Clean **Ve**hicle **R**esearch: LCA and Policy Measures

(CLEVER)

WP6. Fleet analysis

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LIST OF ABBREVIATIONS

BRU	Brussels
CNG	Compressed natural gas
CO_2e	CO_2 equivalents
CS	Charge sustaining hybrid vehicle, uses the combustion engine as a generator for the battery
EF	Emission factor: the emission per distance travelled
Fuel Cell H_2	Hydrogen vehicle with fuel cell
FL	Flanders
H_2 ICE	Hydrogen vehicle with internal combustion engine
Highw	Highway
Km/h	Kilometres an hour
Kms	Kilometres
L	Litre = 1 dm^3
LPG	Liquefied petroleum gas
Mio	Million
PHEV	Plug-in hybrid electric vehicle, uses the electricity grid for charging the battery
TTW	Tank-to-wheel
VOC	Volatile Organic Compounds
vs	versus
WALL	Wallonia

1. Introduction

This report builds upon the scenarios defined and explained in report 5.3 – 'Scenario development'. The policy measures described there act as an input to the 'E-motion Road' model calculations. In this report, the resulting data from the four proposed scenarios are discussed.

Task 6.1 – Environmental performance of Belgian vehicle fleet – of the CLEVER study deals with the outcome of VITO's macroscopic emission road model, with a focus on the baseline scenario. Task 6.2 – Impact of the scenarios – is meant to present the model results for the 3 alternative scenarios (realistic, progressive and visionary). In this report, these tasks are included in chapter 2 and 3, respectively. In the fourth and penultimate chapter, we combine the results from the preceding chapters in order to summarize the differences between the baseline, realistic and progressive scenario in 2020 and 2030.

It has to be stressed that the outcomes mentioned in this report are the result of the complete package of measures included in the scenarios. Consequently, the magnitude of the effects of the separate policy measures are not reported on, as this exercise would go far beyond the scope of this project. Nevertheless, the way each measure was modelled is discussed in report 5.3, briefly mentioning the effects of each measure on new vehicles, existing vehicles and kilometres driven.

2. Environmental performance of the Belgian vehicle fleet (Task 6.1)

2.1. Functioning of the emission model 'E-motion Road'

Before we start with the evaluation of the various scenarios, we kick off by providing a short introduction on the functioning of VITO's 'E-Motion Road' emission model that was used to calculate both the historical (up till 2008) and the future (after 2008) emissions of road transport (see Figure 1).

Concerning the calculation of historic emissions, detailed historical input data on vehicle fleet, mileages, vehicle kilometres, biofuel blends, etc. is inventoried and converted into emissions and energy consumption values by using the emission factor approach from the MIMOSA module. Like most European road transport emission models, MIMOSA belongs to the 'average speed macroscopic emission models', expressing emission and fuel consumption rates as a function of average speed (related to the road type). The same emission factor approach is also used to estimate the future emission and energy results for different scenarios and years. However, this implies that first new estimates of the future transport situation need to be made. To forecast the vehicle stock and kilometres on the road (for different scenarios and different years), the following parameters are very important to mention:

- Survival rates of existing vehicles: this parameter presents the percentage of existing vehicles (per vehicle type and age category) that will 'survive' to the next year and will therefore belong to an older age category the following year. By analyzing the historic trends of the survival rates and the specific measures applied in each scenario, this parameter is estimated for future scenario years. This parameter can differ according to the scenario. Applying a measure such as a scrapping scheme will for example have a large impact on the survival rates of older vehicles since people will tend to change their old vehicle much sooner for a cleaner/newer one.
- Future vehicle technology: this parameter presents the distribution of the vehicle technologies over the new vehicles that enter the vehicle fleet. By analyzing the historic trends of the technology distribution of new vehicles and the specific measures applied in each scenario, this parameter is estimated for future scenario years. Therefore, elasticity values from VUB-MOSI (WP3) were applied for the following measures: a fiscal system based on CO_2 and euro standard, and excises duties (for the realistic scenario) and a RT and kilometre charge based on Ecoscore, excise duties, limited urban access and a scrappage scheme (for the progressive scenario). For the specific switch levels of purchases from one category to another, we refer to sections 4.7.1 and 5.6.1 in report 5.3. A measure such as a tax system based on ecoscore will have an impact on the future technology distribution since vehicles with high ecoscores will be preferred over vehicles with low ecoscores (increasing the share of (hybrid) electric vehicles in the technology distribution).
- Total vehicle kilometres: this parameter represents, per region, the total amount of vehicle kilometres covered on the road (originating from FPS Mobility and Transport). As a baseline estimate for this parameter, the forecasts of the Flemish traffic centre are mainly used (also used in the MIRA REF scenario from VMM), taking into account issues like socio-economic prognoses, demographic forecasts and planned transport infrastructure. The growth figures observed in Flanders can then be applied to the other regions to forecast their future vehicle kilometres. The difference in the total number of kilometres driven between the scenarios is initiated by the following measures: excise duties in the realistic scenario and a kilometre charge and limited urban access in the progressive scenario. More details on the resulting number of kilometres can be found in section 4.7.3 and 5.6.3 of report 5.3.

To estimate the impact of a certain scenario/measure on the different model parameters, both existing literature and inputs from expert evaluations were used. As already mentioned above, information on the levels of the specific measures and the general impacts of these measures/scenarios on the 'existing vehicles', the 'new vehicles' and the 'driven kilometres' is provided in task 5.3 - Scenario Development. Running the model will then result in future vehicle fleet compositions and emission data for different scenario years. Information on the resulting impact of these scenarios on the vehicle fleet and the emissions is presented in the current report.

Besides the emissions of passenger cars, the evolution of the vehicle fleet's ecoscore is modelled as well. Ecoscore is a well-to-wheel indicator expressing the overall environmental impact of a vehicle, taking into account its contribution to global warming, air pollution and noise. Production processes of fuels and electricity generation are probably not the same in 2030 as they were in 2010. However, emissions related to this well-to-tank phase (production and distribution of the fuel) of conventional fuels, are considered to remain unchanged. The reason for this is that the uncertainty on the evolution is too high (e.g., more energy efficient refineries vs. less energy efficient crude oil extraction). Only for electricity generation, we consider the trend to be more positive (higher contribution of renewable energy sources in the electricity mix).

User-friendly databases like EmEneM (emissions and fuel consumptions) and ESCORT (Ecoscores) were developed in order to easily consult the results of the scenario calculations, for example through the use of an SQL browser.

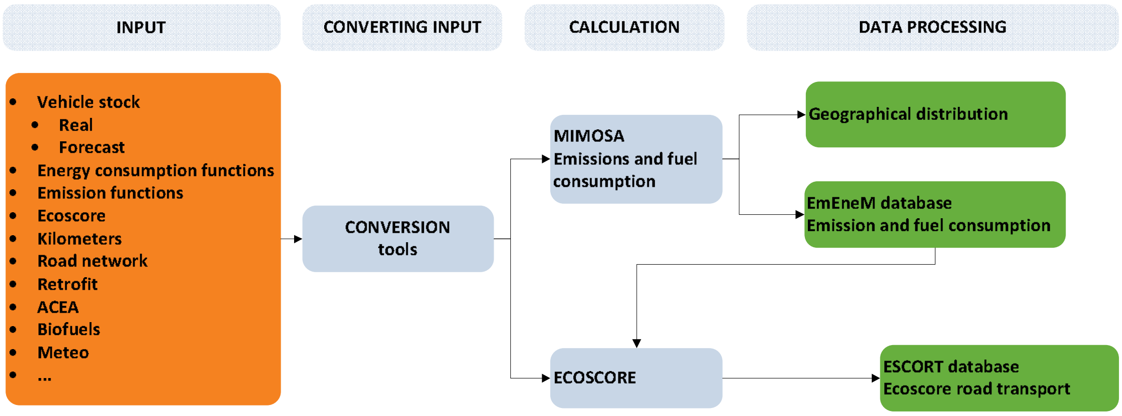

Figure 1: 'E-Motion Road' model

2.2. Results from the baseline scenario

As mentioned in the report from task 5.3, the baseline scenario is an evaluation of the present situation. In other words, in this scenario no extra measures are included on top of the current and planned legislation.

Some of the measures included in this scenario are:

A) Euro 5 and Euro 6 for passenger cars
B) CO_2 legislation for passenger cars
C) Introduction of Biofuels
D) European directive 2006/40/EC - type of coolant in mobile air conditioning
E) Mandatory green public fleet quota (for governmental bodies)

In order to construct the baseline scenario, data are extracted from a variety of sources. In this paragraph, we concisely repeat the particularities mentioned in chapter 3 of report 5.3.

The total number of historical kilometres, as well as the historical kilometres driven by each technology and age class, was retrieved from the FPS Mobility and Transport. The fleet composition up till 2008 originates from DIV. Starting point for the prediction of future total kilometres is the statistics from FPS Mobility and transport, for all three regions. For the benefit of the MIRA REF scenario, the Flemish Traffic Centre has made predictions on total kilometres driven on the three different road types for Flanders up till 2030. For all regions, this relative increase in future kilometres per road type was then taken into account. The future share of the technologies in total fleet composition was also retrieved from this MIRA REF scenario. For the future distribution of the kilometres over the various technologies, we focused on the final historical year (2008 in this study) of the FPS Mobility and Transport. Newer technologies (e.g., electric, hybrid) are assumed to be driven an amount of kilometres similar to the most resembling historical technology class (e.g., diesel kilometres for a diesel hybrid).

We expect the results for this scenario to be the most conservative of all proposed schemes.

In what follows (2.2.1, 2.2.2 and 2.2.3), we will discuss three types of indicators. It is to say, the report is structured around the following blocks: fleet composition (e.g. number of vehicles, unweighted ecoscore), vehicle use (e.g. distances driven) and environmental impact (e.g. emissions and distance-weighted ecoscore), and this for all years from 1995 to 2030. The distance-weighted ecoscore differs from the unweighted variant in that it takes the distance travelled by each separate vehicle into account, instead of giving each vehicle the same weight. More detailed results on these indicators can be found in the tables in annex. For the calculation of ecoscores, the historic data only trace back to 2006.

2.2.1. Fleet composition

2.2.1.1. Number of cars

The most obvious thing to examine is the evolution of the total number of cars in Belgium. This is depicted in Figure 2.

It is worth mentioning that the historic figures (up till 2008) from which we start (e.g., 4.88 million in 2005) are corresponding with the real numbers in (website FOD Economie,KMO,Middenstand en Energie) (e.g., 4.92 million in 2005). In 2010, approximately 5.2 million (mio) cars are registered in Belgium. The model predicts that the number of vehicles will continue to rise at least until 2030 (6.1 mio). This corresponds to an increase of 16% over the period 2010-2030. The increase is taking place rather steadily, with a relatively large jump (> 400,000 cars) in the period 2010-2015.

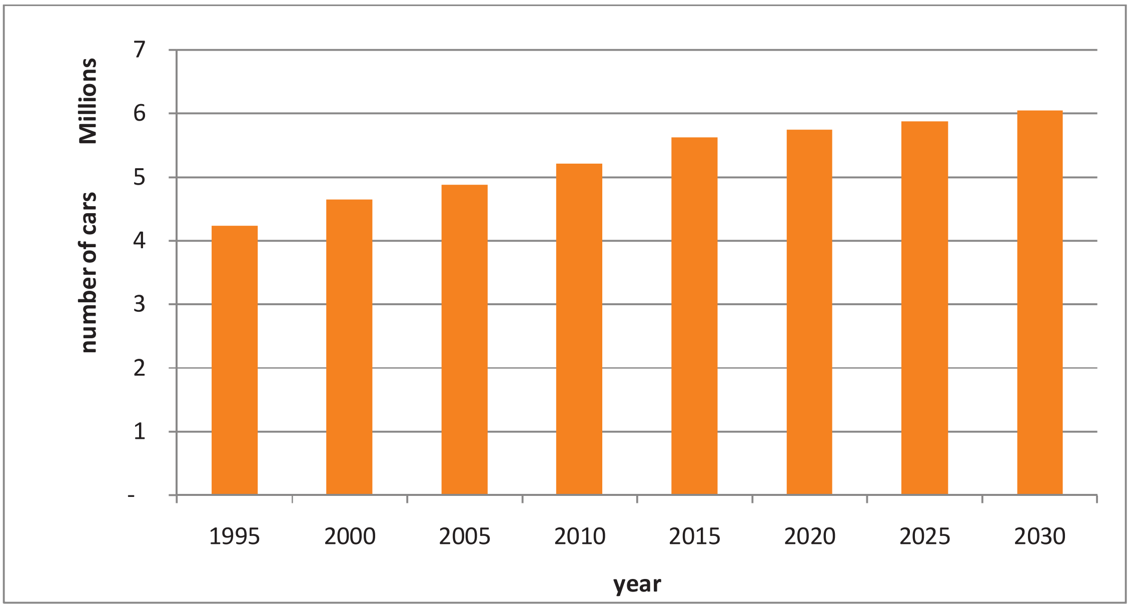

Figure 2: Absolute amount of cars in Belgium

2.2.1.2. Technology

When looking at the fuel technologies of the total fleet, we can arrange Figure 3 below. We chose to merely display the relative distribution in what follows, as the total number is already given in Figure 2. We notice that diesel has overtaken petrol since 2005 as the most important car technology. According to the baseline scenario, the number of conventional diesel cars keeps on growing at least until 2020, to almost 4 mio vehicles. Afterwards, the share of (diesel and petrol) hybrid vehicles starts to climb significantly. We distinguish between charge sustaining (CS) and plug-in hybrid electric vehicles (PHEV). The first category particularly uses its combustion engine to reload its batteries and cannot be connected to the grid. The second category is designed to be plugged into the grid in order to charge its batteries. This category also disposes of a combustion engine, although this should be considered as a range extender. In the mean time, the share of conventional petrol cars is declining steadily. The other alternative fuel systems (CNG, electric, H_2 and LPG) are only playing a marginal role in this scenario.

