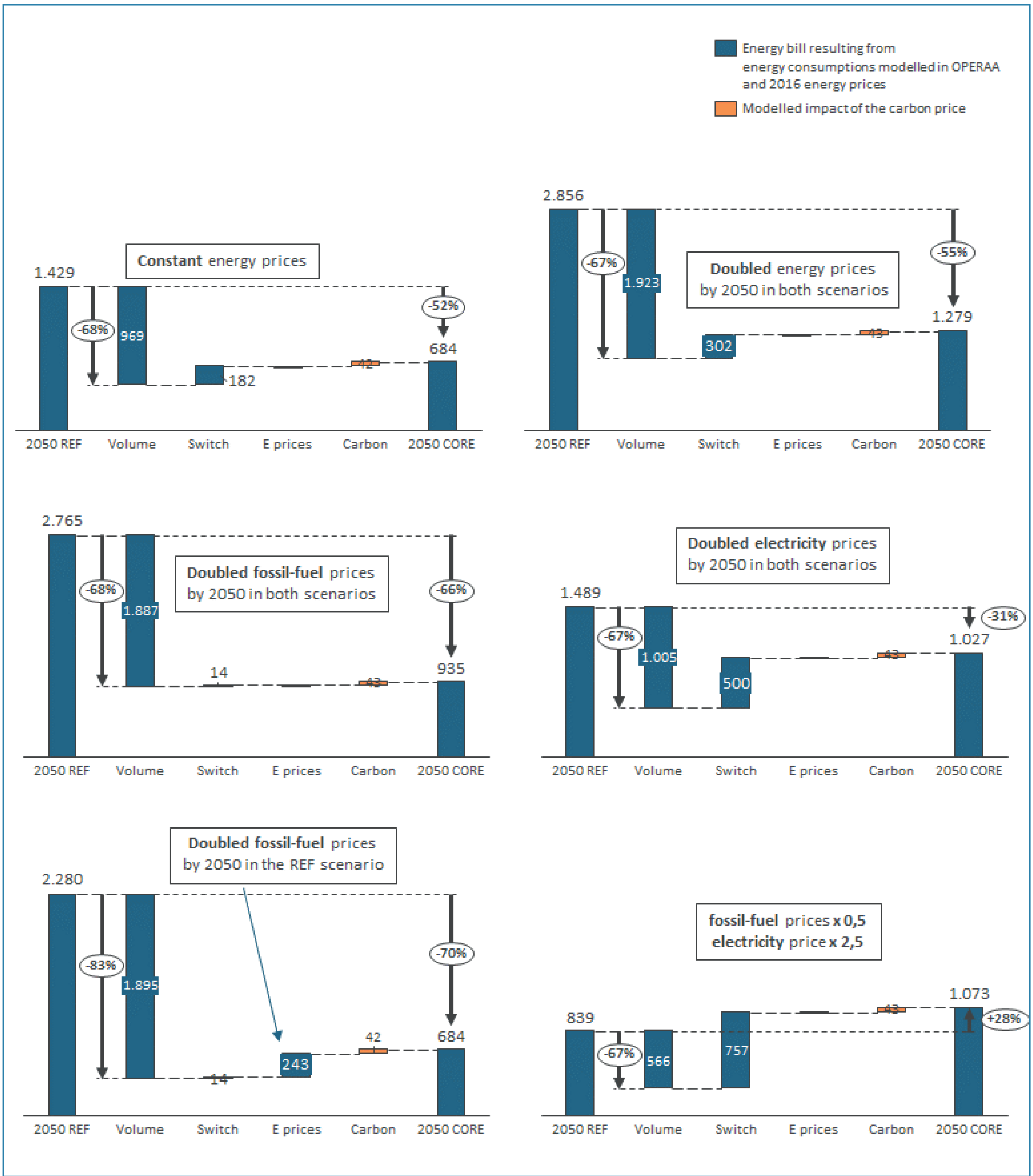
A.4.20: Benchmark analysis CNG

CNG (EUR/MWh)								
	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Situation as it is at the end of 2017								
Final prices	72	90	79	80	50	75	83	85
Difference with BE (abs)	0	-18	-7	-8	21	-3	-11	-13
Difference (%)	0%	-20%	-9%	-10%	43%	-4%	-14%	-15%
CP to close the gap	0,00	90,97	36,39	40,04	105,53	15,47	55,80	63,68
Scenario with 10€ BE CP								
Final prices	74	90	79	80	50	75	83	85
Difference (abs)	0	-16	-5	-6	23	-1	-9	-11
Difference (%)	0%	-18%	-7%	-8%	47%	-1%	-11%	-13%
Scenario with 70€ BE CP								
Final prices	86	90	79	80	50	75	83	85
Difference (abs)	0	-4	7	6	36	11	3	1
Difference (%)	0%	-5%	9%	8%	71%	15%	3%	2%

3. Impact on the energy bill: sensitivity analyses to energy prices

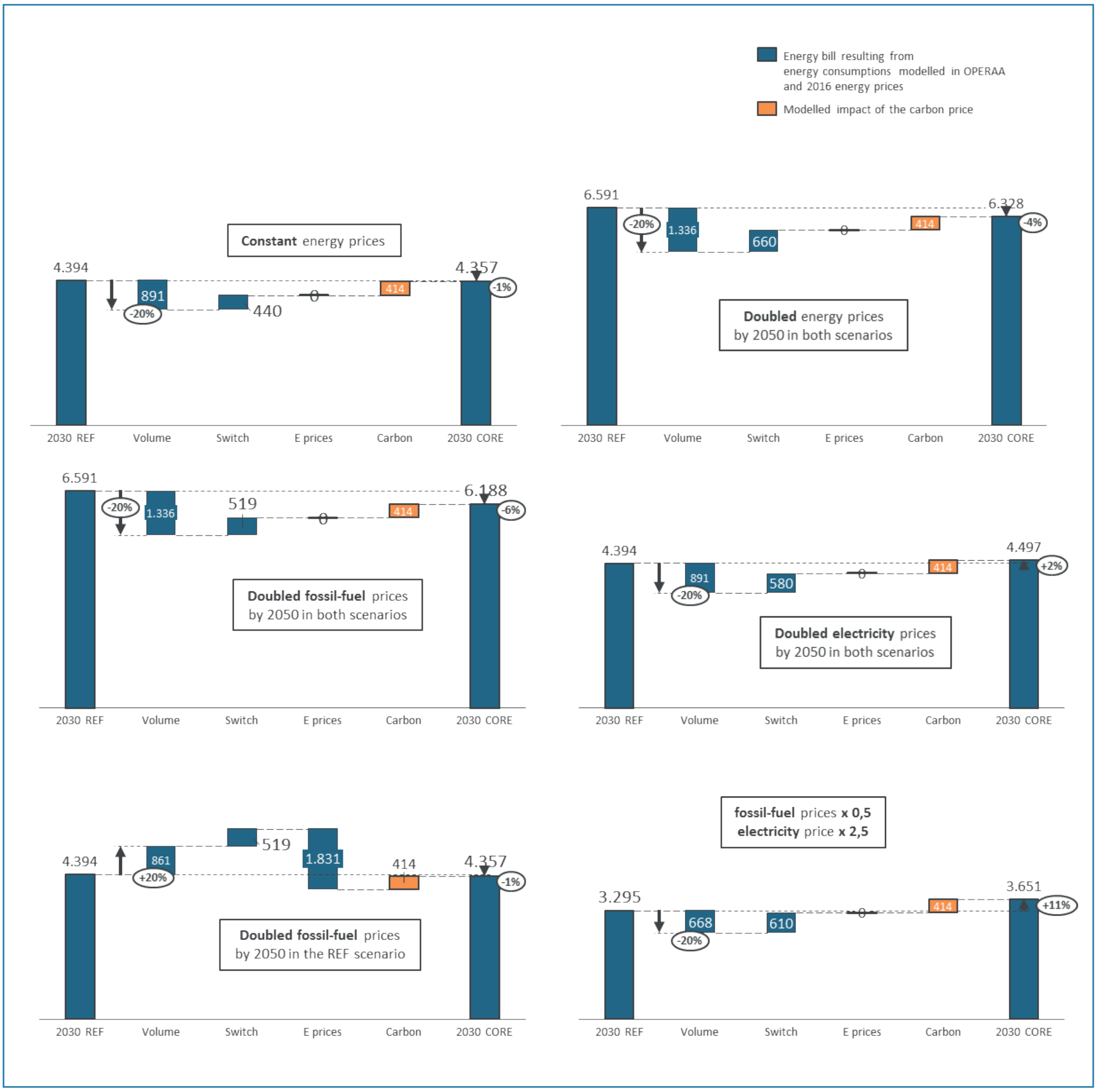
Passenger transport

A.4.21: Annual energy bill for transport by 2050 in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices (in €/vehicle/year)

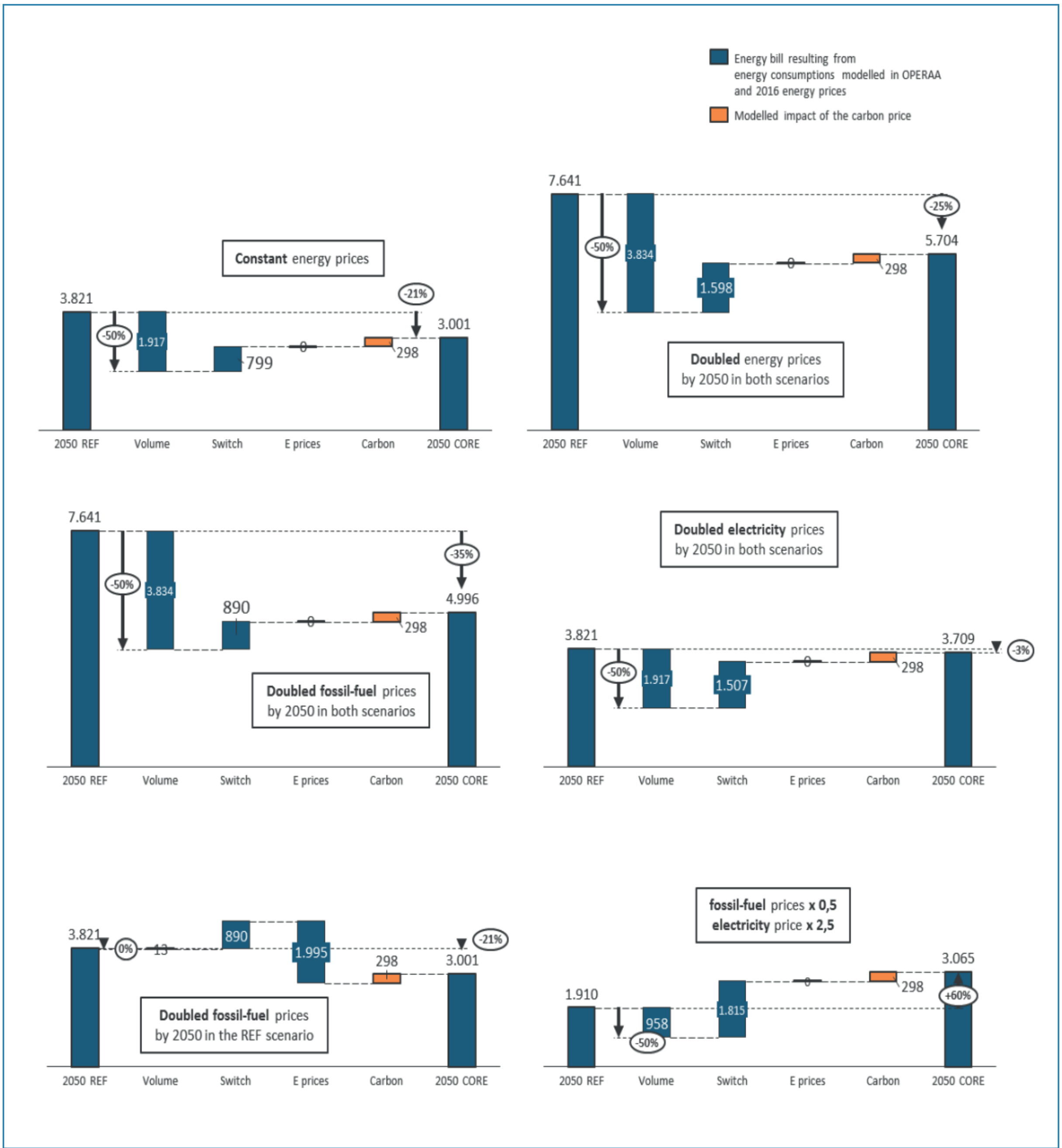


Freight transport

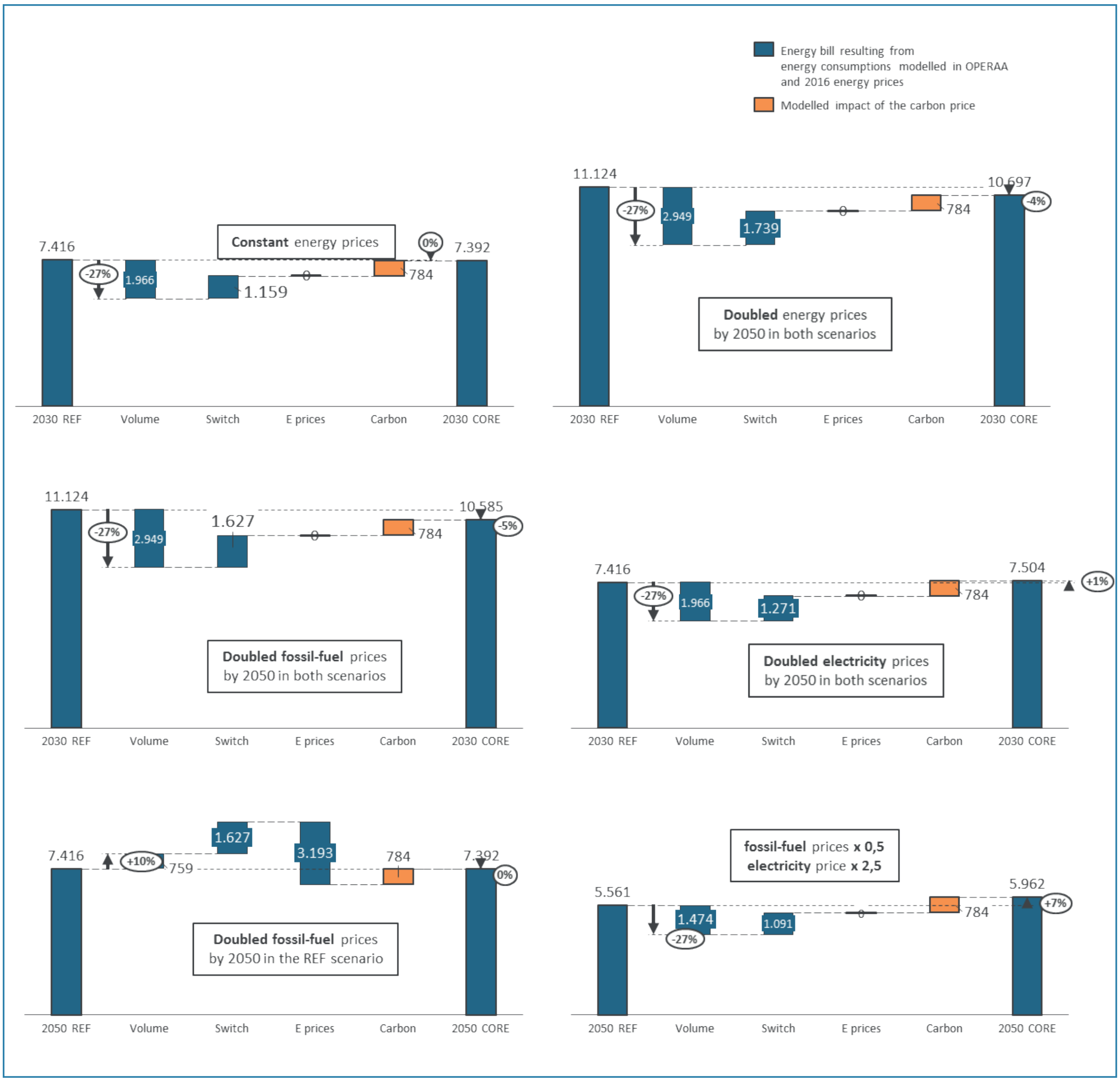
A.4.22: Average energy bill for **LDV** transport by 2030 in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices (in €/**10.000** t.km)



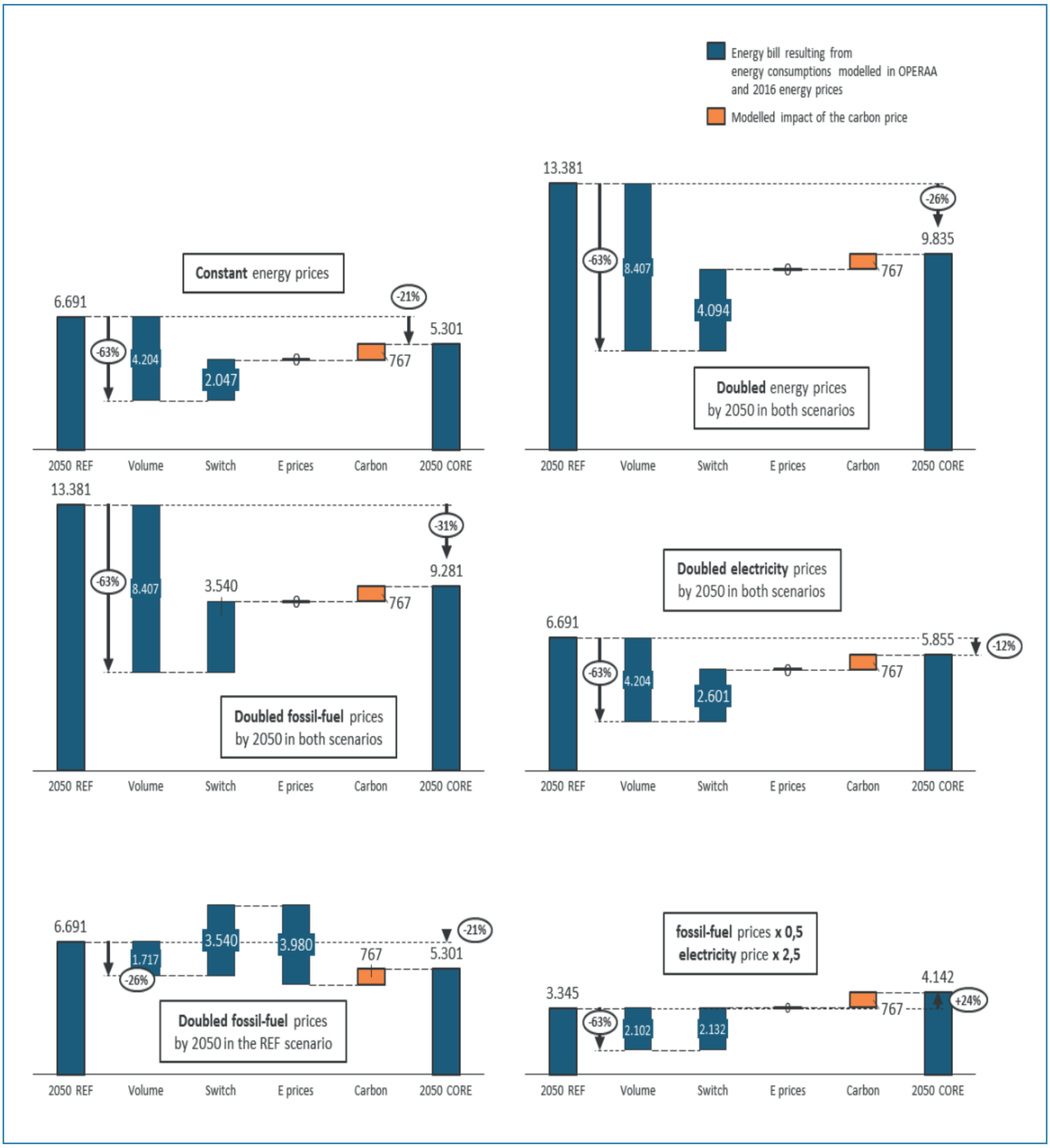
A.4.23: Average energy bill for LDV transport by 2050 in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices (in €/10.000 t.km)



A.4.24: Average energy bill for HDV transport by 2030 in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices (in €/100.000 t.km)



A.4.25: Average energy bill for HDV transport by 2050 in the BaU and the low-carbon scenario with different assumptions on the evolution of energy prices (in €/100.000 t.km)



4. Impact on public carbon revenues

A.4.26: Evolution of the annual public revenues from a carbon price applied to energy consumptions in transport under the three carbon price trajectories (in M€/year)

Carbon price trajectories		2020	2025	2030	2035	2040	2045	2050
A	€/tCO_2e	10,0	23,3	40,0	55,0	70,0	85,0	100,0
B	€/tCO_2e	10,0	40,8	70,0	100,0	130,0	160,0	190,0
C	€/tCO_2e	10,0	58,3	100,0	145,0	190,0	235,0	280,0
Option A								
Transport	M€	288,4	503,6	670,7	702,7	657,8	556,8	416,1
passengers	M€	172,8	281,7	344,6	323,8	262,6	182,2	101,1
freight	M€	115,5	221,9	326,1	378,9	395,2	374,6	315,0
Option B								
Transport	M€	288,4	872,4	1.146,3	1.236,6	1.175,0	1.005,9	762,2
passengers	M€	172,8	488,4	590,7	573,4	474,3	334,7	188,8
freight	M€	115,5	384,0	555,6	663,2	700,7	671,3	573,4
Option C								
Transport	M€	288,4	1.233,6	1.598,6	1.733,5	1.649,1	1.415,6	1.081,5
passengers	M€	172,8	691,1	826,3	809,2	673,5	479,2	273,5
freight	M€	115,5	542,5	772,3	924,3	975,5	936,4	808,1

A.4.27: Evolution of the annual public revenues from a carbon price applied to energy consumptions in freight transport under price trajectory B (in M€/year)

		2020	2025	2030	2035	2040	2045	2050
ROAD LDV	M€	29,33	93,75	130,93	150,27	151,40	135,53	102,39
ROAD HDV	M€	80,13	264,04	378,77	445,60	459,23	420,33	325,63
RAIL	M€	0,60	2,43	4,00	5,42	6,54	7,32	7,73
IWW	M€	5,48	23,95	42,84	64,10	87,04	112,19	140,88