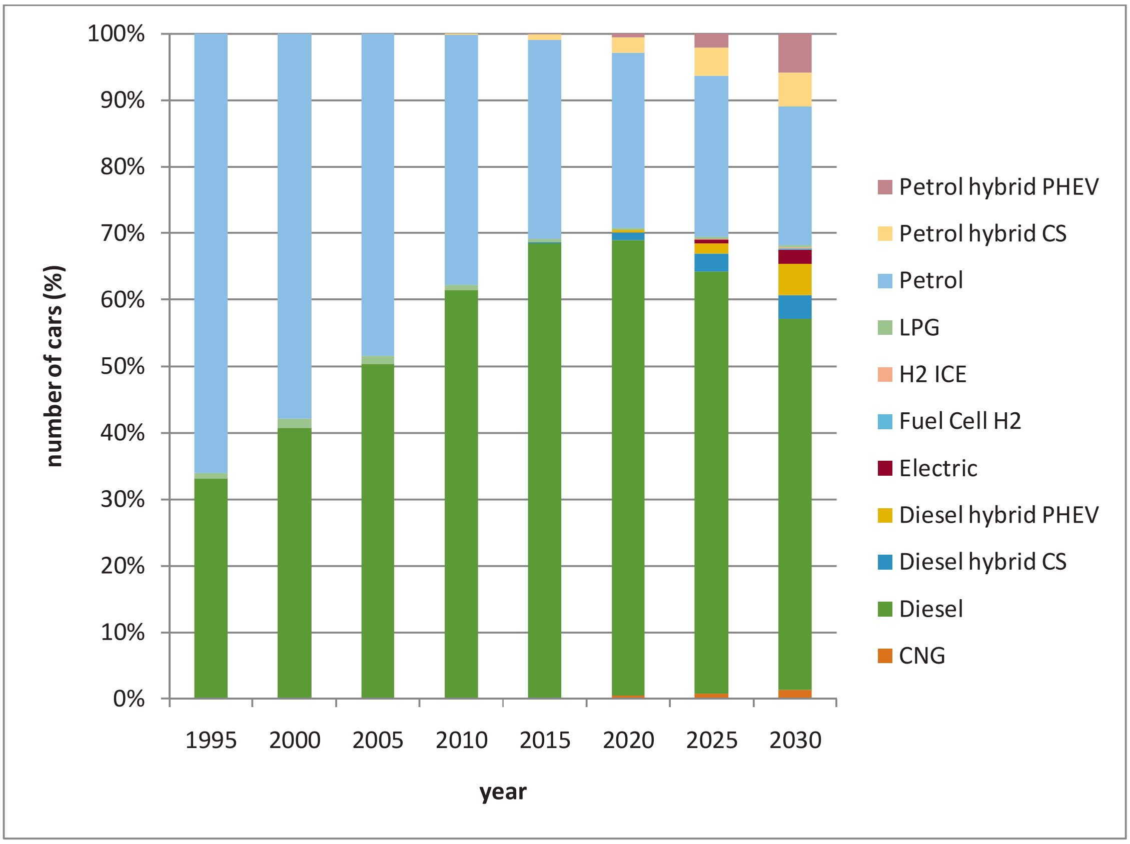

Figure 3: Relative share of cars over different technologies

2.2.1.3. Euro standard

Furthermore, we can study how the introduction of the different euro standards has an effect on the total fleet composition. The relative shares of the euro standards in the total fleet is displayed in Figure 4. Note that the vast majority (75%) of the cars in today's fleet (2010) comply with the euro 3 or 4 standard. The euro 5 standard is partly introduced in 2009, while the euro 6 standard will come into force at the end of 2014. Consequently, after these dates, we notice those categories entering the fleet. Towards 2030, almost 97% of all vehicles is expected to comply with the euro 6 standard (as no additional standard is defined yet, better than euro 6).

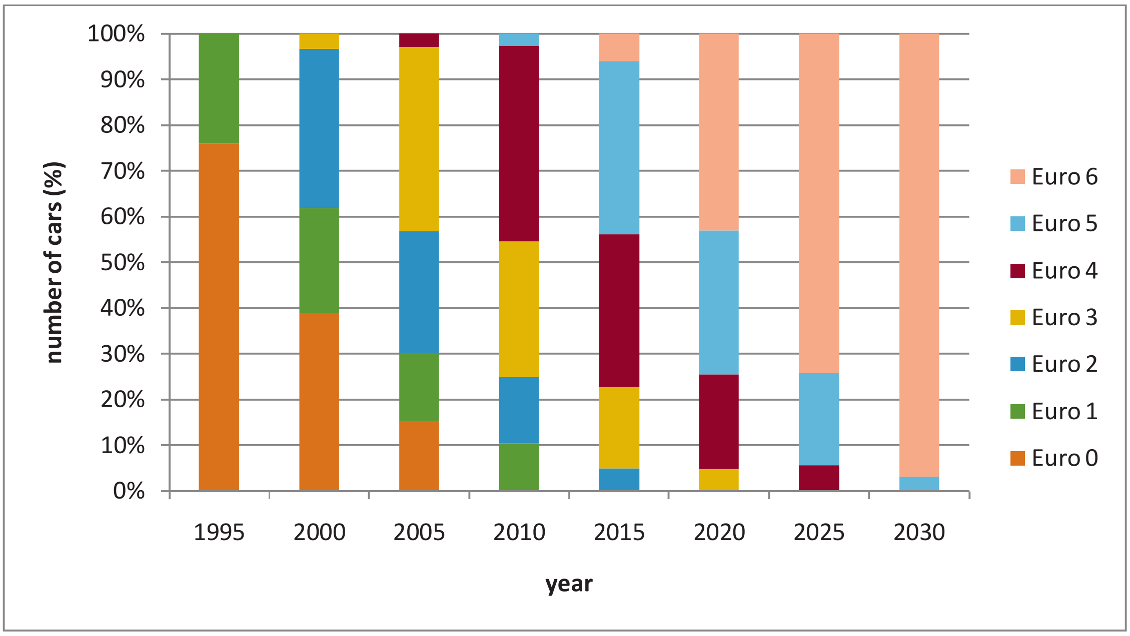

Figure 4: Relative share of cars over different euro standards

2.2.1.4. Engine size

The fleet can also be ordered based on the size of the engine. They are clustered in three categories: small, medium and large vehicles. For conventional engines, these correspond with an engine size of <1.4l, 1.4-2.0l and larger than 2.0l. This notation is also used in the figures that follow through the remainder of this report. Please be aware that for vehicles with (partly) electric engines, we always have to think in terms of small, medium and large vehicles, because cylinder capacities make no sense there. From Figure 5, we conclude that cars with small engines are becoming increasingly popular as from 2010, with an increase from 31 to 51% for the period 2010-2030. This 'downsizing' phenomenon, i.e. the design of engines with an equal power output but a lower cylinder capacity, can be attributed to fiscal incentives and innovation. The number of medium-sized engines are still constituting the largest part of the fleet today (58% in 2010). However, as from 2025, the share of medium-sized engines will have been overtaken by the small engines.

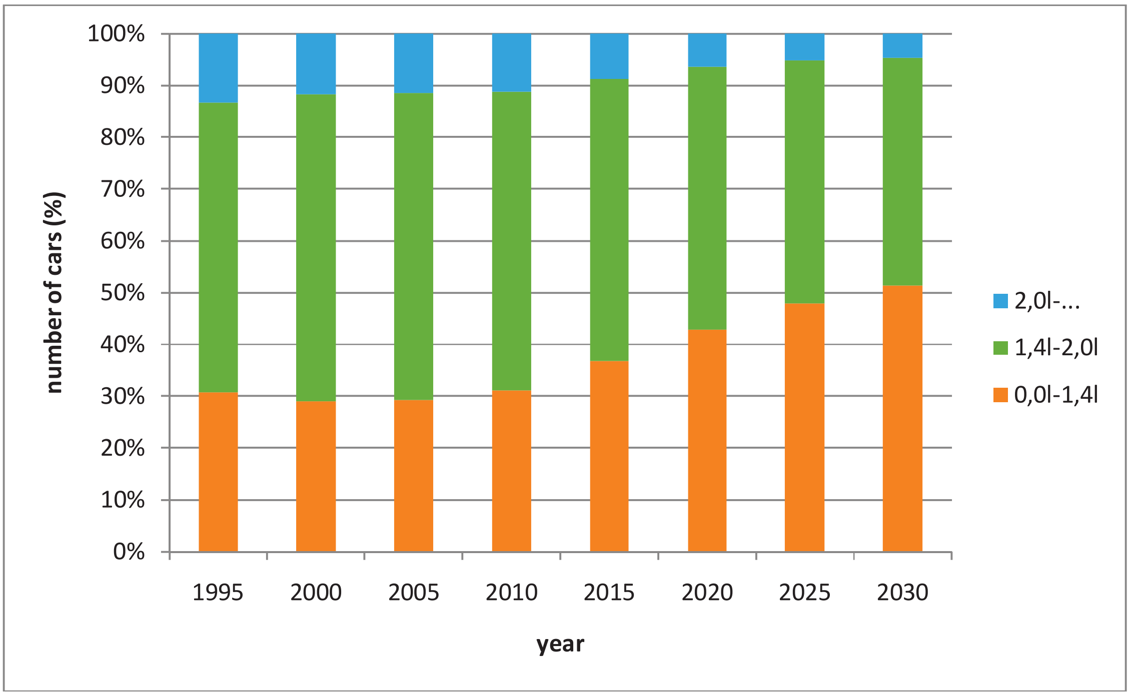

Figure 5: Relative share of cars in the different engine sizes

2.2.1.5. Ecoscore

It is interesting to have an idea of the average ecoscore of the Belgian fleet. The ecoscore can be presented either as an overall (unweighted) average of all the cars in Belgium or as a more sophisticated average, weighted by the number of kilometres driven by each car. Under this section (fleet composition), we discuss the unweighted ecoscore. In the section on the environmental impact, on the other hand, we focus on the weighted average ecoscore, taking into account the distances travelled.

The average ecoscore for the Belgian fleet is displayed in Figure 6. We see that in the four-year period 2006-2010, the average ecoscore already went up by 6 units, from 52 to 58. Our model expects this trend to continue, to an average ecoscore of 73 in the year 2030. This corresponds to an average increase of 0.74 ecoscore units per year over the period 2010-2030. The pace of improvement seems to slow down a bit during the last half of this period (2020-2030).

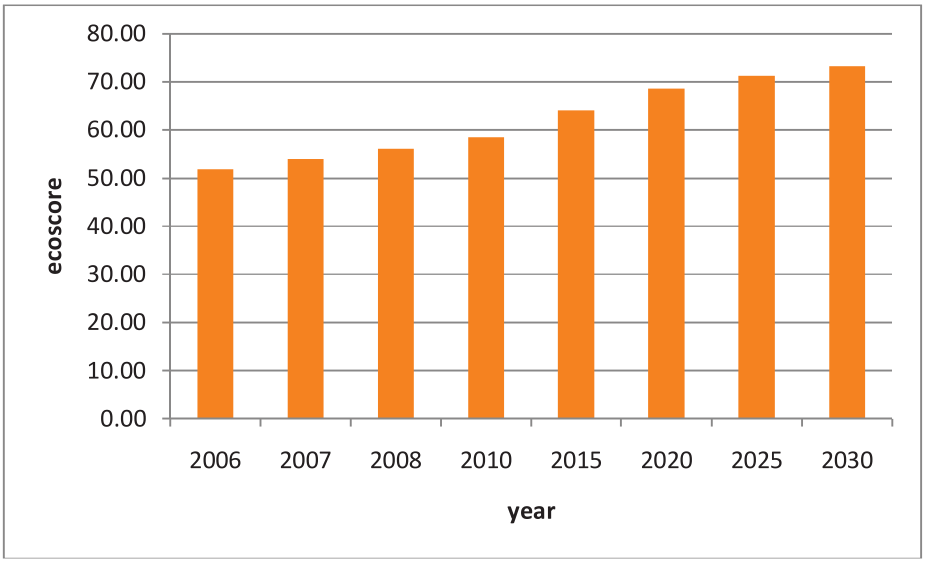

Figure 6: Average ecoscore for Belgian fleet (unweighted)

2.2.1.6. Ecoscore per technology

The average ecoscore for all Belgian cars can also be split for the various technologies. This is depicted in Figure 7.

For each fuel technology separately, it is clear that the ecoscore is expected to grow over the years to come. In this baseline scenario, hybrid vehicles are assumed to be sold on a large scale as from 2015. Their ecoscore is rising rather smoothly during the period 2015-2030. Logically, electric vehicles turn out to be the best performers, with an ecoscore of over 84 in the year 2030. Second-best in class are the hydrogen vehicles (both ICE and fuel cell). However, under this scenario they are expected to be very small in number, even in 2030 (see Figure 3). The ecoscores of the conventional petrol and diesel vehicles are expected to improve as well. As from the year 2020, conventional diesel vehicles are predicted to have caught up the petrol vehicles. Cars running on LPG and CNG are already quite clean today. Therefore, it is no surprise that their expected gain for the future is rather small.