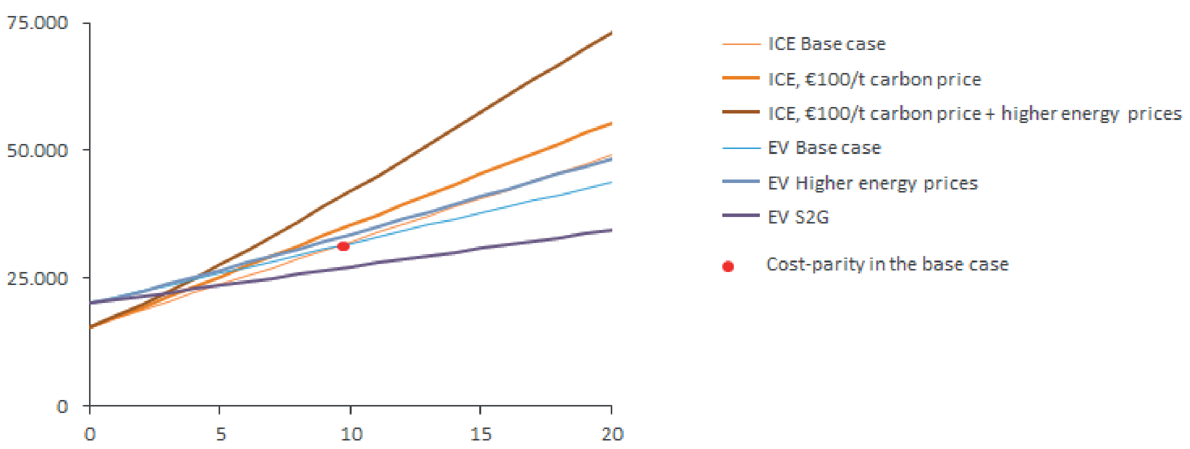
5. Profitability of investments

A.4.28: Vehicle characteristics considered in the micro-economic analysis

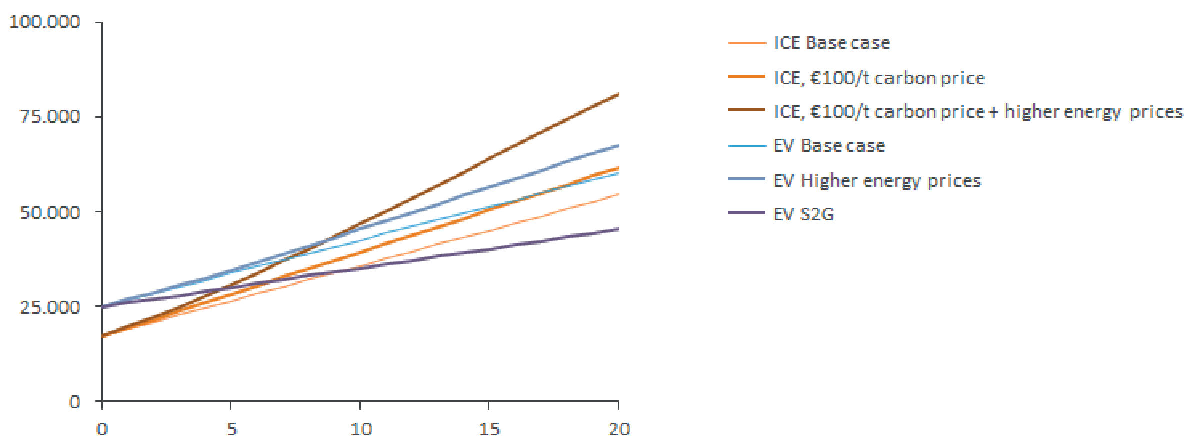
	EV			ICE		
	ADL Compact	**ADL Midsize**	Nissan Leaf	ADL Compact Ford Focus Titanium	**ADL Midsize** Honda Accord EX	VW Golf
Price with Battery /Price without	€26 300 €20 000	**€ 34 100** **€ 25 000**	€ 25 000 €19 000	€ 15 400	**€ 19 100**	€ 25 000
Consumption	8 km/kWh	**5 km/kWh**	5.7 km/kWh	7,8l/100km	**8,7l/100km**	4.1l/100km
Battery size /Autonomy	23 kWh	**34 kWh**	24 kWh	/	**/**	/
km	15 100	**15 100**	15 151	15 100	**15 100**	15 151

Source: Arthur D. Little, Battery Electric Vehicles vs. Internal Combustion Engine Vehicles

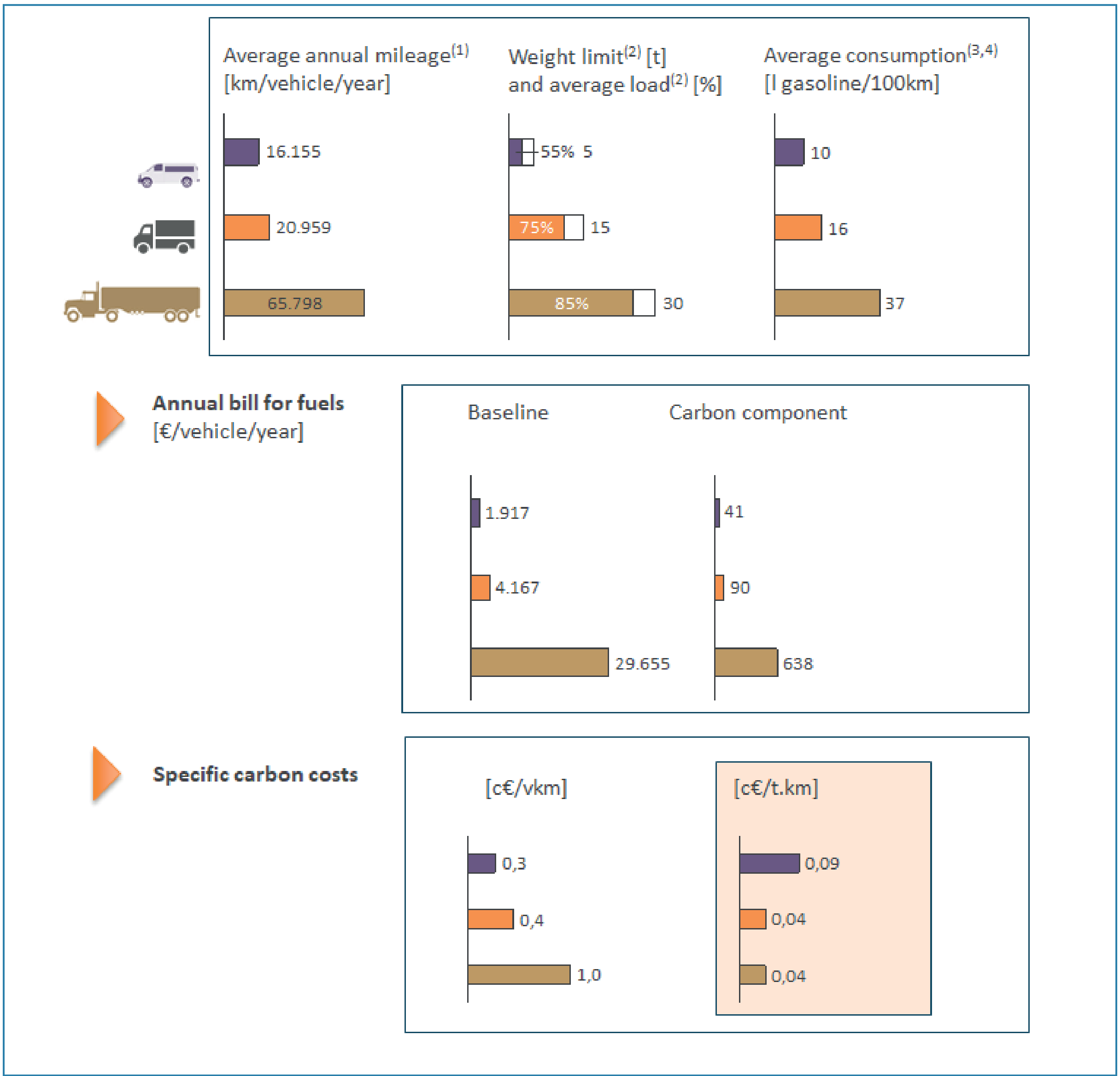
A.4.29: Cumulated expenses (investment, O&M, fuels) for compact vehicles in selected scenario (in € undiscounted)



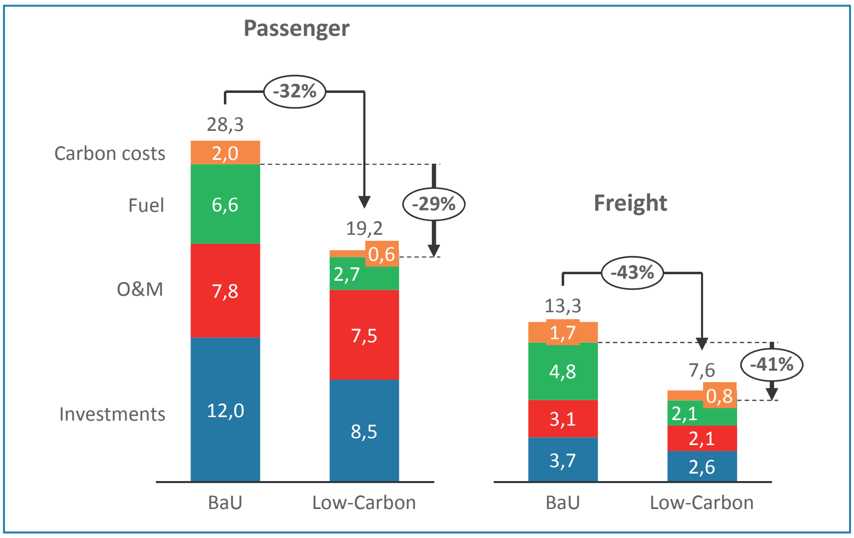
A.4.30: Cumulated expenses (investment, O&M, fuels) for midsize vehicles in selected scenario (in € undiscounted)



A.4.31: Illustration of possible carbon costs for 5t, 15t and 30t vehicles



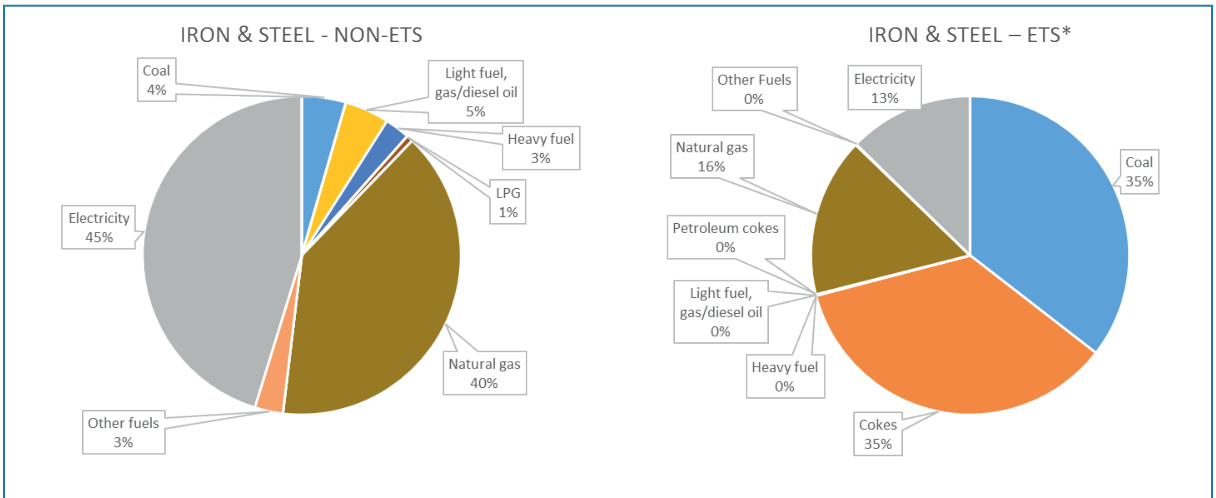
A.4.32: Average annual costs in transport with energy price evolutions described in Appendix 2, 2020-2050 (in b€/year)



APPENDIX 5 ADDITIONAL INFORMATION ON THE NON-ETS INDUSTRY

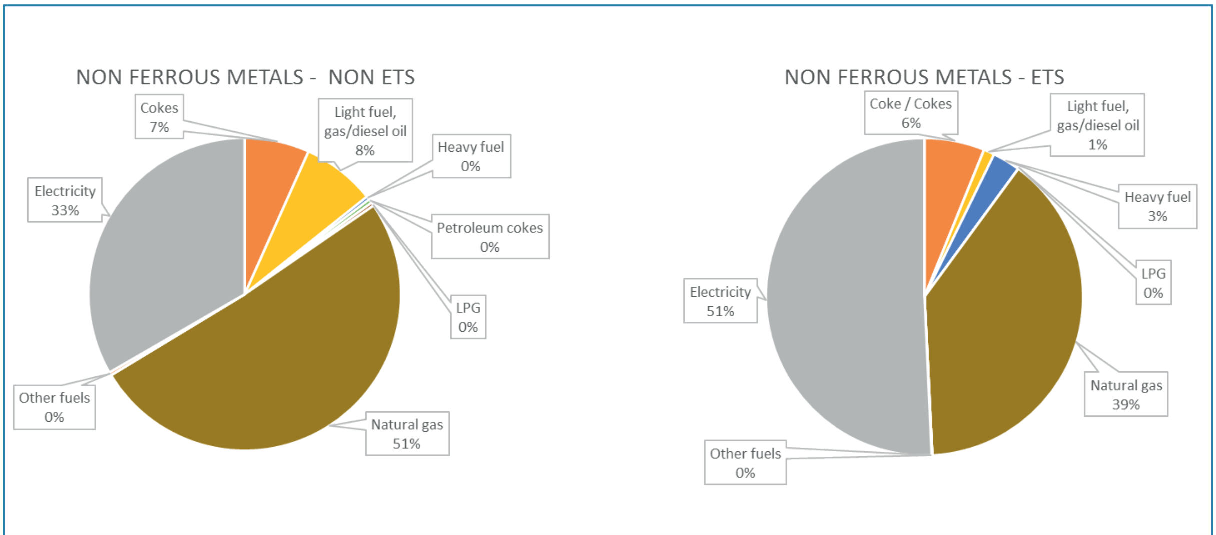
1. Energy consumption in every Belgian industrial subsector per energy vector, ETS vs non-ETS (2015 data for the Walloon Region, 2016 data for the Flemish region)

A.5.1: Energy consumption per energy vector in the Iron & Steel industry, ETS vs non-ETS

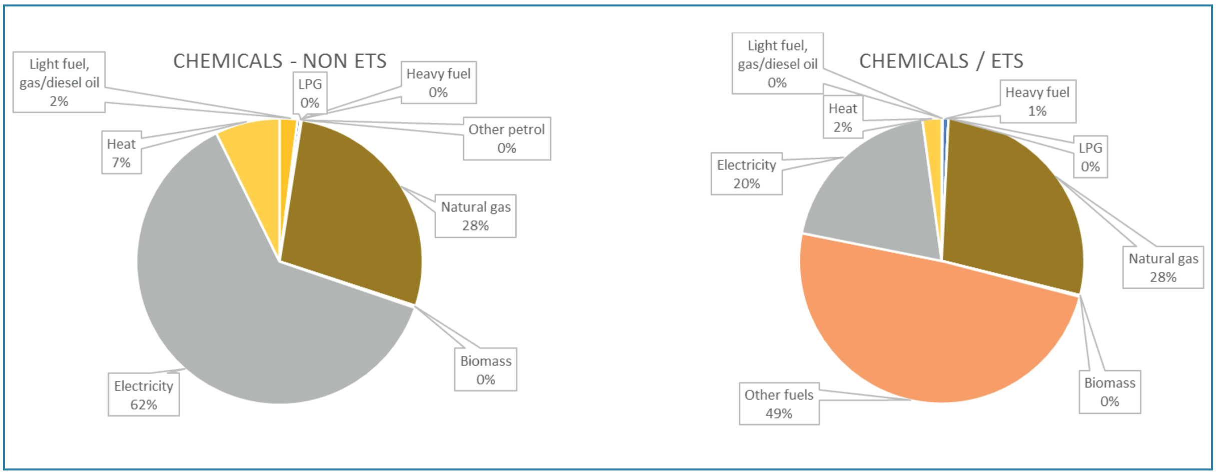


* Not taking into account blast furnace gas, for which the sector is a net exporter

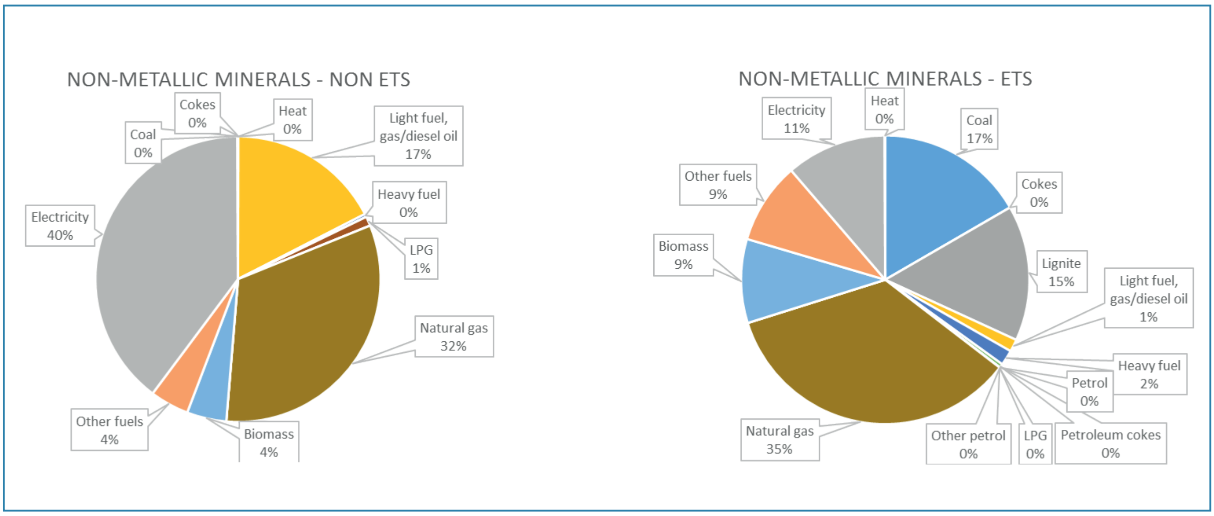
A.5.2: Energy consumption per energy vector in the Non-ferrous metals industry, ETS vs non-ETS



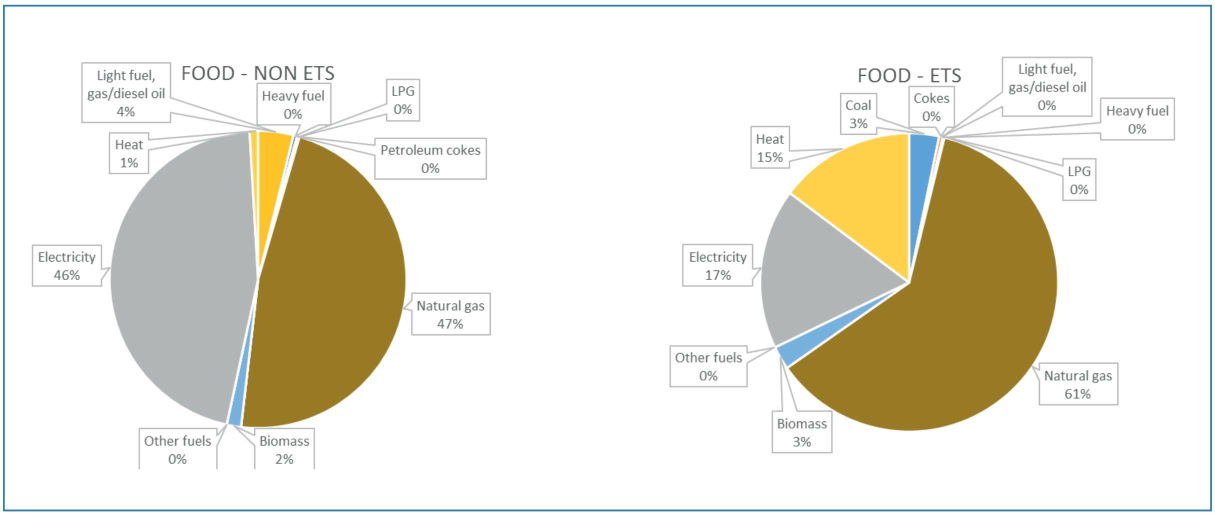
A.5.3: Energy consumption per energy vector in the Chemicals industry, ETS vs non-ETS



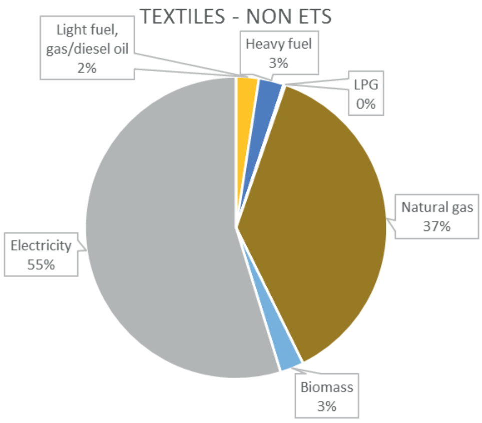
A.5.4: Energy consumption per energy vector in the Non-metallic minerals industry, ETS vs non-ETS

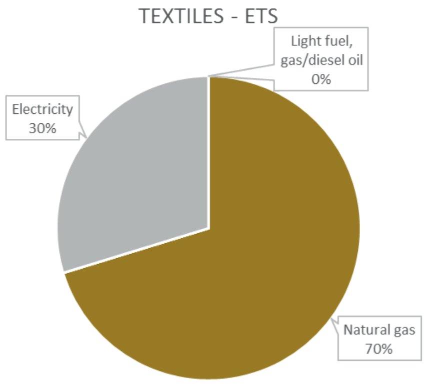


A.5.5: Energy consumption per energy vector in the Food industry, ETS vs non-ETS

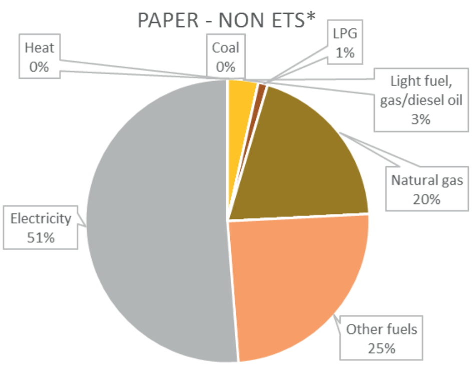


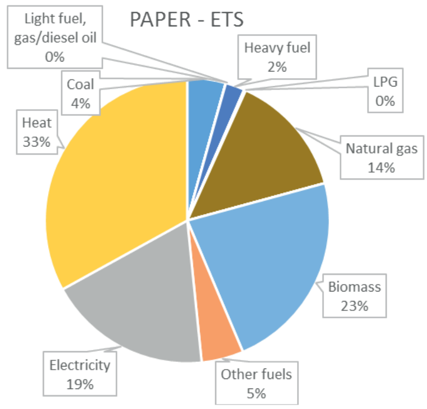
A.5.6: Energy consumption per energy vector in the Textile industry, ETS vs non-ETS