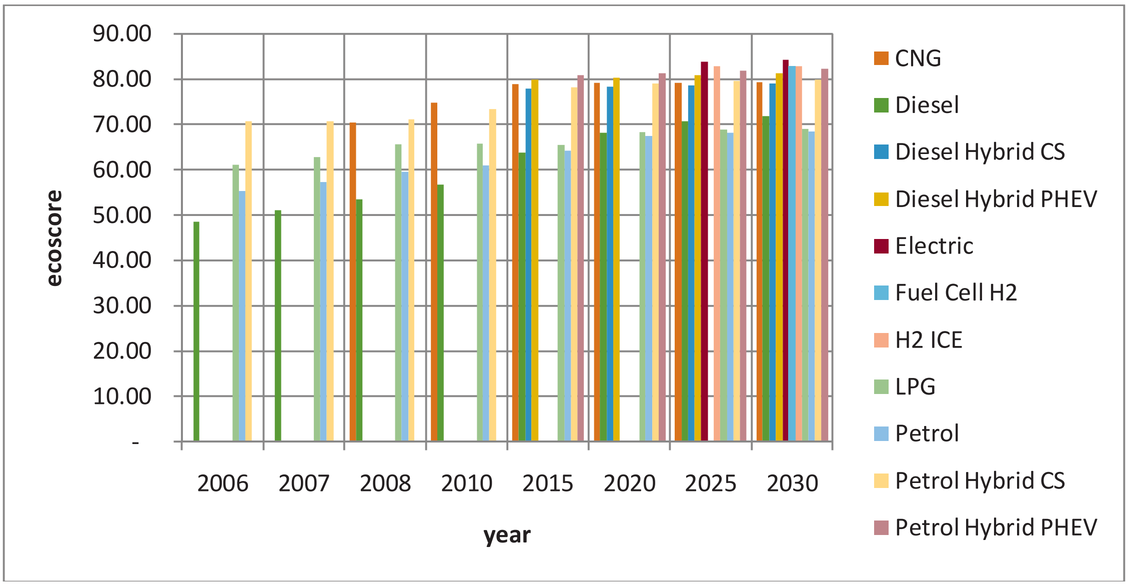

Figure 7: Average ecoscore per technology (unweighted)

2.2.2. Vehicle use

In this section, we are no longer interested in the number of vehicles in one particular year. Instead, we investigate how the vehicle use evolves over time. First of all, we discuss the overall number of kilometres driven in Belgium, for all cars and road types. Afterwards, we continue by distinguishing for road types, technologies, etc.

2.2.2.1. Kilometres driven

The total number of kilometres is displayed in Figure 8. The model forecasts a continuing increase in the total number of kilometres driven, at least until 2030 (94 billion km versus 79 billion km in 2010, i.e. +18%). Remarkable is the sharp increase (+10%) in the period 2010-2015, in line with the jump over the period 2005-2010 (+6.5%).

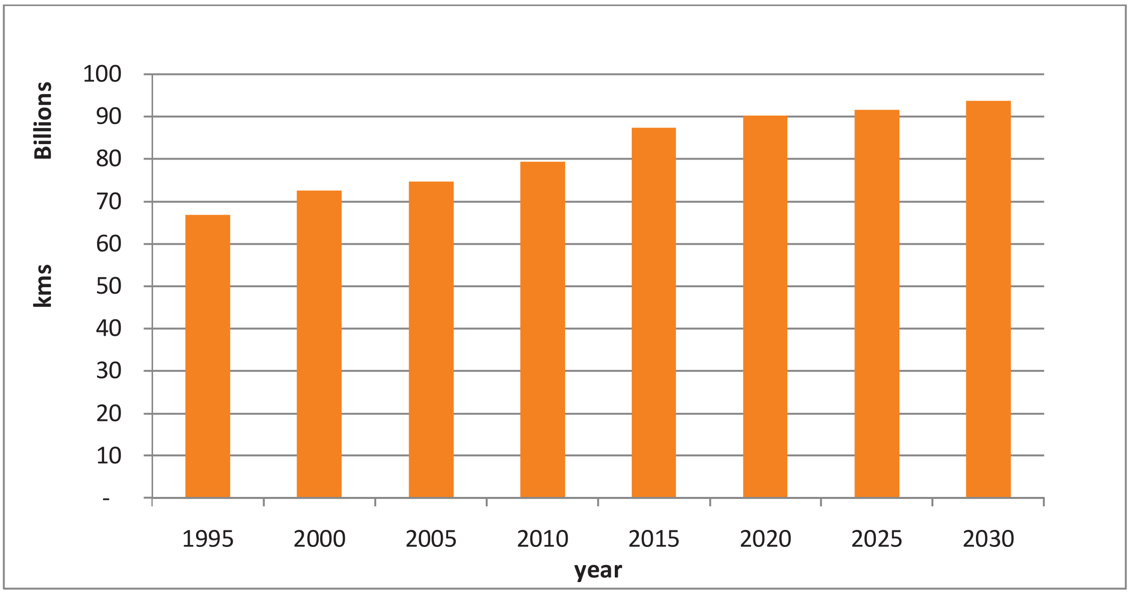

Figure 8: Kilometres driven in Belgium

2.2.2.2. Kilometres per road type

We can split the total number of kilometres according to the road types where the cars are driven. We observe an increasing trend, at least until 2030. In 2010, more than 40% of all kilometres are driven on rural roads, while one third is travelled on highways (highw). Consequently, the remaining quarter is done in an urban context. Those ratios remain practically unchanged over all the years considered.

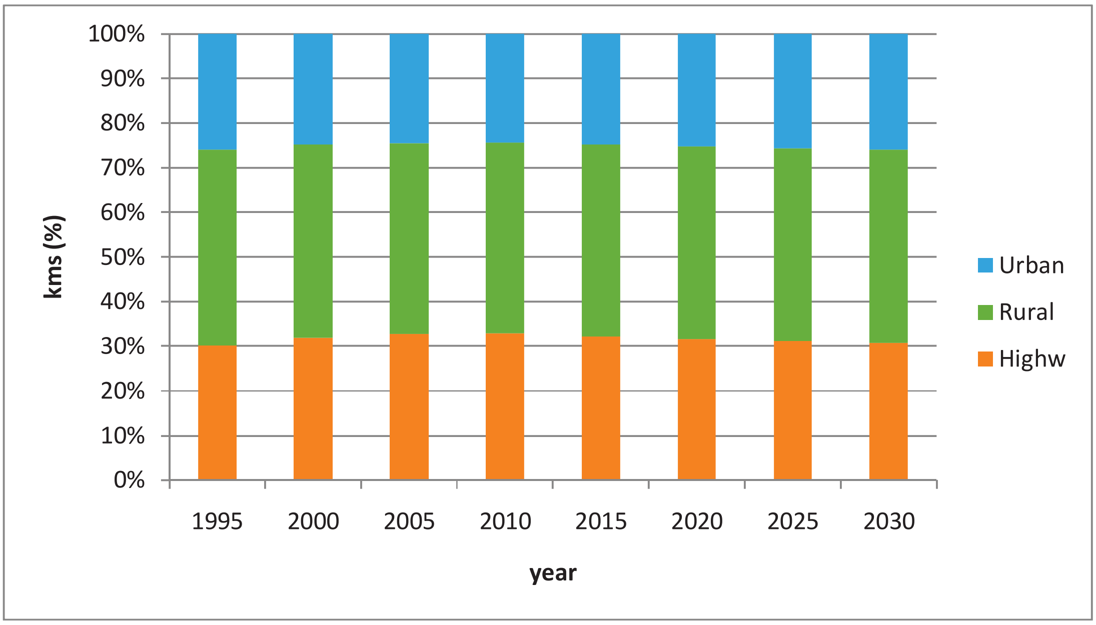

Figure 9: Relative share of kilometres driven over different road types

2.2.2.3. Kilometres per fuel technology

When we split the vehicle's distance travelled according to the different fuel technologies, we see that the annual number of diesel kilometres travelled (since 1995) has always been higher than those covered by petrol cars. In 2010, almost 63 billion or 79% of all kilometres is done by diesel cars. According to this scenario, diesel technology will continue to play a major role in the future, especially if distance is concerned (still 63% of all kms in 2030). The diminished share of diesel kilometres after 2015 is now mainly driven by the diesel hybrids (PHEV and to a lesser extent CS).

As we compare those results to Figure 3, it becomes clear that the average diesel vehicle drives more kilometres per year than the average petrol vehicle, as we could have expected based on the current fuel prices. Hybrid vehicles are also used more than their number should make us expect, and this is the case for both diesel and petrol hybrids. Electric vehicles, on the other hand, are driven proportionally less kilometres compared to their sales figures.

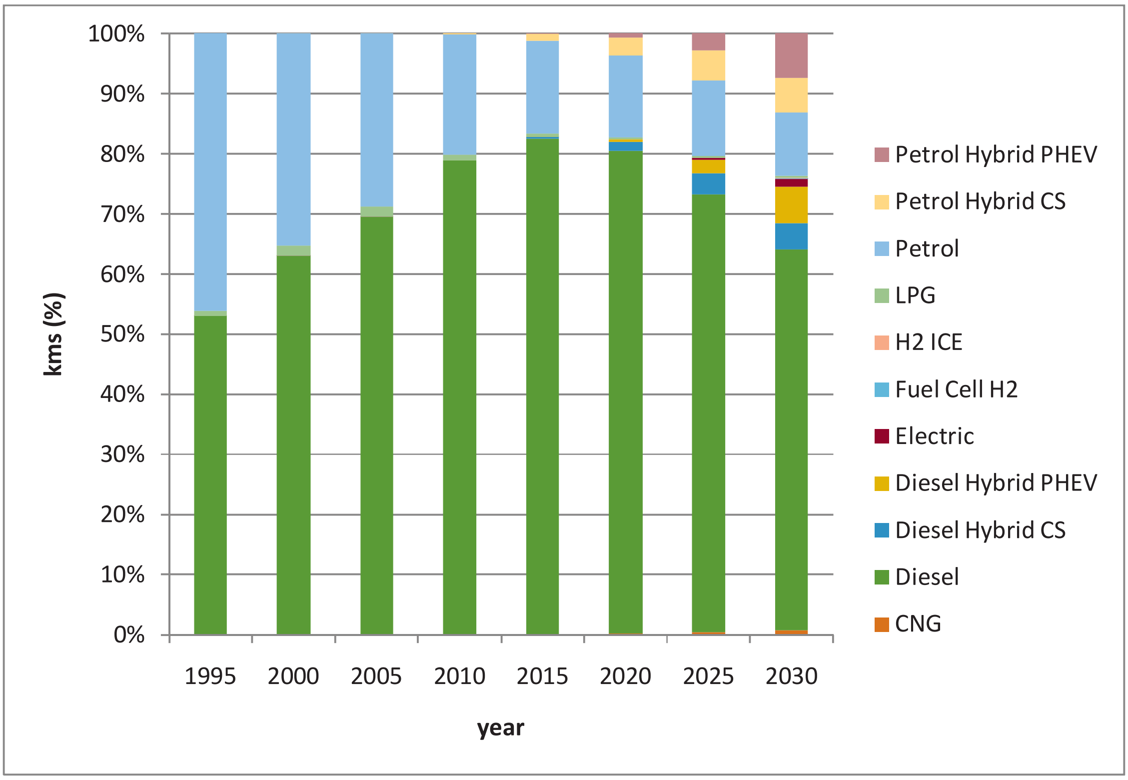

Figure 10: Relative share of kilometres driven by different technologies

2.2.2.4. Kilometres per euro standard

The number of kilometres travelled over Belgian roads by the different euro standard classes is displayed in Figure 11. Today, 80% of all kilometres is done by euro 3 and euro 4 vehicles, while only 4% is covered by euro 5 cars. We expect that in 2030, 98% of all kilometres is driven by euro 6 vehicles, or higher.

When we compare this result with the fleet results in Figure 4, we conclude that the newer cars (i.e., with a higher euro standard) are covering more kilometres than the older ones.

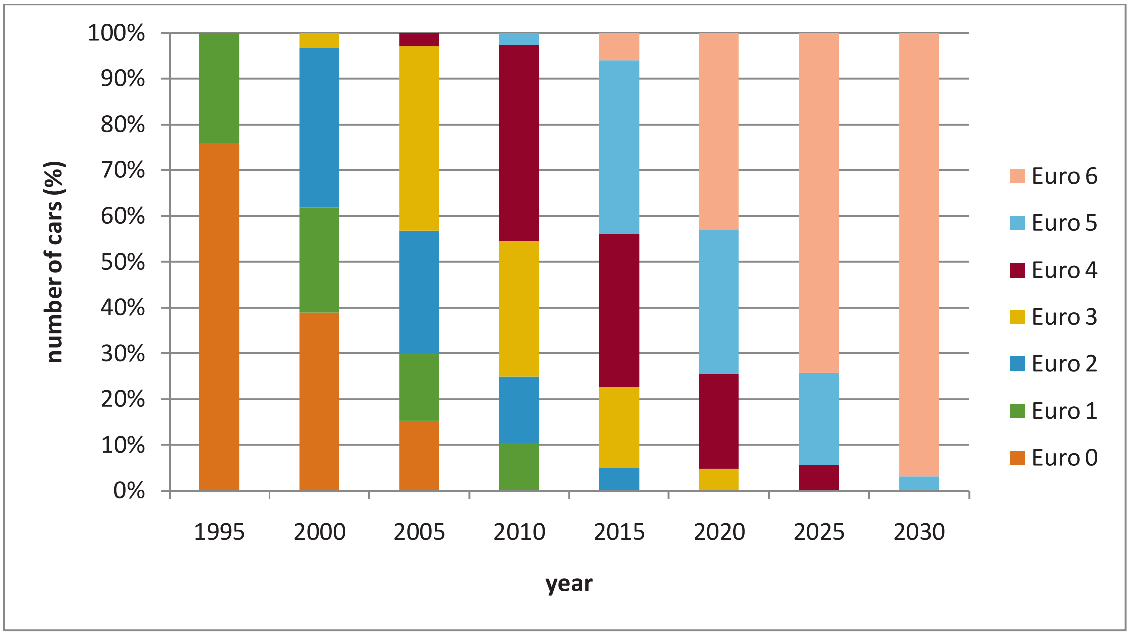

Figure 11: Relative share of kilometres driven by different euro standards

2.2.2.5. Kilometres per engine size

The number of kilometres driven by the various engine sizes is depicted in Figure 12. Until 2010, the number of cars with an engine smaller than 1.4 litres was rather small (23% of all kms in 2010). However, we expect this percentage to massively rise in the future, to approximately 44% in 2030. The share of large engine (>2.0l) kilometres is predicted to drop from 12 to 5% over the period 2010-2030. At the same time, the distances covered by medium-sized engines is expected to fall to 51%, coming from 65% in 2010.

Compared to Figure 5, the share of medium-sized and large engines (>1.4l) is higher for the current section on vehicle use. This implies that those engines are driven more kilometres each year, on average, than the engines with a smaller cylinder capacity (<1.4l).

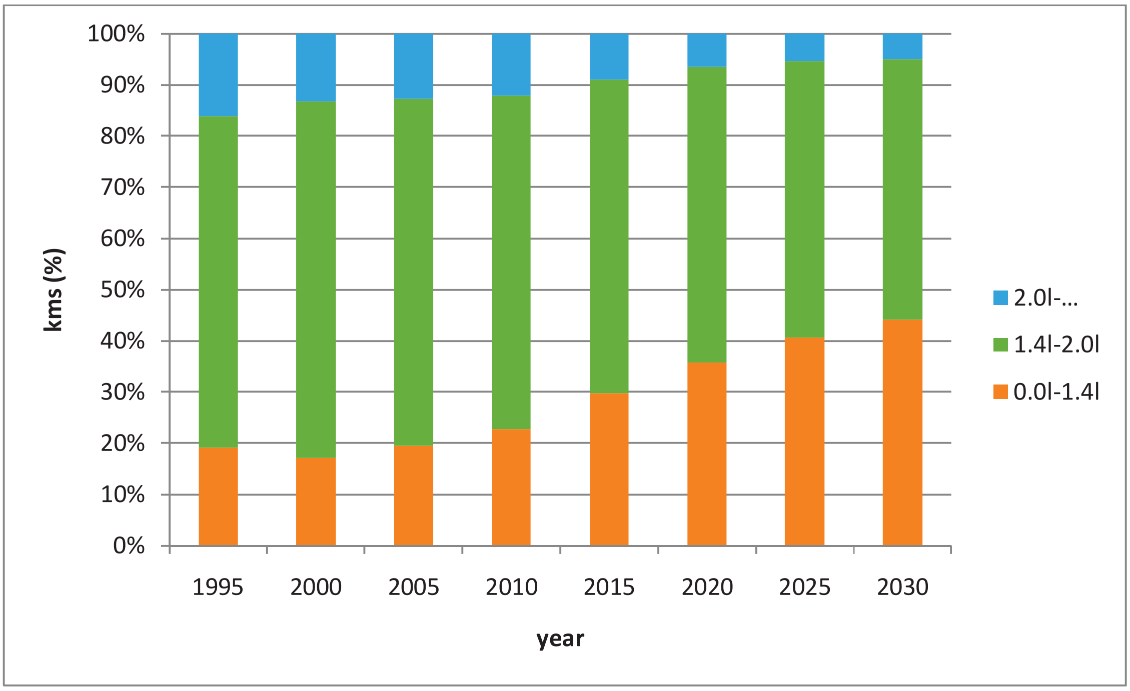

Figure 12: Relative share of kilometres driven by different engine sizes

2.2.3. Environmental impact

2.2.3.1. Ecoscore

As mentioned in section 2.2.1.5, we can calculate an average weighted ecoscore for the Belgian car fleet. Therefore, we weigh the ecoscore for each car type by the (predicted) number of kilometres driven. This indicator gives us a better idea of the overall performance of the Belgian passenger cars.

It is to say, newer cars (i.e. cleaner cars, on average) are usually driven more frequently than older cars. Therefore, we should expect that the weighted average ecoscore is somewhat higher than the unweighted indicator.

Indeed, this observation is confirmed by Figure 13. It is to say, when we compare this figure with the numbers found in section 2.2.1.5, we notice a slight increase (between 0.20 and 0.70 units) in the ecoscore, for all years starting from 2010. The overall weighted ecoscore is expected to rise from 59 till 74 over the period 2010-2030 (versus 58 till 73 for the unweighted indicator), i.e. an average increase of 0.76 units per year.

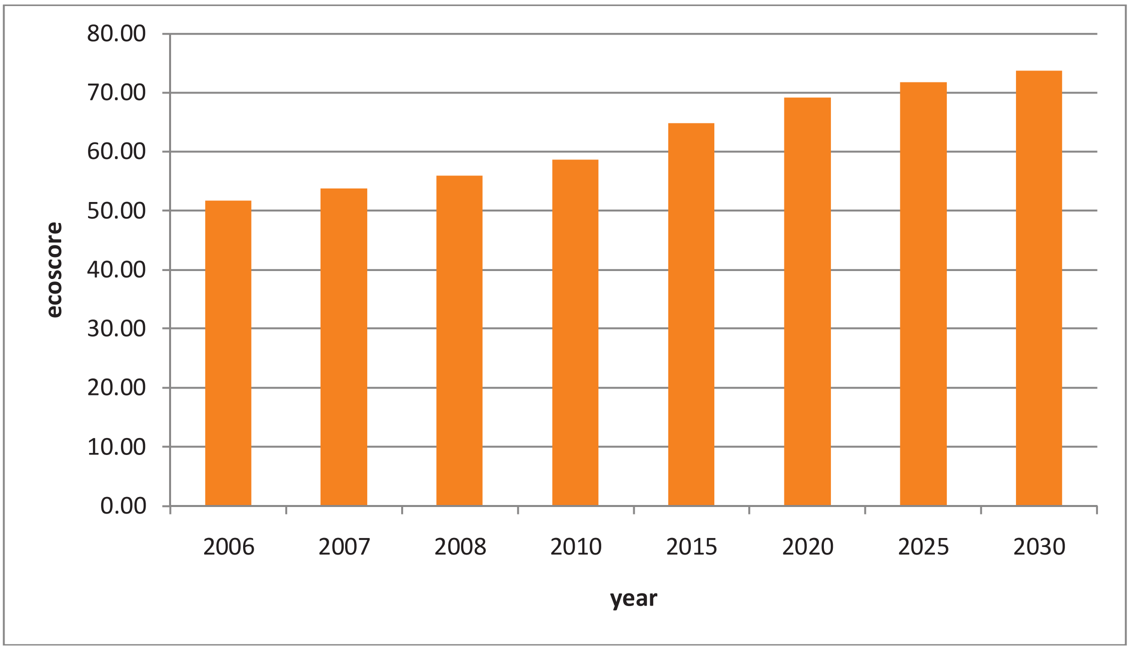

Figure 13: Average ecoscore for Belgian fleet (km weighted)

2.2.3.2. Ecoscore per technology

Again, we can split the overall average over the different vehicle technologies. The differences compared to Figure 7 are quite small, so the same conclusions apply here.

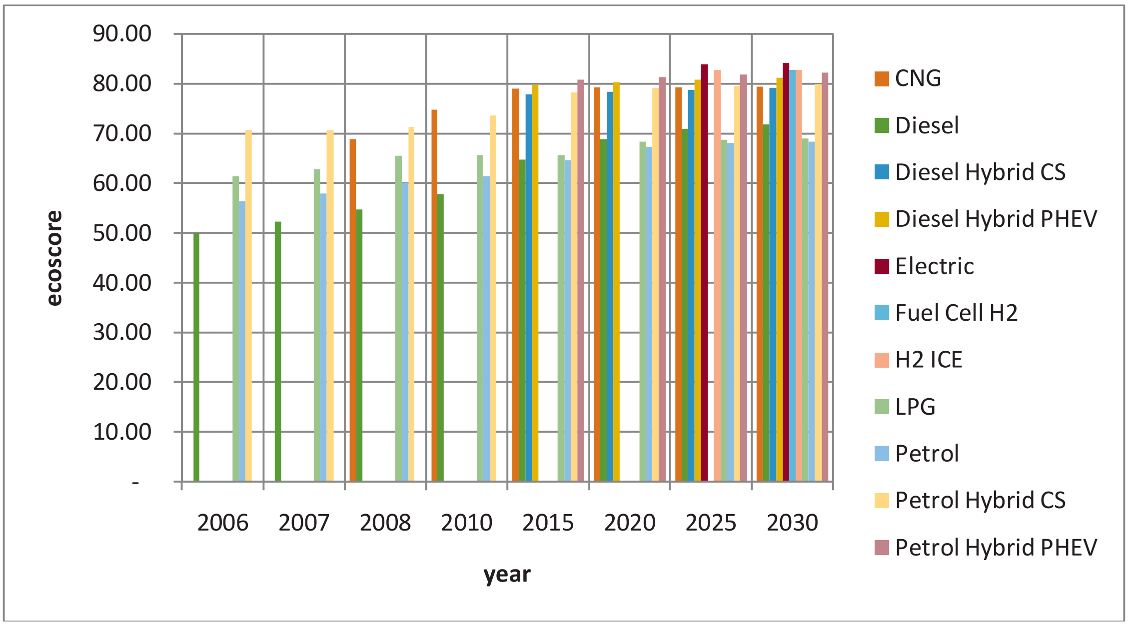

Figure 14: Average ecoscore per technology (km weighted)

2.2.3.3. Emissions

We investigated the emission quantities in Belgium for the following pollutants: CO_2 equivalents (CO_2e), PM2.5, NO_x, CO, VOCs, SO_2 and NH_3. These are also the emission pollutants that will be evaluated throughout the remainder of this report. We think those pollutants cover the most important vehicle emission classes. Please note that only tank-to-wheel (TTW) emissions are taken into account. Under this approach, electric vehicles are causing no emissions at all. We will build our discussion on emissions by a split over the different technologies, in order to give the opportunity to the reader to immediately link the pollutant with their emitting technologies.

The results are presented in Figure 15 until Figure 21.

All greenhouse gas emissions are expressed as CO_2 equivalents, found by weighing each unit of CO_2, CH_4 and N_2O by a factor 1, 21 and 310, respectively (website IPCC). This is called the global warming potential (GWP) and the GWP of CO_2 is by convention equal to one. Today, approximately 12.2 mio tonnes of CO_2e is emitted by the Belgian car fleet. Even under this baseline scenario, this number is expected to fall steadily to 10.4 mio tonnes in 2030.

In spite of the rising trend in the number of vehicles and the distance travelled, we observe a spectacular decrease in the predicted emission levels of PM2.5, CO, VOC, SO_2. Emissions of NO_x and NH_3 will also go down in this scenario, although it will happen slower.

The figures given below display the distribution of emissions over the various technologies as well. For some pollutants, there is a quite strong correlation with certain technologies.

Concerning CO_2e, we know there is a direct relationship between fuel consumption and emissions. Nevertheless, the amount of CO_2 released is higher for a litre of diesel than for petrol, which is again higher than a litre of LPG. From Figure 15, we conclude that diesel vehicles cause the majority of the CO_2e emissions from Belgian cars.

Furthermore, it seems that diesel vehicles are and will be responsible for the majority of the PM2.5 exhaust.

Diesel cars also play a crucial role in the emissions of nitrogen oxides (NO_x): before the year 2000, the largest share of emissions originated from petrol engines. In recent years, however, the amount of NO_x emissions by petrol engines has drastically been reduced, thanks to the application of the three-way catalytic converter. Nowadays, the largest share of NO_x from car transport should be attributed to diesel engines (92% in 2010) and our model predicts that this situation will persist at least until 2030 (87%).

Diesel engines used to emit lots of SO_2 as well, however, this has changed in the early noughties thanks to reduced fuel sulphur contents. Consequently, great progress has already been made in the past, such that the model expects the SO_2 emissions to remain relatively stable (only -15%) over the period 2010-2030.

Concerning emissions of CO and VOC, we observe a quite similar image. It is to say, petrol engines used to be the most important polluters in the past. Nevertheless, when the three-way catalytic converter came available, emissions started to plummet. In 2010, 79% (70%) of all CO

(VOC) car emissions are still originating from petrol vehicles. However, our model expects this share to further drop to 36% (41%) towards 2030.

On the other hand, the widespread introduction of three-way catalytic converters has worsened the level of NH_3 emissions towards the year 2000. This relationship is described by (Whitehead et al., 2004). The decreased number of petrol kilometres (-38% in 2000-2010 and a supplementary -23% towards 2030) are the main reason for the observed emission drop (till 2010) and the projected emission decline in the future.