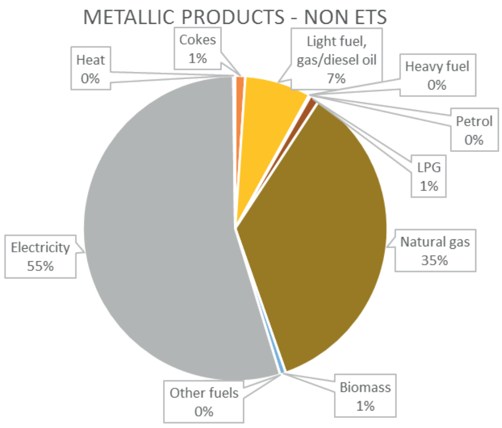
A.5.7: Energy consumption per energy vector in the Paper industry, ETS vs non-ETS

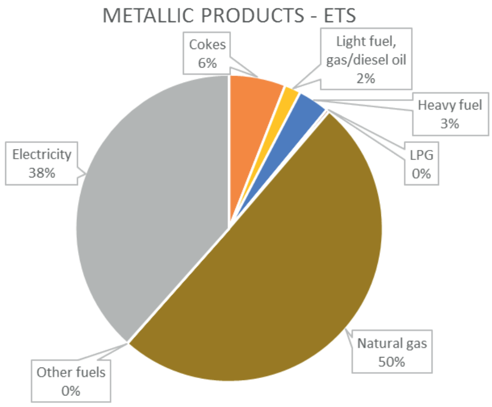




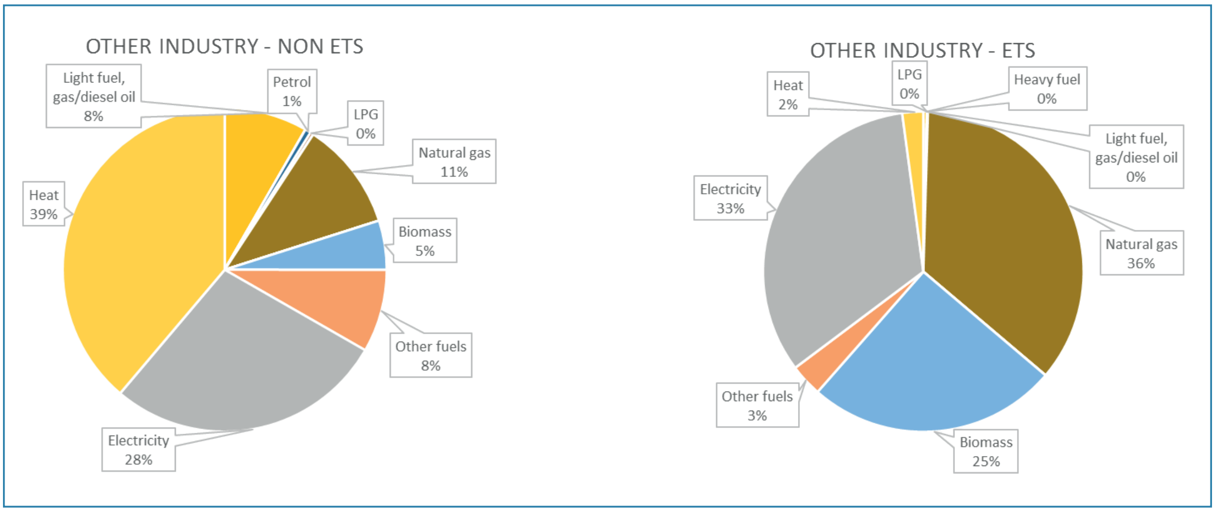
*Not taking into account biomass, for which the sector is a net exporter

A.5.8: Energy consumption per energy vector in the Metallic products industry, ETS vs non-ETS



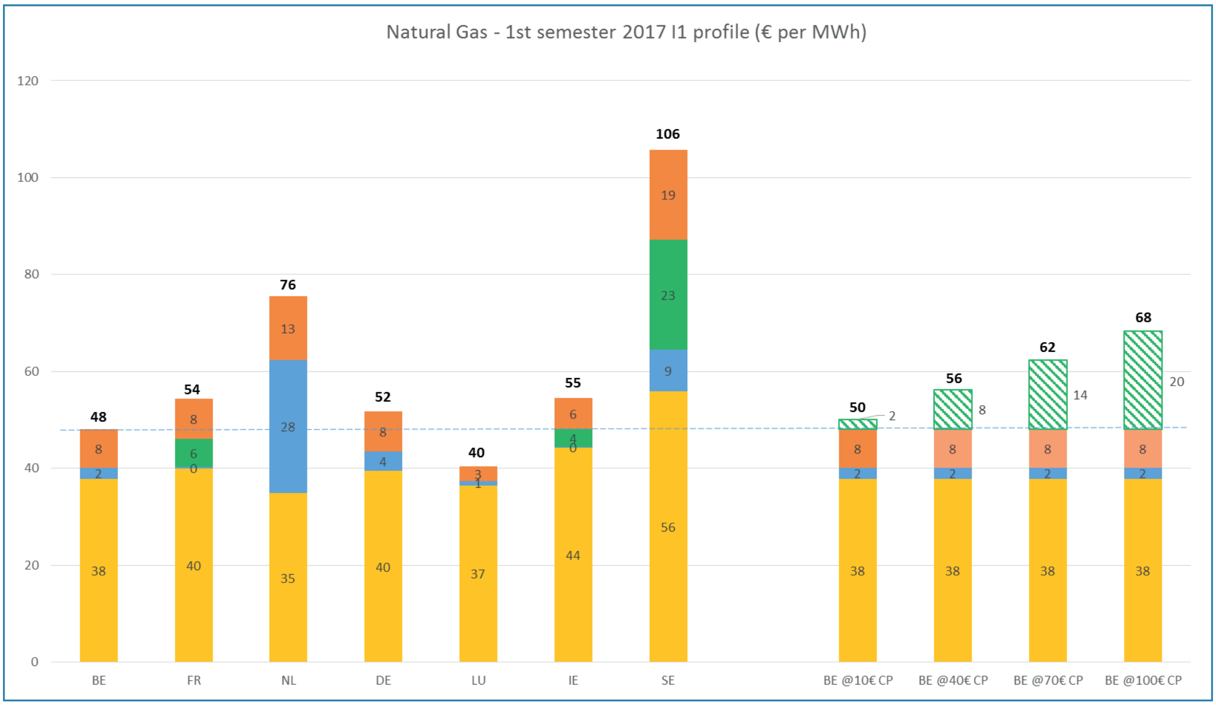


A.5.9: Energy consumption per energy vector in the Other industry, ETS vs non-ETS

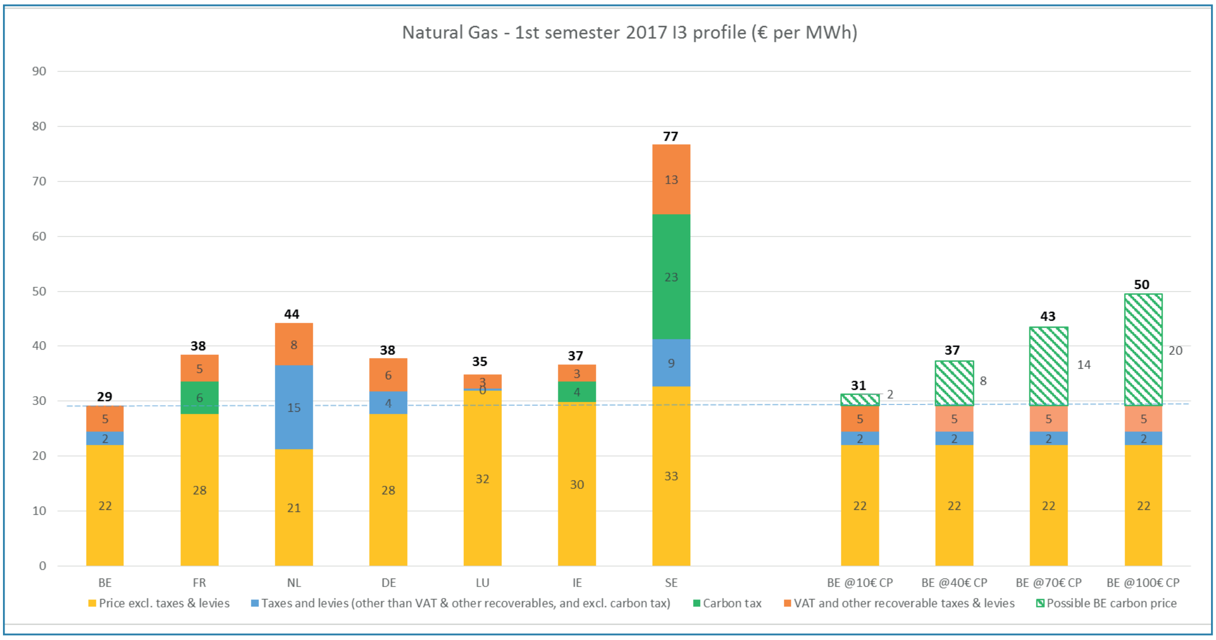


2. Comparison of additional consumption profiles for natural gas and electricity

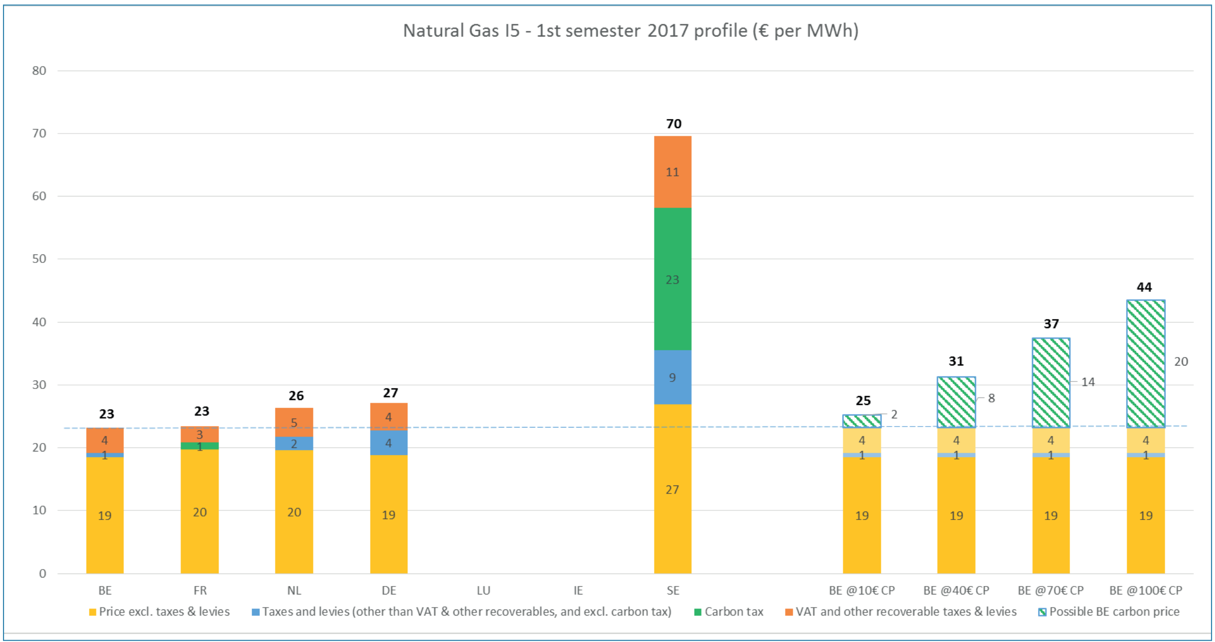
A.5.10: Comparison of final prices of natural gas (I1 profile) and impact of carbon price in Belgium



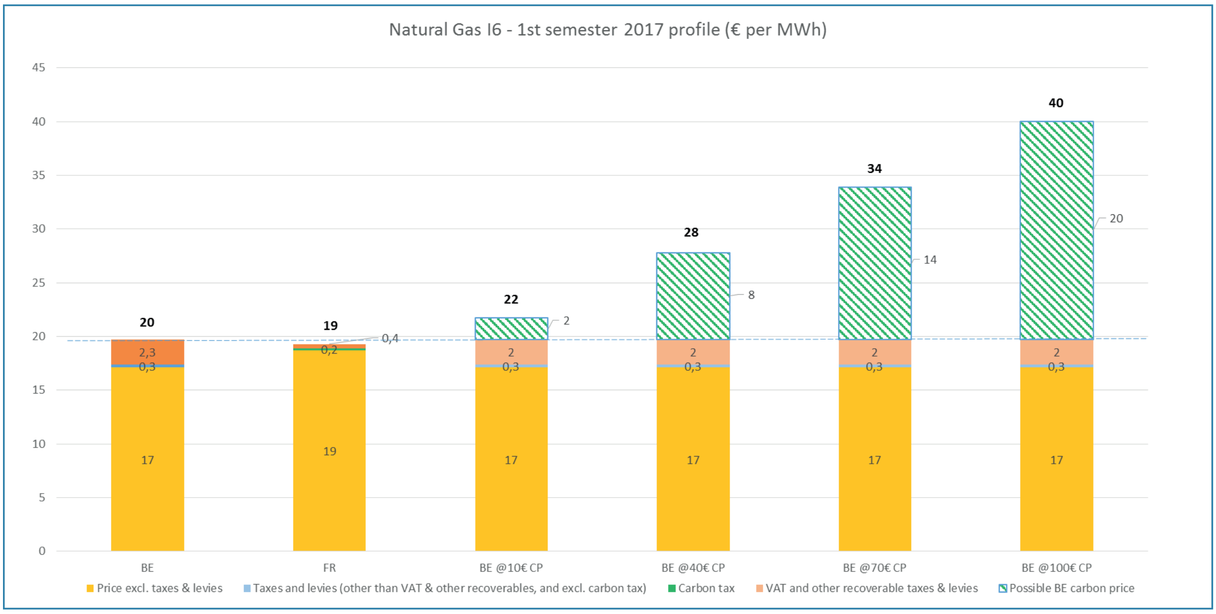
A.5.11: Comparison of final prices of natural gas (I3 profile) and impact of carbon price in Belgium



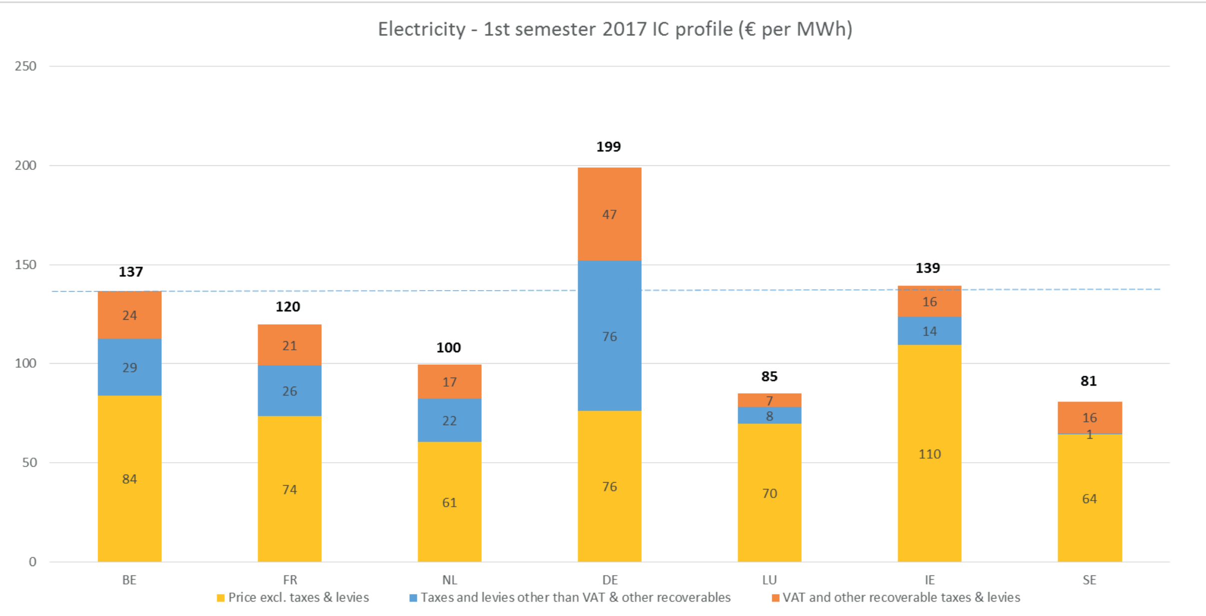
A.5.12: Comparison of final prices of natural gas (I5 profile) and impact of carbon price in Belgium



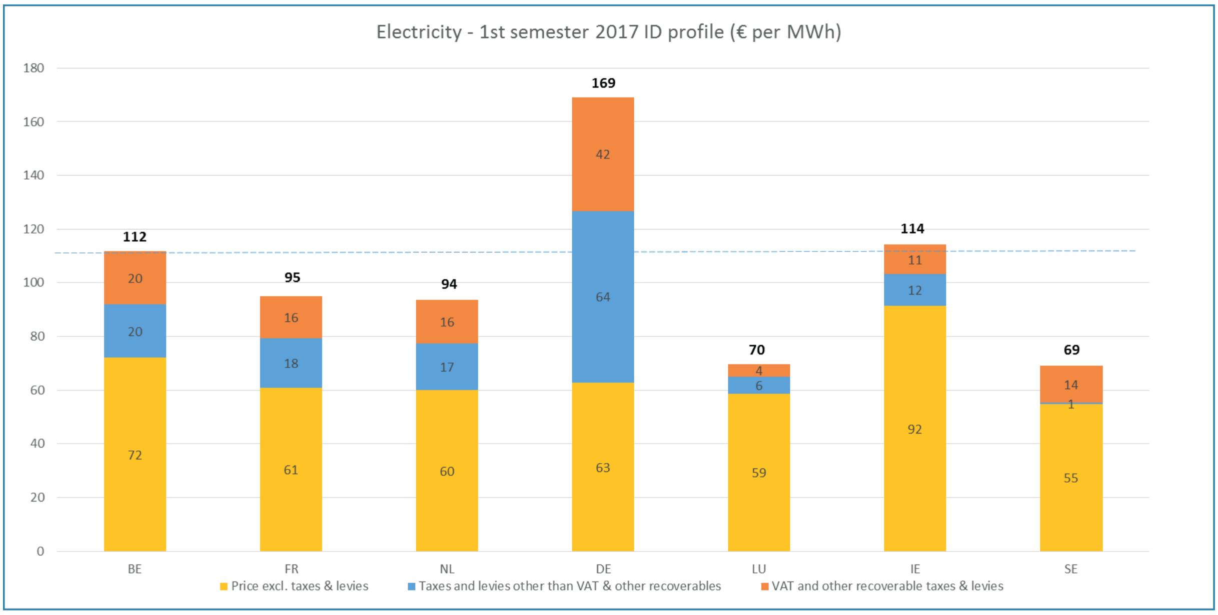
A.5.13: Comparison of final prices of natural gas (I6 profile) and impact of carbon price in Belgium



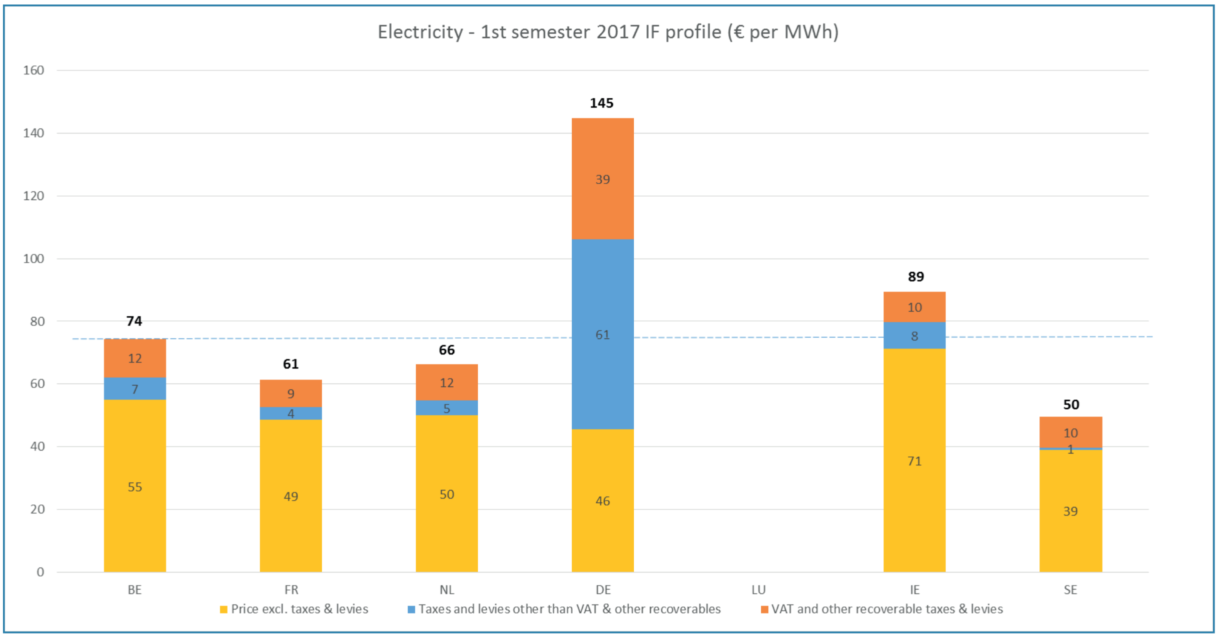
A.5.14: Comparison of final prices of electricity (IC profile)



A.5.15: Comparison of final prices of electricity (ID profile)



A.5.16: Comparison of final prices of electricity (IF profile)



A.5.17: Benchmark analysis on natural gas I1 profile

Natural Gas prices - 1st semester 2017 I1 profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Final prices (all taxes & levies included)	48,10	54,40	75,50	51,80	40,40	55,53	60,57	64,95
Difference with BE (abs)	0,00	-6,30	-27,40	-3,70	7,70	-7,43	-12,47	-16,85
Difference (%)	0%	-12%	-36%	-7%	19%	-13%	-21%	-26%
CP to close the gap	0,00	31,03	134,98	18,23	37,93	36,58	61,41	83,00
Prices (excl. VAT and other recoverable taxes & levies)	40,10	46,10	62,40	43,50	37,40	47,35	50,67	54,25
Difference with BE (abs)	0,00	-6,00	-22,30	-3,40	2,70	-7,25	-10,57	-14,15
Difference (%)	0%	-13%	-36%	-8%	7%	-15%	-21%	-26%
CP to close the gap	0,00	29,56	109,85	16,75	13,30	35,71	52,05	69,70