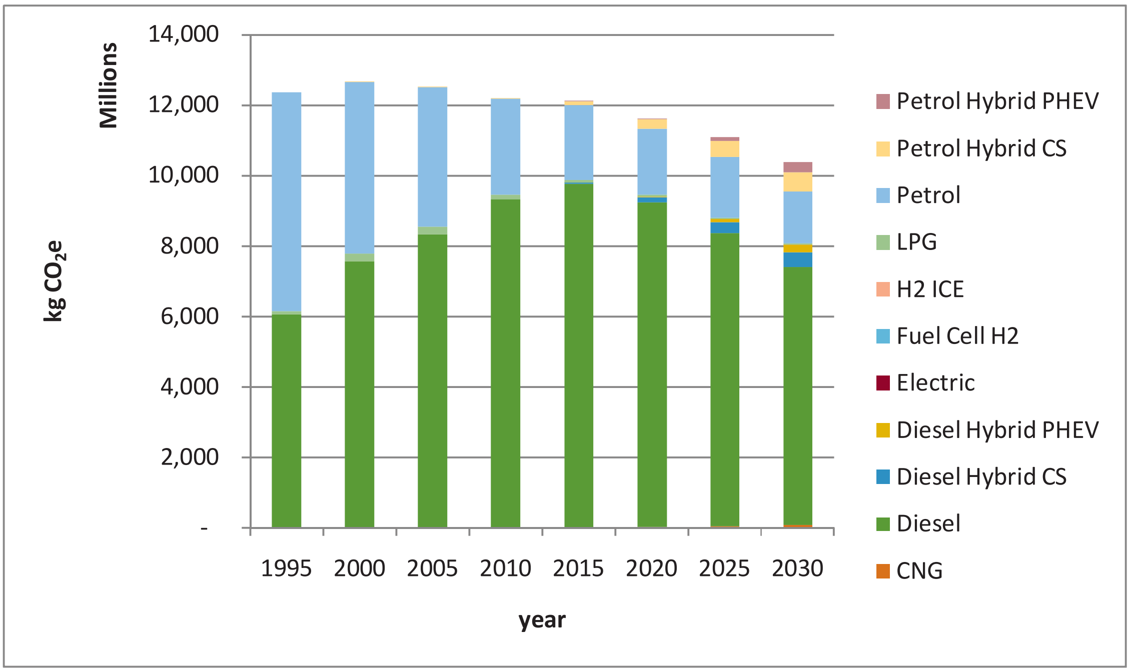

Figure 15: TTW emissions CO_2e per technology

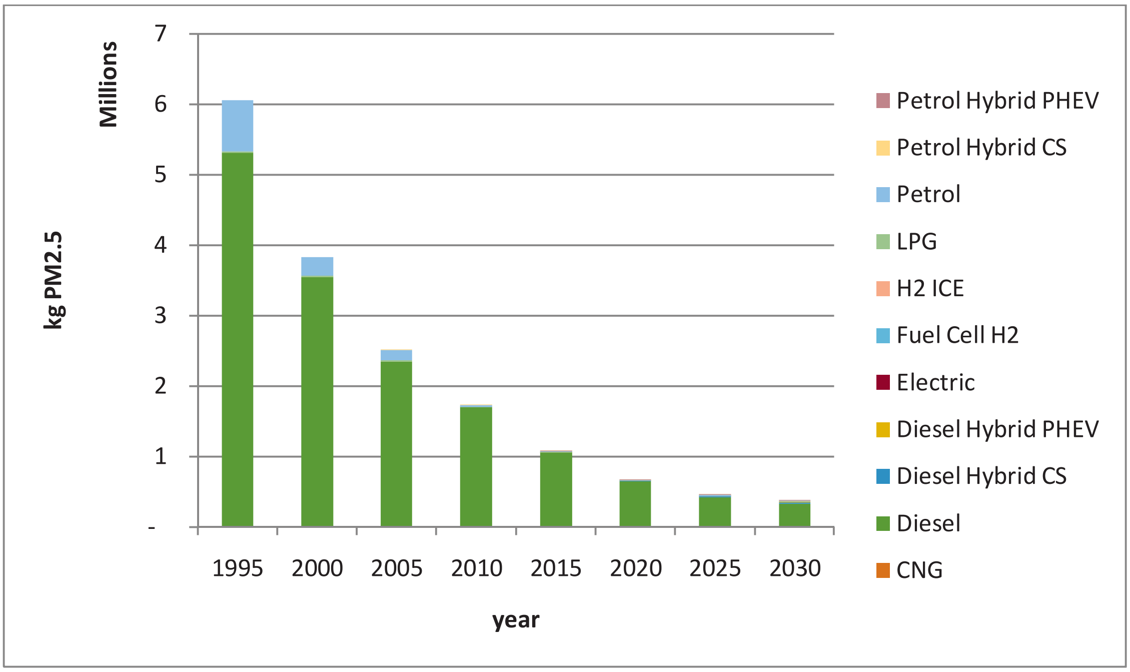

Figure 16: TTW emissions PM2.5 per technology

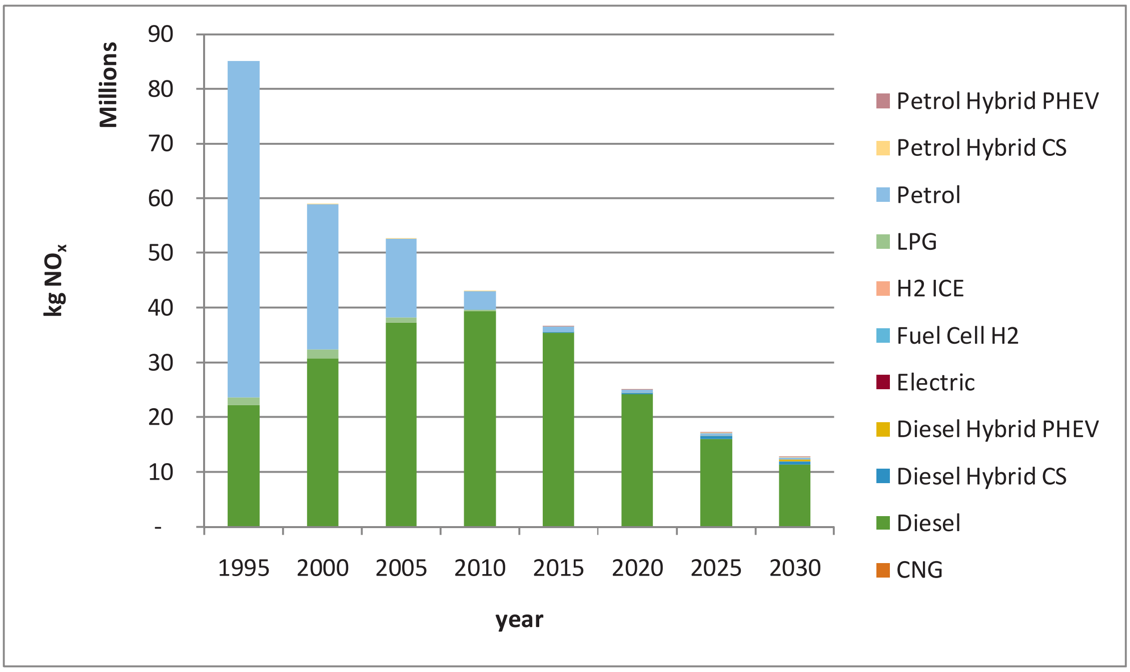

Figure 17: TTW emissions NO_x per technology

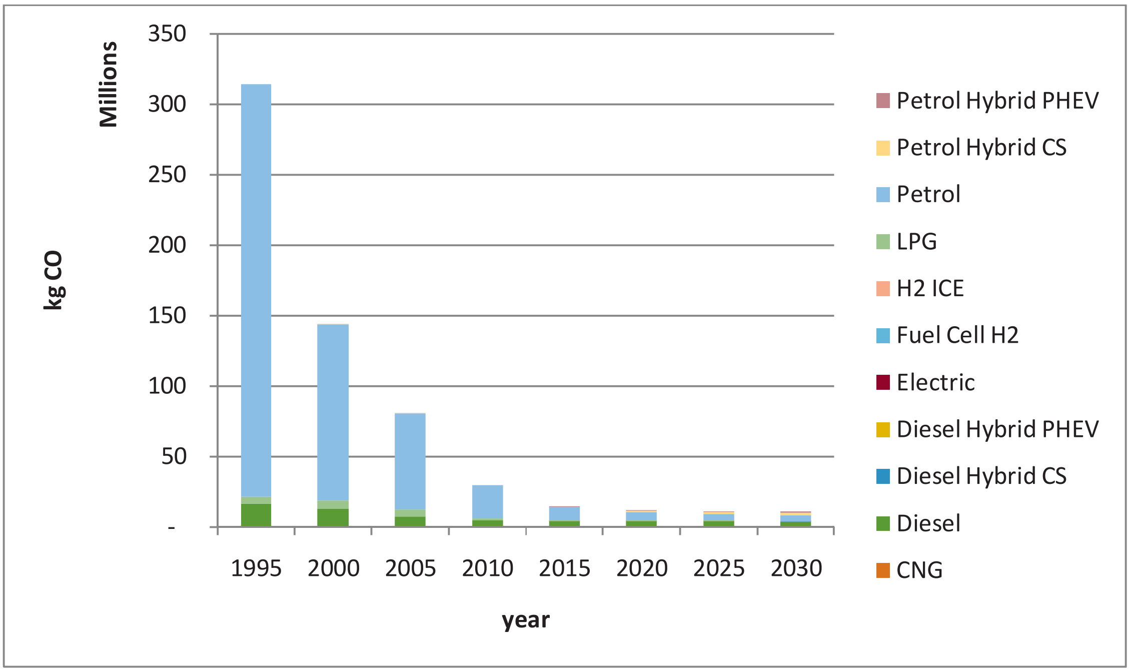

Figure 18: TTW emissions CO per technology

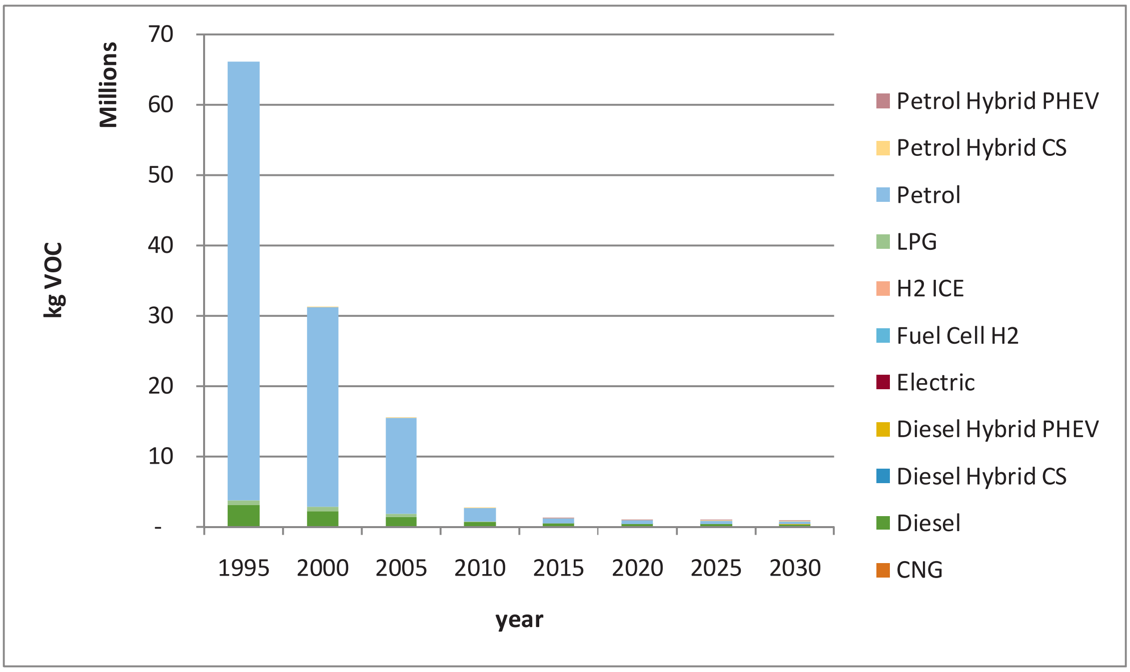

Figure 19: TTW emissions VOC per technology

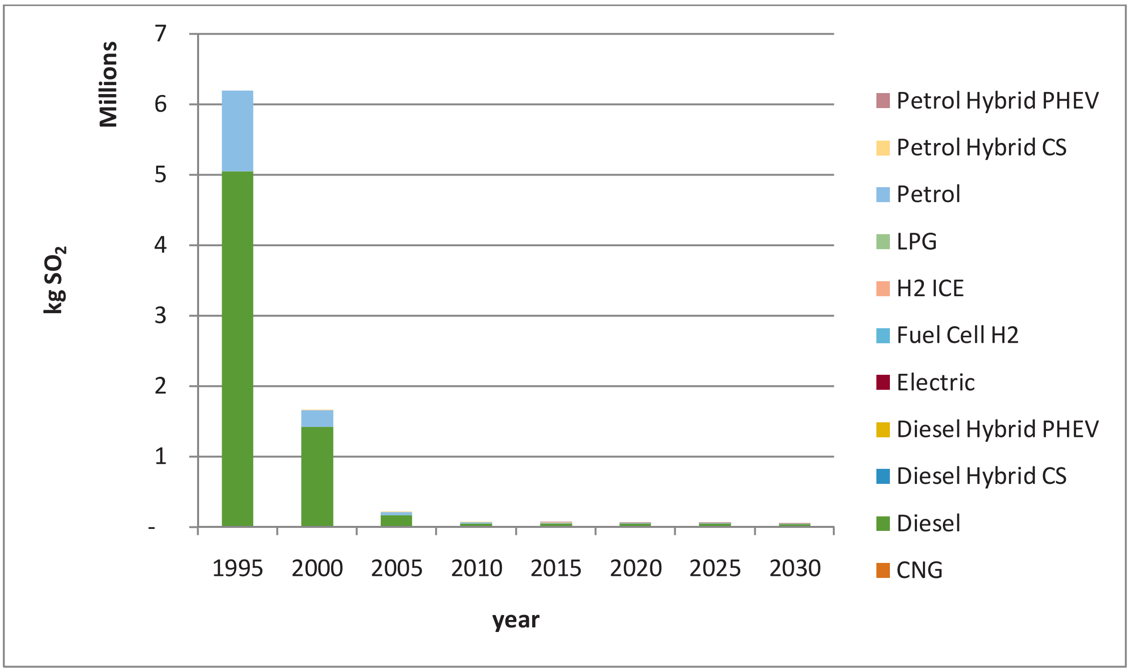

Figure 20: TTW emissions SO_2 per technology

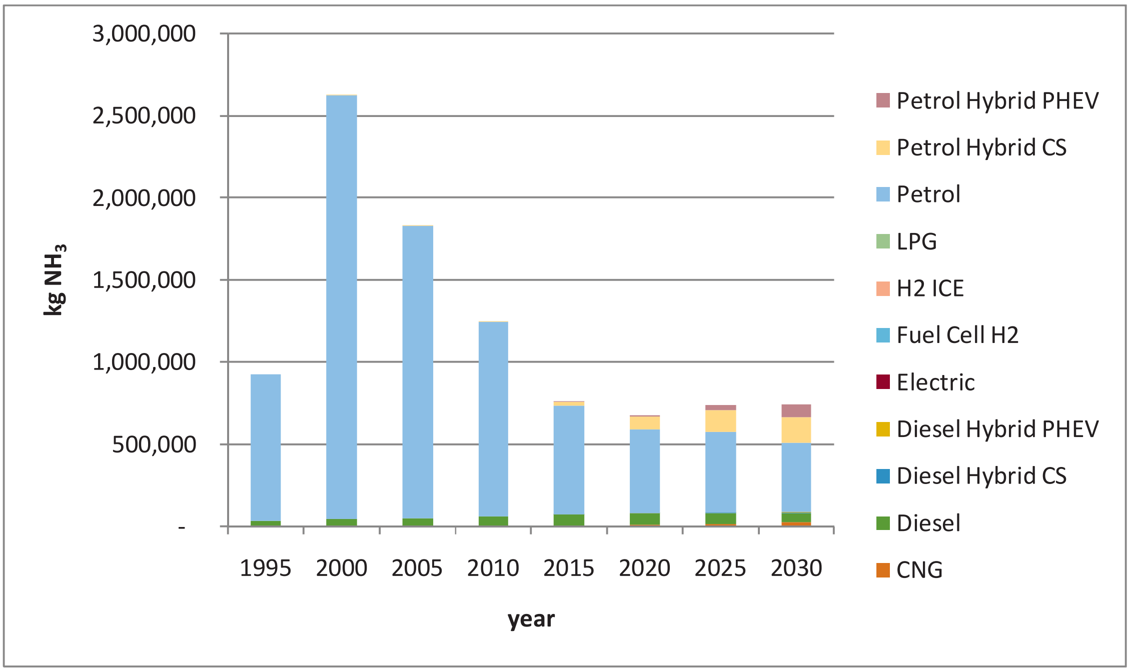

Figure 21: TTW emissions NH_3 per technology

3. Impact of the scenarios (Task 6.2)

In this section, we examine the effects of the 3 alternative setups, viz, the realistic, progressive and visionary scenario. The arrangement is similar as for the baseline scenario: the effects from each scenario are subdivided into fleet composition, vehicle use and environmental impact data. Detailed result tables are again provided in the annex at the end of the report.

3.1. Realistic scenario

The measures introduced under the realistic scenario are repeated below. We also provide a timeline (Table 1) with an indication of the start date and running period (yellow) for a specific measure and a first estimation of the period with the largest effects (or shocks) on fleet and environmental impact (black shading). Please note that the cell under '2000' represents the period from the beginning of the year 2000 till the end of 2004. For a detailed description of all the adopted measures, we refer to the report of task 5.3 'Scenario development'.

Extra measures under the realistic scenario compared to the baseline scenario:

A) Tax system based on combination of CO_2 and Euro standard
B) Advantages for Euro 6 vehicles
C) Clean fuels: standardization and availability (CNG and E85)
D) Change in excise duties
E) Subsidies for retrofitting old cars with filters
F) Subsidies for cleaner fuel systems (LPG and CNG)

	2000	2005	2010	2015	2020	2025
A						
B						
C						
D						
E						
F						

Table 1: Timing of the realistic measures (yellow) and the period with their largest expected impact (shading)

3.1.1. Fleet composition

3.1.1.1. Number of cars

Under the realistic scenario, the total number of Belgian cars is expected to rise to 5.8 million in 2030. This is 4% lower than under the baseline scenario. This difference compared to the baseline is built up steadily over the period 2010-2030.

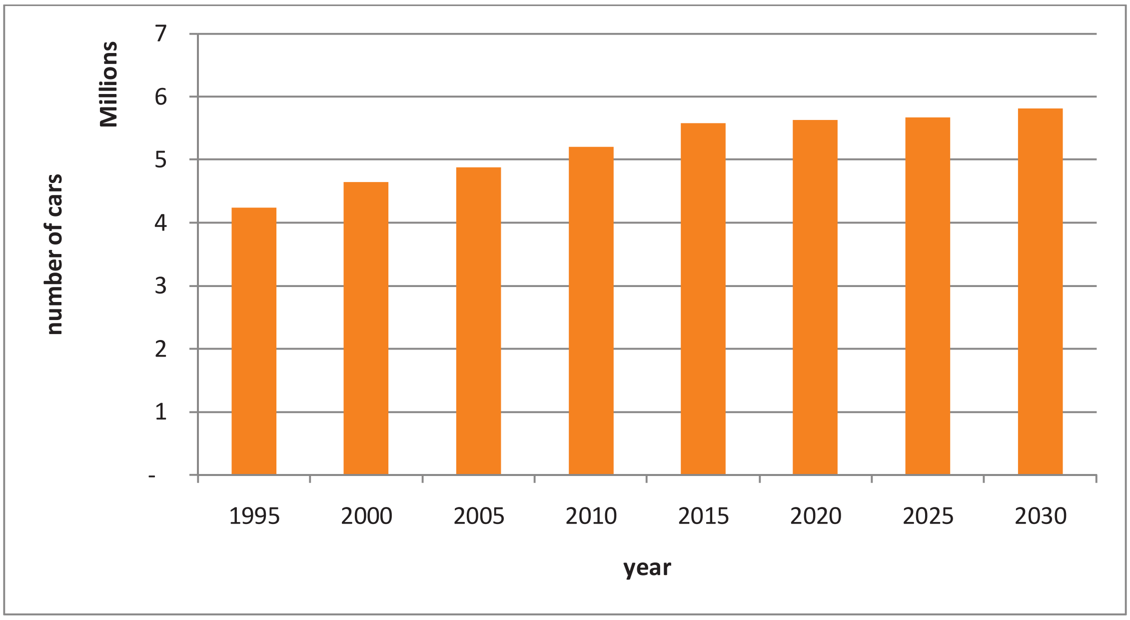

Figure 22: Absolute amount of cars in Belgium

3.1.1.2. Technology

When we split over the various vehicle technologies, we observe the distribution given in Figure 23. There are only some small differences compared to the baseline results. It is to say, the share of LPG and CNG vehicles rises slightly, whereas petrol and petrol hybrid CS cars are losing ground. The share of diesel cars is slightly smaller than under the baseline in 2015 and 2020, but a little bit higher for the years 2025 and 2030. Although the study of the separate effects from the policy measures lies beyond the scope of this report, we can imagine that the retrofit subsidies and the stimulation of clean fuels play an important role here. Moreover, a tax system based on CO_2 is obviously not beneficial for stimulating the purchase of petrol vehicles, as their carbon dioxide emissions are usually substantially higher compared to diesel engines.

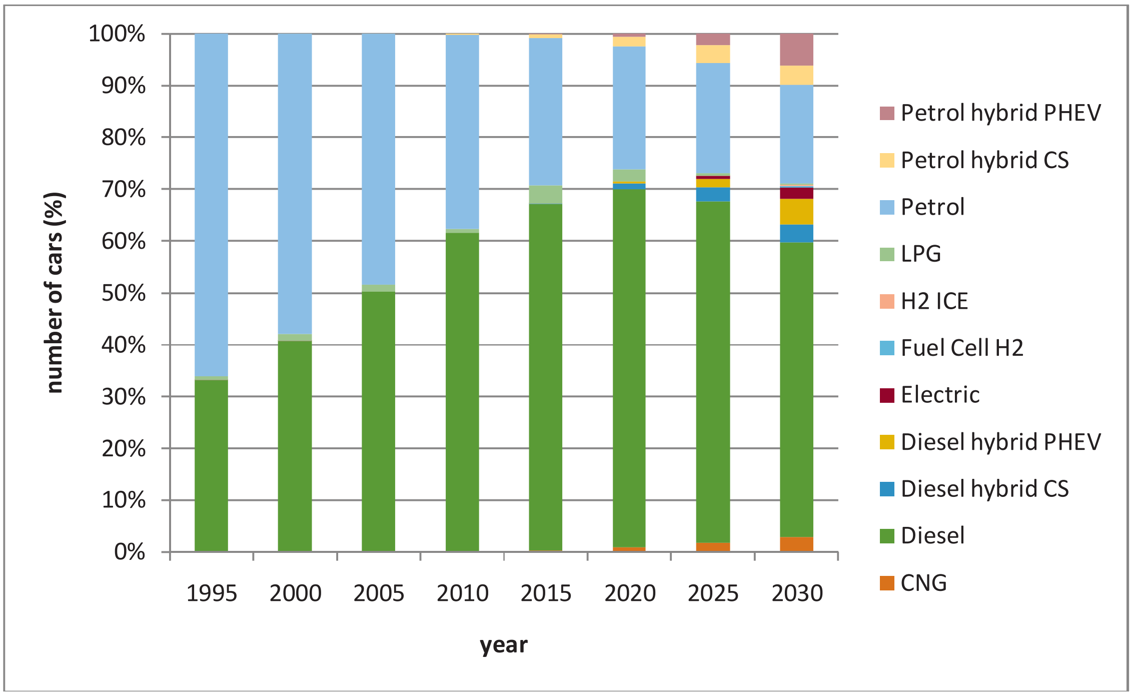

Figure 23: Relative share of cars over different technologies

3.1.1.3. Euro standard

The split over the euro standards is given in Figure 24. Newer standards are picked up somewhat earlier under this realistic scenario than under the baseline, for the period 2010-2030 (41 vs 38% Euro 5 in 2015 and 46 vs 43% Euro 6 in 2020). This is probably due to the benefits for vehicles complying with these standards. However, the distribution for the two scenarios is similar in 2030 (97% Euro 6), as the rate of improvement for the realistic scenario relatively decelerates in the last few years before 2030.

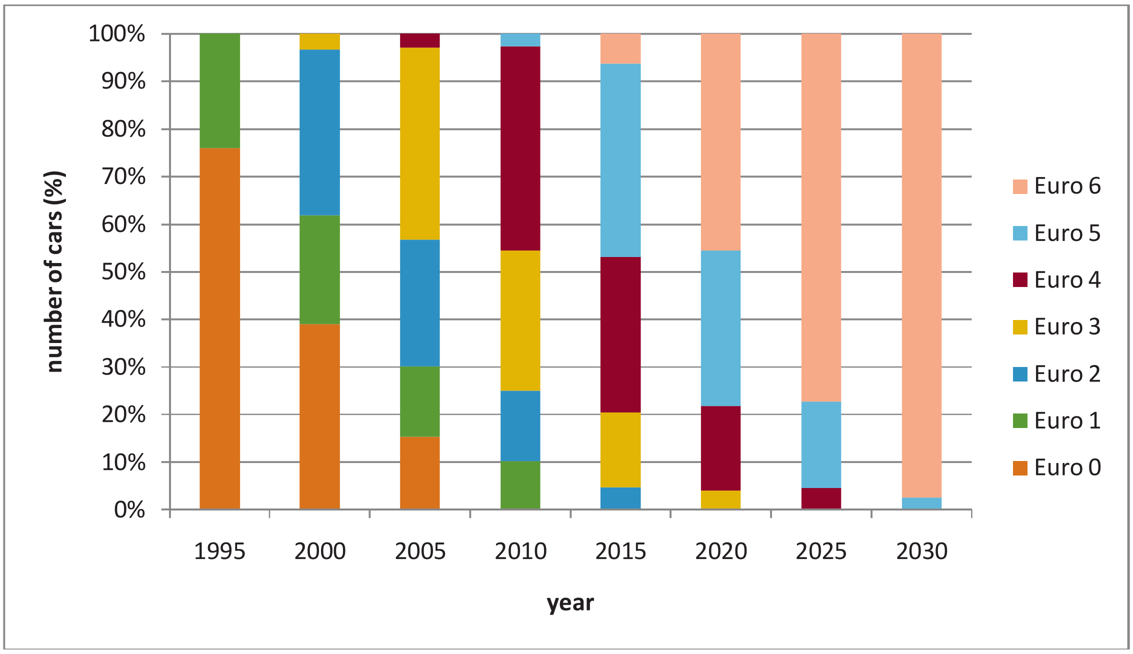

Figure 24: Relative share of cars over different euro standards

3.1.1.4. Engine size

When we split over the engine sizes of the fleet, we notice that the difference vis-à-vis the baseline is negligible. Again, the downsizing trend is clearly visible, and the smallest category constitutes 51% of the total fleet towards 2030.