A.5.18: Benchmark analysis on natural gas I2 profile

Natural Gas prices - 1st semester 2017 I2 profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neigh-bouring countries (FR, NL, DE, LU)	Average 3 neigh-bouring countries (FR, NL, DE)	Average 2 neigh-bouring countries (FR, NL)
Final prices (all taxes & levies included)	37,70	46,20	67,00	42,20	37,70	48,28	51,80	56,60
Difference with BE (abs)	0,00	-8,50	-29,30	-4,50	0,00	-10,58	-14,10	-18,90
Difference (%)	0%	-18%	-44%	-11%	0%	-22%	-27%	-33%
CP to close the gap	0,00	41,87	144,33	22,17	0,00	52,09	69,46	93,10
Prices (excl. VAT and other recoverable taxes & levies)	31,40	38,90	55,40	35,40	34,80	41,13	43,23	47,15
Difference with BE (abs)	0,00	-7,50	-24,00	-4,00	-3,40	-9,73	-11,83	-15,75
Difference (%)	0%	-19%	-43%	-11%	-10%	-24%	-27%	-33%
CP to close the gap	0,00	36,95	118,23	19,70	16,75	47,91	58,29	77,59

A.5.19: Benchmark analysis on natural gas I3 profile

Natural Gas prices - 1st semester 2017 I3 profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neigh-bouring coun-tries (FR, NL, DE, LU)	Average 3 neigh-bouring coun-tries (FR, NL, DE)	Average 2 neigh-bouring coun-tries (FR, NL)
Final prices (all taxes & levies included)	29,20	38,40	44,20	37,80	34,80	38,80	40,13	41,30
Difference with BE (abs)	0,00	-9,20	-15,00	-8,60	-5,60	-9,60	-10,93	-12,10
Difference (%)	0%	-24%	-34%	-23%	-16%	-25%	-27%	-29%
CP to close the gap (€/tCO_2)	0,00	45,32	73,89	42,36	27,59	47,29	53,86	59,61
Prices (excl. VAT and other recoverable taxes & levies)	24,40	32,60	36,50	31,70	32,30	33,28	33,60	34,55
Difference with BE (abs)	0,00	-8,20	-12,10	-7,30	-7,90	-8,88	-9,20	-10,15
Difference (%)	0%	-25%	-33%	-23%	-24%	-27%	-27%	-29%
CP to close the gap (€/tCO_2)	0,00	40,39	59,61	35,96	38,92	43,72	45,32	50,00

A.5.20: Benchmark analysis on natural gas I4 profile

Natural Gas prices - 1st semester 2017 I4 profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neigh-bouring coun-tries (FR, NL, DE, LU)	Average 3 neigh-bouring coun-tries (FR, NL, DE)	Average 2 neigh-bouring coun-tries (FR, NL)
Final prices (all taxes & levies included)	24,00	28,80	30,60	31,10	24,80	28,83	30,17	29,70
Difference with BE (abs)	0,00	-4,80	-6,60	-7,10	-0,80	-4,83	-6,17	-5,70
Difference (%)	0%	-17%	-22%	-23%	-3%	-17%	-20%	-19%
CP to close the gap	0,00	23,65	32,51	34,98	3,94	23,77	30,38	28,08
Prices (excl. VAT and other recoverable taxes & levies)	20,20	24,80	25,30	26,10	23,10	24,83	25,40	25,05
Difference with BE (abs)	0,00	-4,60	-5,10	-5,90	-2,90	-4,63	-5,20	-4,85
Difference (%)	0%	-19%	-20%	-23%	-13%	-19%	-20%	-19%
CP to close the gap	0,00	22,66	25,12	29,06	14,29	22,78	25,62	23,89

A.5.21: Benchmark analysis on natural gas I5 profile

Natural Gas prices - 1st semester 2017 I5 profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neigh-bouring coun-tries (FR, NL, DE, LU)	Average 3 neigh-bouring coun-tries (FR, NL, DE)	Average 2 neigh-bouring coun-tries (FR, NL)
Final prices (all taxes & levies included)	23,20	23,40	26,30	27,10	NA	NA	25,60	24,85
Difference with BE (abs)	0,00	-0,20	-3,10	-3,90	NA	NA	-2,40	-1,65
Difference (%)	0%	-1%	-12%	-14%	NA	NA	-9%	-7%
CP to close the gap	0,00	0,99	15,27	19,21	NA	NA	11,82	8,13
Prices (excl. VAT and other recoverable taxes & levies)	19,20	20,80	21,70	22,80	NA	NA	21,77	21,25
Difference with BE (abs)	0,00	-1,60	-2,50	-3,60	NA	NA	-2,57	-2,05
Difference (%)	0%	-8%	-12%	-16%	NA	NA	-12%	-10%
CP to close the gap	0,00	7,88	12,32	17,73	NA	NA	12,64	10,10

A.5.22: Benchmark analysis on natural gas I6 profile

Natural Gas prices - 1st semester 2017 I6 profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neigh-bouring coun-tries (FR, NL, DE, LU)	Average 3 neigh-bouring coun-tries (FR, NL, DE)	Average 2 neigh-bouring coun-tries (FR, NL)
Final prices (all taxes & levies included)	19,70	19,30	NA	NA	NA	NA	NA	NA
Difference with BE (abs)	0,00	0,40	NA	NA	NA	NA	NA	NA
Difference (%)	0%	2%	NA	NA	NA	NA	NA	NA
CP to close the gap	0,00	1,97	NA	NA	NA	NA	NA	NA
Prices (excl. VAT and other recoverable taxes & levies)	17,40	18,90	NA	NA	NA	NA	NA	NA
Difference with BE (abs)	0,00	-1,50	NA	NA	NA	NA	NA	NA
Difference (%)	0%	-8%	NA	NA	NA	NA	NA	NA
CP to close the gap	0,00	7,39	NA	NA	NA	NA	NA	NA

A.5.23: Benchmark analysis on electricity IB profile

Electricity prices - 1st semester 2017 IB profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neighbouring countries (FR, NL, DE, LU)	Average 3 neighbouring countries (FR, NL, DE)	Average 2 neighbouring countries (FR, NL)
Final prices (all taxes & levies included)	189,90	147,50	165,30	230,50	109,40	163,18	181,10	156,40
Difference with BE (abs)	0,00	42,40	24,60	-40,60	80,50	26,73	8,80	33,50
Difference (%)	0%	29%	15%	-18%	74%	16%	5%	21%
Prices (excl. VAT and other recoverable taxes & levies)	160,40	123,30	136,60	178,30	100,70	134,73	146,07	129,95
Difference with BE (abs)	0,00	37,10	23,80	-17,90	59,70	25,68	14,33	30,45
Difference (%)	0%	30%	17%	-10%	59%	19%	10%	23%

A.5.24: Benchmark analysis on electricity IC profile

Electricity prices - 1st semester 2017 IC profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neighbouring countries (FR, NL, DE, LU)	Average 3 neighbouring countries (FR, NL, DE)	Average 2 neighbouring countries (FR, NL)
Final prices (all taxes & levies included)	136,70	119,80	99,50	199,10	84,90	125,83	139,47	109,65
Difference with BE (abs)	0,00	16,90	37,20	-62,40	51,80	10,88	-2,77	27,05
Difference (%)	0%	14%	37%	-31%	61%	9%	-2%	25%
Prices (excl. VAT and other recoverable taxes & levies)	112,70	99,20	82,20	151,90	78,00	102,83	111,10	90,70
Difference with BE (abs)	0,00	13,50	30,50	-39,20	34,70	9,88	1,60	22,00
Difference (%)	0%	14%	37%	-26%	44%	10%	1%	24%

A.5.25: Benchmark analysis on electricity ID profile

Electricity prices - 1st semester 2017 ID profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neighbouring countries (FR, NL, DE, LU)	Average 3 neighbouring countries (FR, NL, DE)	Average 2 neighbouring countries (FR, NL)
Final prices (all taxes & levies included)	111,70	95,00	93,60	169,20	69,60	106,85	119,27	94,30
Difference with BE (abs)	0,00	16,70	18,10	-57,50	42,10	4,85	-7,57	17,40
Difference (%)	0%	18%	19%	-34%	60%	5%	-6%	18%
Prices (excl. VAT and other recoverable taxes & levies)	91,90	79,30	77,40	126,80	65,10	87,15	94,50	78,35
Difference with BE (abs)	0,00	12,60	14,50	-34,90	26,80	4,75	-2,60	13,55
Difference (%)	0%	16%	19%	-28%	41%	5%	-3%	17%

A.5.26: Benchmark analysis on electricity IE profile

Electricity prices - 1st semester 2017 IE profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neighbouring countries (FR, NL, DE, LU)	Average 3 neighbouring countries (FR, NL, DE)	Average 2 neighbouring countries (FR, NL)
Final prices (all taxes & levies included)	87,60	76,00	74,30	134,00	43,40	81,93	94,77	75,15
Difference with BE (abs)	0,00	11,60	13,30	-46,40	44,20	5,68	-7,17	12,45
Difference (%)	0%	15%	18%	-35%	102%	7%	-8%	17%
Prices (excl. VAT and other recoverable taxes & levies)	72,20	64,00	61,40	97,20	40,10	65,68	74,20	62,70
Difference with BE (abs)	0,00	8,20	10,80	-25,00	32,10	6,53	-2,00	9,50
Difference (%)	0%	13%	18%	-26%	80%	10%	-3%	15%

A.5.27: Benchmark analysis on electricity IF profile

Electricity prices - 1st semester 2017 IF profile (EUR/MWh)								
Situation first semester 2017	BE	FR	NL	DE	LU	Average 4 neighbouring countries (FR, NL, DE, LU)	Average 3 neighbouring countries (FR, NL, DE)	Average 2 neighbouring countries (FR, NL)
Final prices (all taxes & levies included)	74,40	61,30	66,30	144,70	NA	NA	90,77	63,80
Difference with BE (abs)	0,00	13,10	8,10	-70,30	NA	NA	-16,37	10,60
Difference (%)	0%	21%	12%	-49%	NA	NA	-18%	17%
Prices (excl. VAT and other recoverable taxes & levies)	62,10	52,60	54,80	106,20	NA	NA	71,20	53,70
Difference with BE (abs)	0,00	9,50	7,30	-44,10	NA	NA	-9,10	8,40
Difference (%)	0%	18%	13%	-42%	NA	NA	-13%	16%

A.5.28: Additional information from PwC study performed by the CREG: « A European comparison of electricity and gas prices for large industrial consumers », 2017 update. Prices of January 2017, VAT not taken into account.