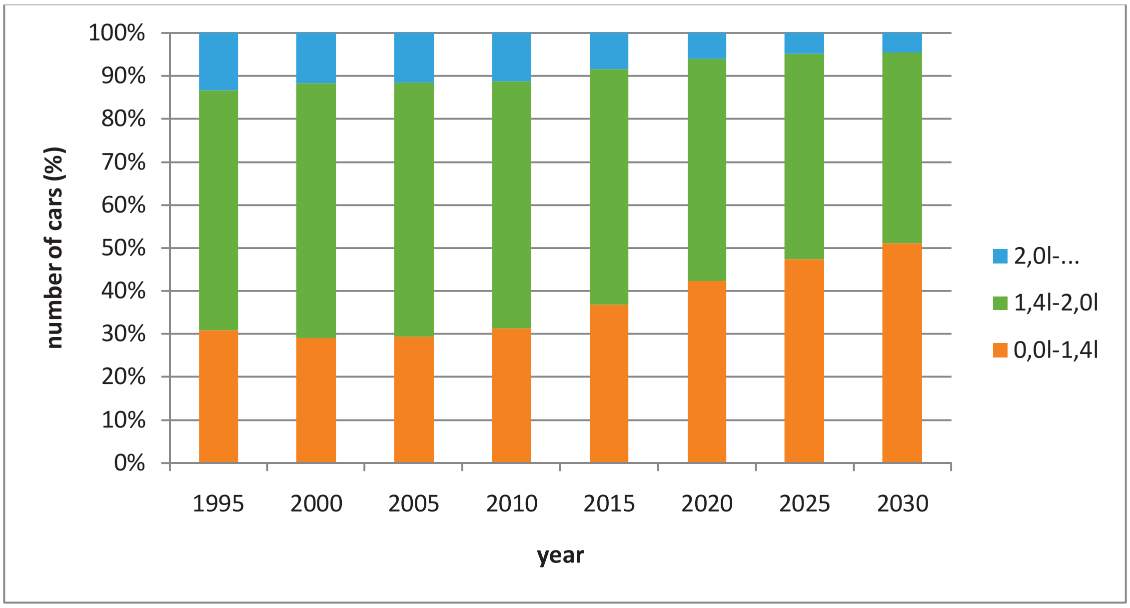

Figure 25: Relative share of cars over different engine sizes

3.1.1.5. Ecoscore

The rate of increase of the average ecoscore is somewhat higher under this scenario compared to the baseline (0.75 vs 0.74 units/year) over the period 2010-2030. The largest shift is observed for 2010-2015, when the ecoscore is expected to rise from 58.40 to 64.78. See Figure 26.

The split of ecoscores over the technologies is not repeated here (nor under the progressive scenario), as the differences compared to the baseline are marginal. However, the result table can be found in the annex at the end of this report.

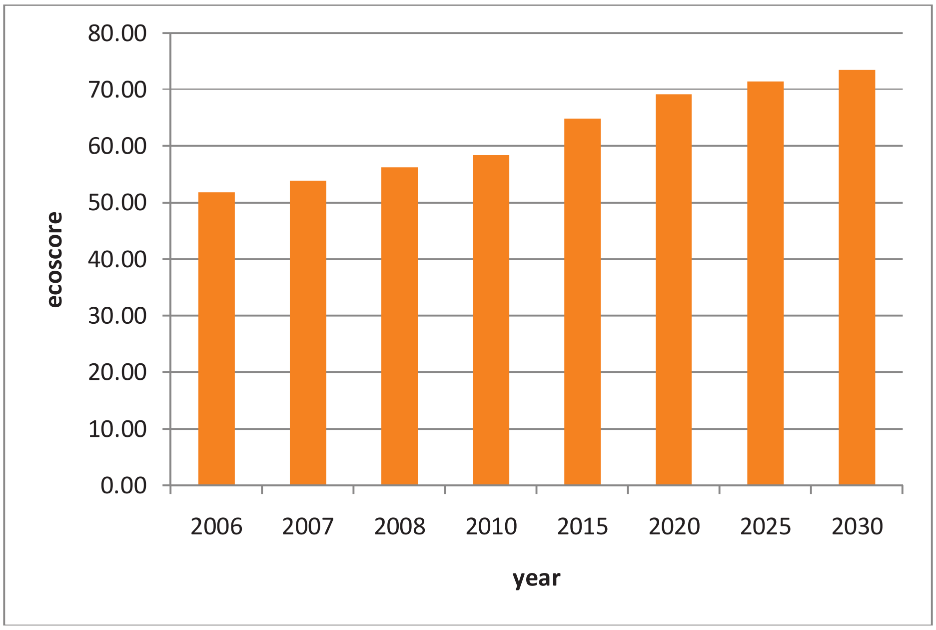

Figure 26: Average ecoscore for Belgian fleet (unweighted)

3.1.2. Vehicle use

3.1.2.1. Kilometres driven

The total number of kilometres driven is depicted in Figure 27. The total distance travelled now only increases to 92 billion kilometres in 2030. It is to say, we expect a smaller climb in the total distance travelled, compared to the baseline (+16 vs 18% over the period 2010-2030).

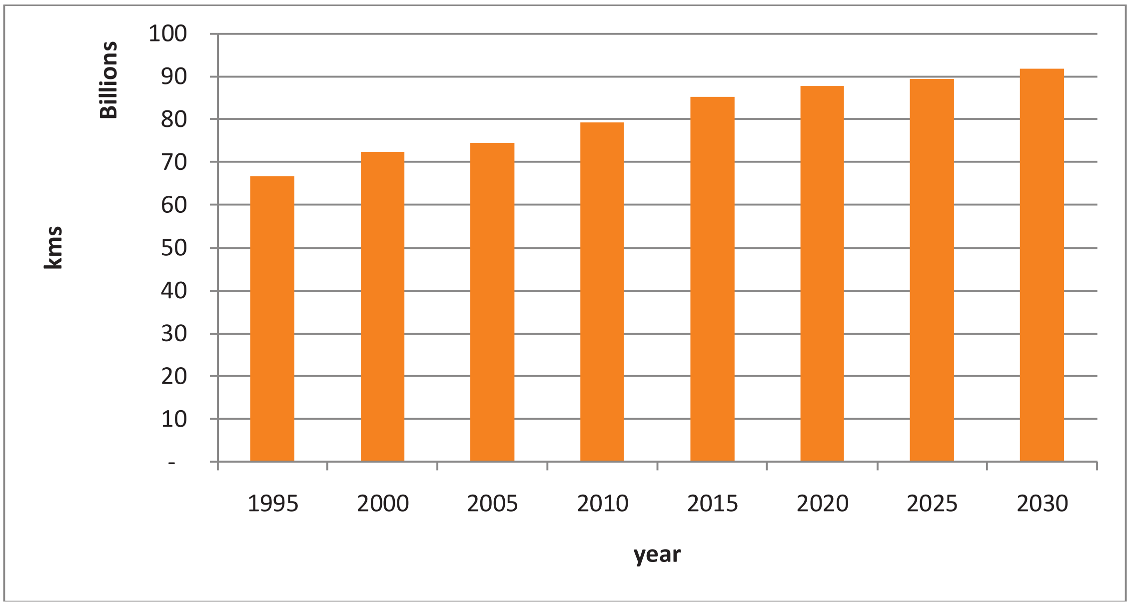

Figure 27: Kilometres driven in Belgium

3.1.2.2. Kilometres per road type

The relative shares mentioned in 2.2.2.2 do also apply for the realistic scenario, as the differences between the relative shares are infinitesimal.

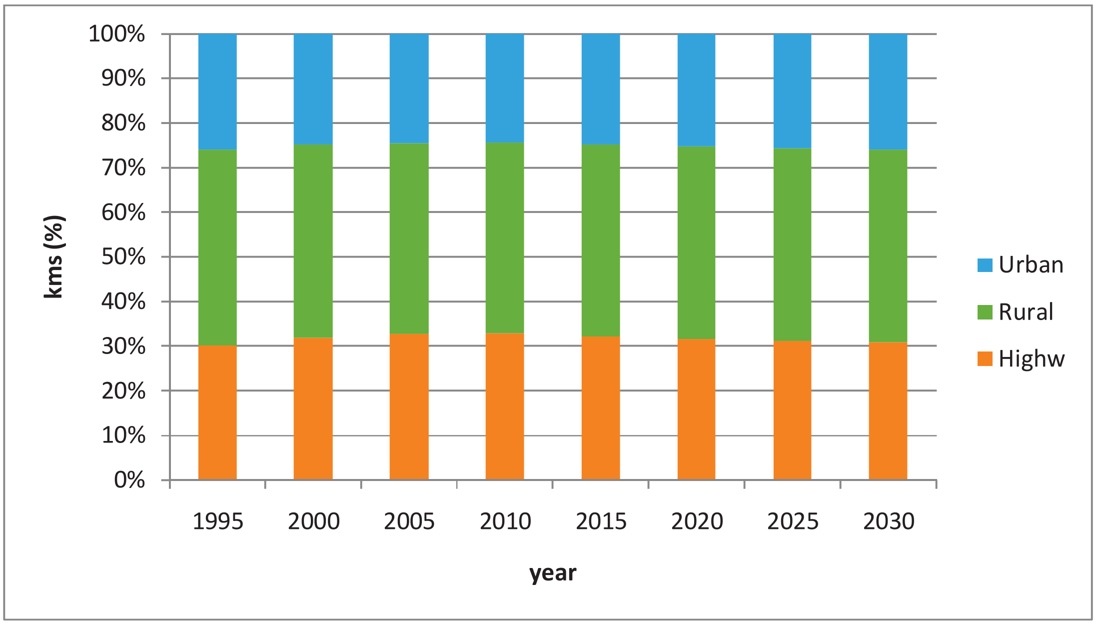

Figure 28: Relative share of kilometres driven over different road types

3.1.2.3. Kilometres per fuel technology

Just like we saw in 3.1.1.2, the technology distribution is only slightly different from the one in the baseline scenario. We clearly observe an increased distance covered by LPG (2015 and 2020) and CNG vehicles (2025 and 2030), whereas petrol and petrol hybrid CS cars are driven a smaller relative share. The relative share of diesel kilometres is again slightly smaller for the years 2015 and 2020 compared to the baseline, and somewhat higher for 2025-2030.

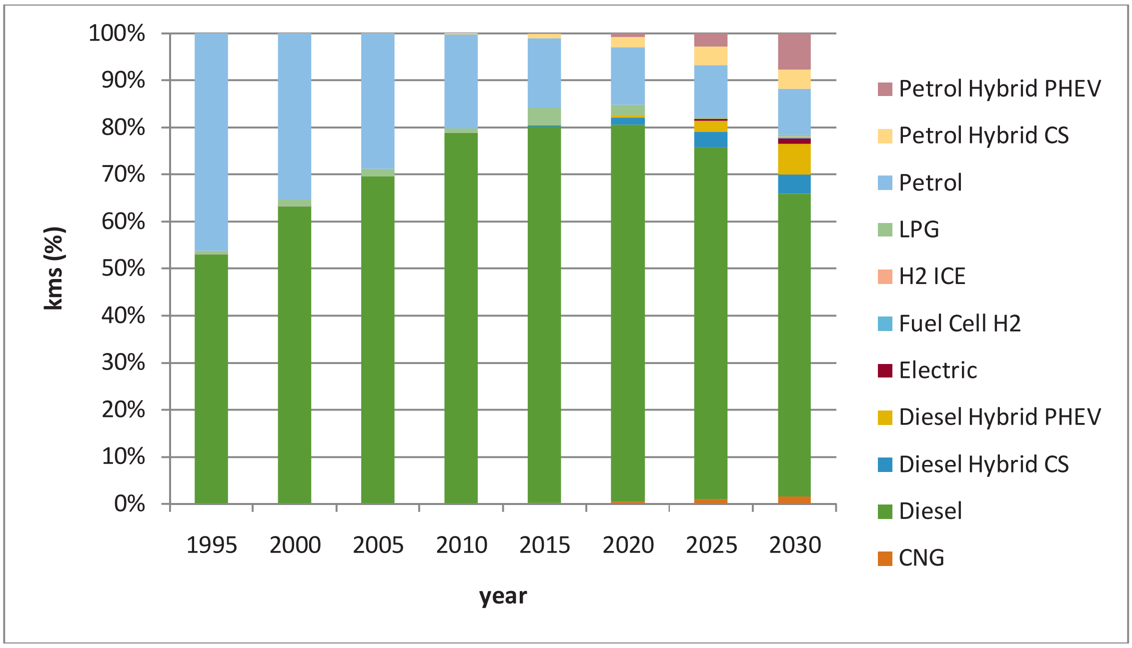

Figure 29: Relative share of kilometres driven by different technologies

3.1.2.4. Kilometres per euro standard

We observe the same trend as mentioned under 3.1.1.3 (number of vehicles). The fact is that the recent standards are picked up earlier and driven accordingly than under the baseline (46 vs 44% Euro 5 in 2015 and 52 vs 51% Euro 6 in 2020).