EUR / MWh	Commodity Price	Network costs	Taxes, levies, certificate schemes (min. electro-intensive)	Taxes, levies, certificate schemes (max. electro-intensive)	Taxes, levies, certificate schemes (max. non electro-intensive)	TOTAL MIN. EI	TOTAL MAX. EI	TOTAL MAX. NEI
E1 consumer profile (10 GWh/y)								
BE - AVE	45,00	13,63	27,67	27,67	27,67	86,30	86,30	86,30
DE AVE	33,80	28,70	3,40	36,70	89,80	65,90	99,20	152,30
FR (zone 1)	43,80	16,40	1,70	8,70	23,20	61,90	68,90	83,40
NL (zone 1)	37,20	9,60	0,50	0,50	15,60	47,30	47,30	62,40
UK (zone 1)	55,30	25,00	16,30	16,30	16,30	96,60	96,60	96,60
E2 consumer profile (25 GWh/y)								
BE - AVE	45,00	7,80	21,83	21,83	21,83	74,63	74,63	74,63
DE AVE	33,80	21,43	3,20	33,20	89,60	58,43	88,43	144,83
FR (zone 1)	43,80	11,00	0,90	7,90	21,90	55,70	62,70	76,70
NL (zone 1)	37,20	7,90	0,50	0,50	6,50	45,60	45,60	51,60
UK (zone 1)	55,30	12,60	16,30	16,30	16,30	84,20	84,20	84,20
E3 consumer profile (100 GWh/y)								
BE - AVE	43,80	4,40	13,10	13,10	13,10	61,30	61,30	61,30
DE AVE	33,40	1,78	3,10	31,50	89,60	38,28	66,68	124,78
FR (zone 1)	42,40	4,20	0,50	7,50	21,70	47,10	54,10	68,30
NL (zone 1)	36,80	2,80	0,50	0,50	1,30	40,10	40,10	40,90
UK (zone 1)	55,20	6,10	16,30	16,30	16,30	77,60	77,60	77,60

A.5.29: Additional information from PwC study performed by the CREG – Comparison with Eurostat data for BE & DE[128]

PwC profile	Corresponding Eurostat profile	PwC prices DE (VAT excl.)	Eurostat prices DE (excl. VAT & other recoverable taxes)	PwC prices BE(VAT excl.)	Eurostat prices BE (excl. VAT & other recoverable taxes)
E1 - 10 GWh	ID - 2 < consumption < 20 GWh	Min. 65,90 - Max. 99,2 (EI)/152,3 (NEI)	127	86,3	92
E2 - 25 GWh	IE - 20 < consumption < 70 GWh	Min. 58,43 - max. 88,43 (EI)/144,83 (NEI)	97	74,63	72
E3 - 100 GWh	IF - 70 < consumption < 150 GWh	Min. 38,28 - max. 66,68 (EI)/124,78 (NEI)	106	61,3	62

A.5.30: Comparison of applicable tariffs for gasoil

GASOIL	Motor fuel (EUR/1000 L)	Heating (EUR/1000 L)	Difference with BE (abs)		Difference with BE (%)	
			Motor fuel	Heating	Motor fuel	Heating
BE	22,88	18,65	NA	NA	NA	NA
FR	150,90 / 70,2*	118,90 / 38,2*	-128,02 / -47,32*	-96,02 / -15,32*	-85% / -67%*	-81% / -40%*
NL	485,92	485,92	-463,04	-463,04	-95%	-95%
DE	61,35	46,01	-38,47	-23,13	-63%	-50%
LU	21,00	0,00	1,88	22,88	9%	NA

* Assumed reduced tariff for energy-intensive companies that are at risk of carbon leakage (assumption that they do not pay any additional taxes linked with the introduction of the carbon tax).

The difference with average excise duties in the neighbouring countries corresponds to the following carbon prices:

- Heating purposes: between 54,19 EUR/tCO_2e (FR-NL-DE-LU average) and 99,64 EUR/tCO_2e (FR-NL average). Between 46,52 EUR/tCO_2e (FR-NL-DE-LU average) and 84,30 EUR/tCO_2e (FR-NL average) if reduced tariffs apply due to *;
- Motor fuel: between 60,69 EUR/tCO_2e (FR-NL-DE-LU average) and 105,73 EUR/tCO_2e (FR-NL average). Between 53,02 EUR/tCO_2e (FR-NL-DE-LU average) and 90,38 EUR/tCO_2e (FR-NL average) if reduced tariffs apply due to *.

[128] Eurostat data are more general and provide average prices within sometimes significant ranges of consumption profiles. For larger industrial consumers, the PwC study provides more detailed information on prices and therefore complements the insights provided by the Eurostat data.

3. Impact on public carbon revenues

A.5.31: Evolution of maximum theoretical annual public revenues from a carbon price applied to energy consumptions in non-ETS industry under the three carbon price trajectories (in M€/year)

Emissions trajectories (ktCO2eq)	2016	2020	2025	2030	2035	2040	2045	2050
Energy combustion	3434	3525	3081	2636	2192	1747	1303	859
Process	1887	1937	1693	1449	1204	960	716	472
Price trajectories (euros/tCO2eq)								
Price trajectory A		10	23,3	40	55	70	85	100
Price trajectory B		10	40,8	70	100	130	160	190
Price trajectory C		10	58,3	100	145	190	235	280
Revenues trajectory A (Meuros)		2020	2025	2030	2035	2040	2045	2050
Energy combustion		35	72	105	121	122	111	86
Process		19	39	58	66	67	61	47
Total		55	111	163	187	190	172	133
Revenues trajectory B (Meuros)		2020	2025	2030	2035	2040	2045	2050
Energy combustion		35	126	185	219	227	208	163
Process		19	69	101	120	125	115	90
Total		**55**	195	**286**	340	352	323	253
Revenues trajectory C (Meuros)		2020	2025	2030	2035	2040	2045	2050
Energy combustion		35	180	264	318	332	306	240
Process		19	99	145	175	182	168	132
Total		55	278	409	492	514	474	372

APPENDIX 6 ADDITIONAL INFORMATION ON THE AGRICULTURE SECTOR

1. Comparison of applicable tariffs for natural gas and gasoil in the agriculture sector

A.6.1: Comparison of applicable tariffs for natural gas

NATURAL GAS	Propellant (EUR/MWh)	Heating (EUR/MWh)	Difference with BE (abs)	
			Propellant	Heating
BE	0	0	NA	NA
FR	0,119	0,119	-0,119	-0,119
NL (heating I1 & I4)*	16,45	1,95 - 4,15	-16,45	-1,95 & -4,15
DE	12,52	4,12	-12,52	-4,12
LU (heating I1 & I4)**	0	0,30 - 1,08	0	-0,30 & -1,08

* For calculating the average paid excise duties for consumption profile I4, the median of this consumption profile (i.e. 152.778 MWh) was used, resulting in average paid excise duties of 1,95 EUR/MWh.

** In LU, there are 5 different tariffs that apply on natural gas used for heating purposes: the lowest tariff presented here applies to a yearly consumption of more than 4.100 MWh and if companies sign an agreement with the government to improve their energy efficiency (Cat. C2 – this consumption falls within I4 profile), the highest tariff applies to a yearly consumption of max. 550 MWh (Cat. A ~ I1 profile).

The difference with average excise duties in the neighbouring countries corresponds to the following carbon prices:

- Natural gas used for heating purposes: between 10,51 EUR/tCO_2e (FR-NL average), 11,66 EUR/tCO_2e (FR-NL-DE-LU average) and 13,78 EUR/tCO_2e (FR-NL-DE average) in the case of low consumption profile I1 in NL & LU, or between 5,10 EUR/tCO_2e (FR-NL average), 8 EUR/tCO_2e (FR-NL-DE-LU average) and 10,16 EUR/tCO_2e (FR-NL-DE average) in the case of high consumption profile I4 in NL & LU;
- Natural gas used as motor fuel: between 35,82 EUR/tCO_2e (FR-NL-DE-LU average), 40,81 EUR/tCO_2e (FR-NL average) and 47,77 EUR/tCO_2e (FR-NL-DE average).

A.6.2: Comparison of applicable tariffs for gasoil

GASOIL	Propellant (EUR/1000 L)	Heating (EUR/1000 L)	Difference with BE (abs)	
			Propellant	Heating
BE	0	0	NA	NA
FR	38,6	118,9	-38,6	-118,9
NL*	485,92	485,92	-485,92	-485,92
DE	255,6	46,01	-255,6	-46,01
LU	0	0	0	0

* In NL, a reimbursement scheme for gasoil used in greenhouses was in place until 2012, but was abolished in 2013. Therefore, next to a reimbursement for natural gas used to heat greenhouses, the only remaining reimbursement in place is for LPG used for heating greenhouses, where no connection to the gas grid is available.

The difference with average excise duties in the neighbouring countries corresponds to the following carbon prices:

- Gas oil used for heating purposes: between 54,61 EUR/tCO_2e (FR-NL-DE-LU average), 72,81 EUR/tCO_2e (FR-NL-DE average) and 100,41 EUR/tCO_2e (FR-NL average);
- Use as motor fuel: between 74,16 EUR/tCO_2e (FR-NL-DE-LU average), 98,87 EUR/tCO_2e (FR-NL-DE average) and 99,72 EUR/tCO_2e (FR-NL average).

2. Impact on public carbon revenues

A.6.3: Evolution of the annual public revenues from a carbon price applied to energy consumptions in agriculture under the three carbon price trajectories (in M€/year)

Emissions trajectories (ktCO2eq)	2016	2020	2025	2030	2035	2040	2045	2050
Stationary	1626	1626	1423	1220	1016	813	610	407
Offroad vehicles, other machinery and fishing	697	697	610	523	436	348	261	174
Price trajectories (euros/tCO2eq)								
Price trajectory A		10	23,3	40	55	70	85	100
Price trajectory B		10	40,8	70	100	130	160	190
Price trajectory C		10	58,3	100	145	190	235	280
Revenues trajectory A (Meuros)		2020	2025	2030	2035	2040	2045	2050
Stationary		16	33	49	56	57	52	41
Offroad vehicles, other machinery and fishing		7	14	21	24	24	22	17
Total		23	47	70	80	81	74	58
Revenues trajectory B (Meuros)		2020	2025	2030	2035	2040	2045	2050
Stationary		16	58	85	102	106	98	77
Offroad vehicles, other machinery and fishing		7	25	37	44	45	42	33
Total		**23**	83	**122**	145	151	139	110
Revenues trajectory C (Meuros)		2020	2025	2030	2035	2040	2045	2050
Stationary		16	83	122	147	154	143	114
Offroad vehicles, other machinery and fishing		7	36	52	63	66	61	49
Total		23	119	174	211	221	205	163

A.6.4: Evolution of the annual public revenues from a carbon price applied to energy consumptions in waste under the three carbon price trajectories (in M€/year)

Emissions trajectories (ktCO2eq)	2016	2020	2025	2030	2035	2040	2045	2050
Electricity and heat	2173	2016	1764	1512	1260	1008	756	504
Solid waste disposal	888	655	573	491	409	327	246	164
Biological treatment of solid waste	64	64	56	48	40	32	24	16
Incineration and open burning of waste	23	23	20	17	14	12	9	6
Waste water treatment and discharge	294	264	231	198	165	132	99	66
Price trajectories (euros/tCO2eq)								
Price trajectory A		10	23,3	40	55	70	85	100
Price trajectory B		10	40,8	70	100	130	160	190
Price trajectory C		10	58,3	100	145	190	235	280
Revenues trajectory A (Meuros)		2020	2025	2030	2035	2040	2045	2050
Electricity and heat		20	41	60	69	71	64	50
Solid waste disposal		7	13	20	23	23	21	16
Biological treatment of solid waste		1	1	2	2	2	2	2
Incineration and open burning of waste		0	0	1	1	1	1	1
Waste water treatment and discharge		3	5	8	9	9	8	7
Total		30	62	91	104	106	96	76
Revenues trajectory B (Meuros)		2020	2025	2030	2035	2040	2045	2050
Electricity and heat		20	72	106	126	131	121	96
Solid waste disposal		7	23	34	41	43	39	31
Biological treatment of solid waste		1	2	3	4	4	4	3
Incineration and open burning of waste		0	1	1	1	2	1	1
Waste water treatment and discharge		3	9	14	17	17	16	13
Total		30	108	159	189	196	181	144
Revenues trajectory C (Meuros)		2020	2025	2030	2035	2040	2045	2050
Electricity and heat		20	103	151	183	192	178	141
Solid waste disposal		7	33	49	59	62	58	46
Biological treatment of solid waste		1	3	5	6	6	6	4
Incineration and open burning of waste		0	1	2	2	2	2	2
Waste water treatment and discharge		3	13	20	24	25	23	19
Total		30	154	227	274	287	266	212

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TOWARDS A
LOW CARBON SOCIETY

COLOPHON

This Report is edited and distributed by the Belgian Federal Climate Change Section of the Federal Public Service Health, Food Chain Safety and Environment, in close collaboration with
Climact, PwC and SuMa Consulting.

June 2018

Place Victor Horta 40 - box 10
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