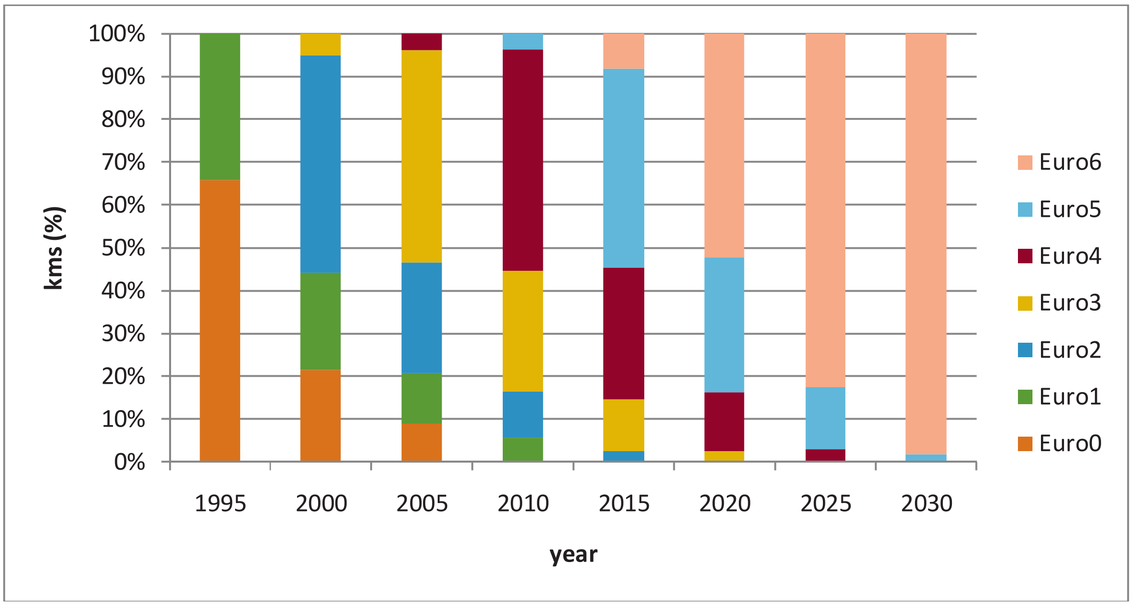

Figure 30: Relative share of kilometres driven by different euro standards

3.1.2.5. Kilometres per engine size

The effects from the realistic scenario on the distance distribution over the engine size are negligible, as all comments stated under 2.2.2.5 are valid for the current paragraph as well.

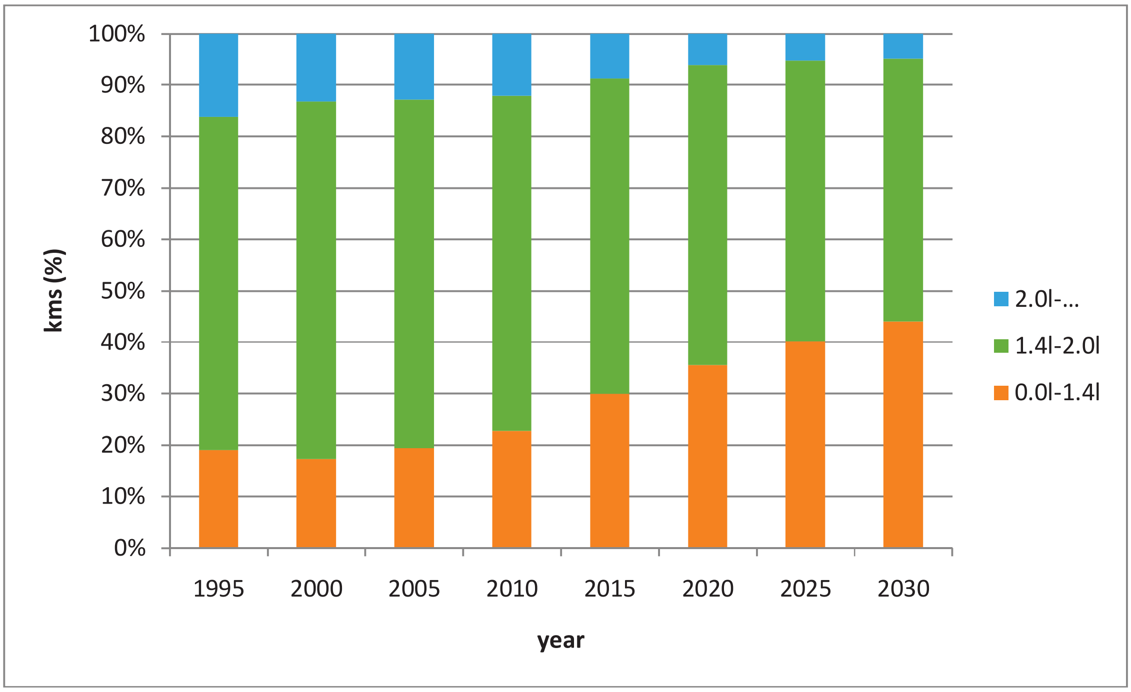

Figure 31 : Relative share of kilometres driven by different engine sizes

3.1.3. Environmental impact

3.1.3.1. Ecoscore

The expected evolution of the km-weighted ecoscore over the period 2010-2030 is very similar to the one in the baseline (from 59 to 74, or an average of 0.76 units/year). However, the realistic scenario forces the weighted ecoscore to follow a steeper path (compared to baseline) in the near future (2010-2015), and a more modest evolution in the years thereafter.

Please note that the technology split is not discussed in more detail here (nor in the progressive scenario). Nevertheless, the raw data tables can be found in the annex on detailed results.

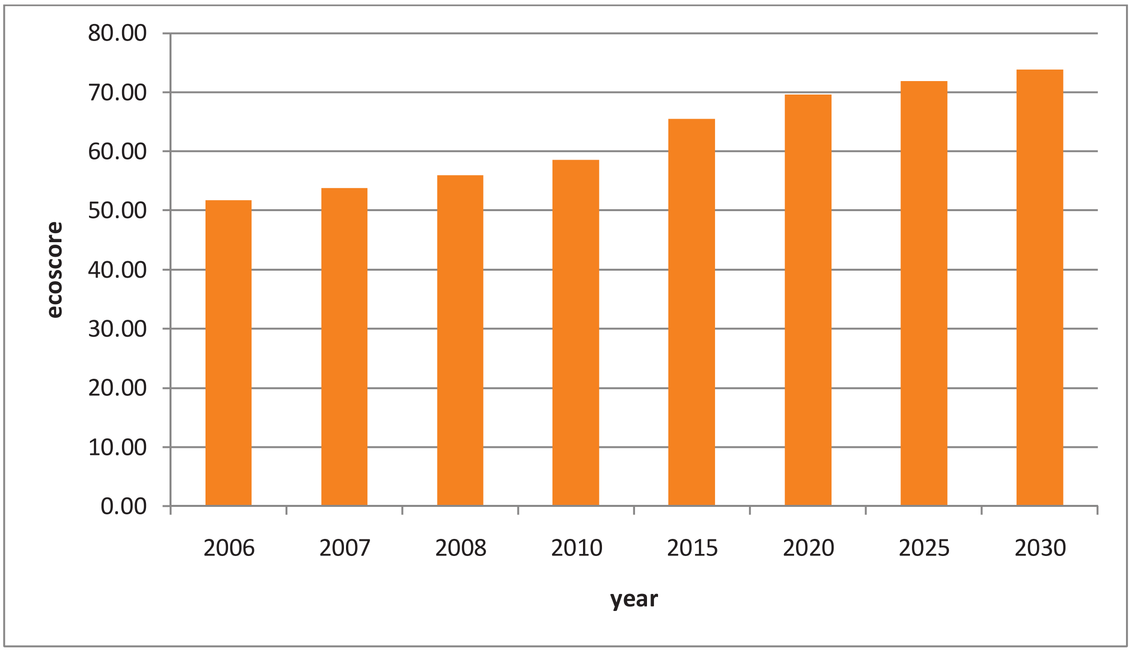

Figure 32: Average ecoscore for Belgian fleet (km weighted)

3.1.3.2. Emissions

For the realistic and the progressive scenario, we decide to restrict the discussion to emissions of CO_2e, PM2.5 and NO_x, as we believe these are the most important pollutants in the current Belgian context. As a consequence, emissions of CO, VOC, SO_2 and NH_3 are no longer dealt with. However, you can still find them under the annex on detailed results.

Emissions of CO_2e (Figure 33) are now expected to fall to 9.3 mio tonnes towards 2030, which implies a 24% decrease over the period 2010-2030 (vs 15% for the baseline scenario). For the years 2015 and 2020, the relative share of CO2e emissions from diesel, petrol and petrol hybrid CS vehicles will be slightly lower than under the baseline scenario, whereas the emissions originating from LPG will be higher. In 2025 and 2030, the share of CO2e emissions from diesel cars is significantly higher than for the baseline, while the petrol and petrol hybrid CS vehicles will continue to emit relatively less CO2e.

Speaking in relative terms, there is no significant difference in the technology distribution of PM2.5 emissions between the baseline and the realistic scenario. Also the absolute numbers differ only to a very small extent (Figure 34). The absolute amount of emission is estimated at 375 tonne in 2030 vs 380 tonne under the baseline.

From Figure 35, it is clear that regarding NO_x emissions, the differences in relative shares compared to the baseline are negligible. So, all conclusions for NO_x given in 2.2.3.3 do also apply here. Total NO_x emissions differ only slightly compared to the baseline, and are now expected to amount to 12,670 tonne in 2030 (vs 12,886 under the baseline scenario).

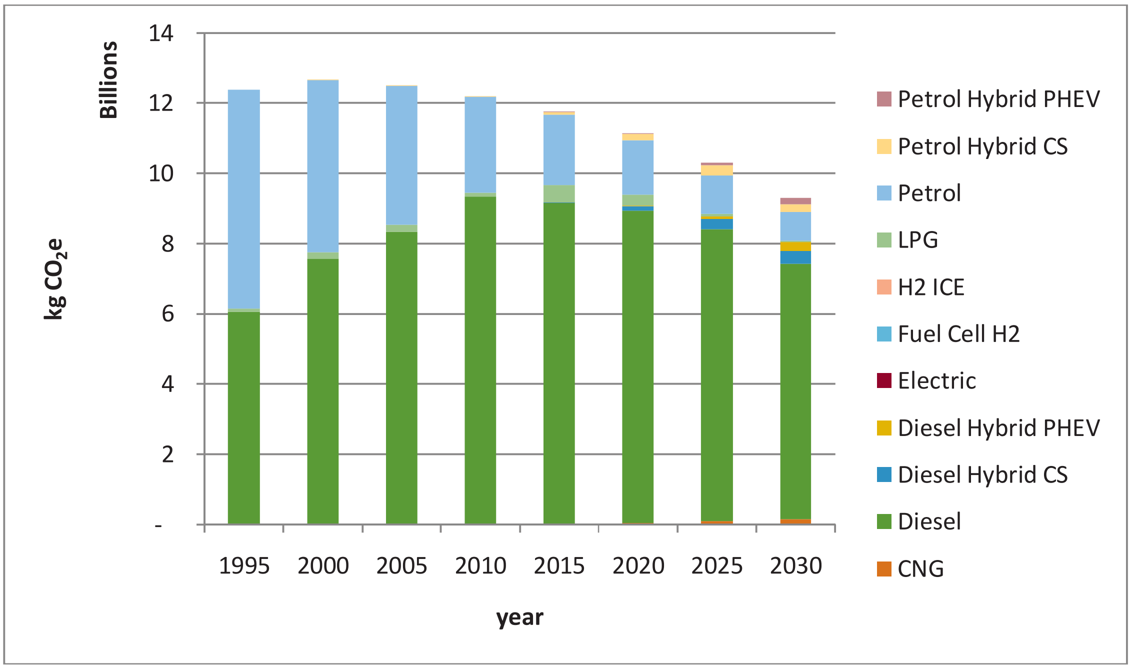

Figure 33: TTW emissions CO_2e per technology

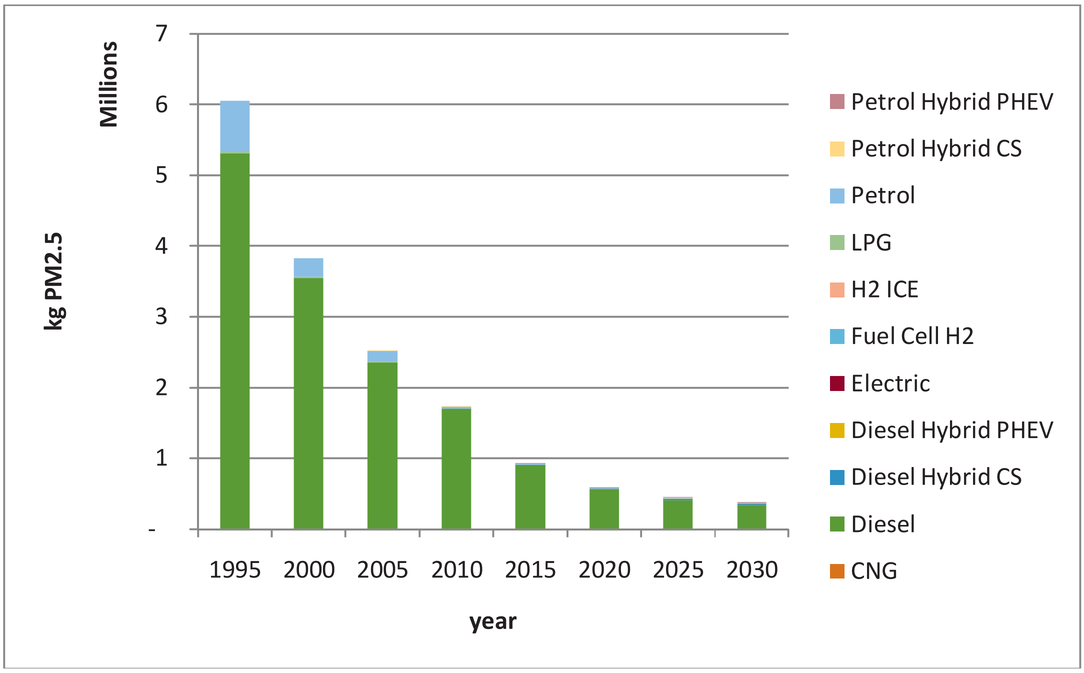

Figure 34: TTW emissions PM2.5 per technology

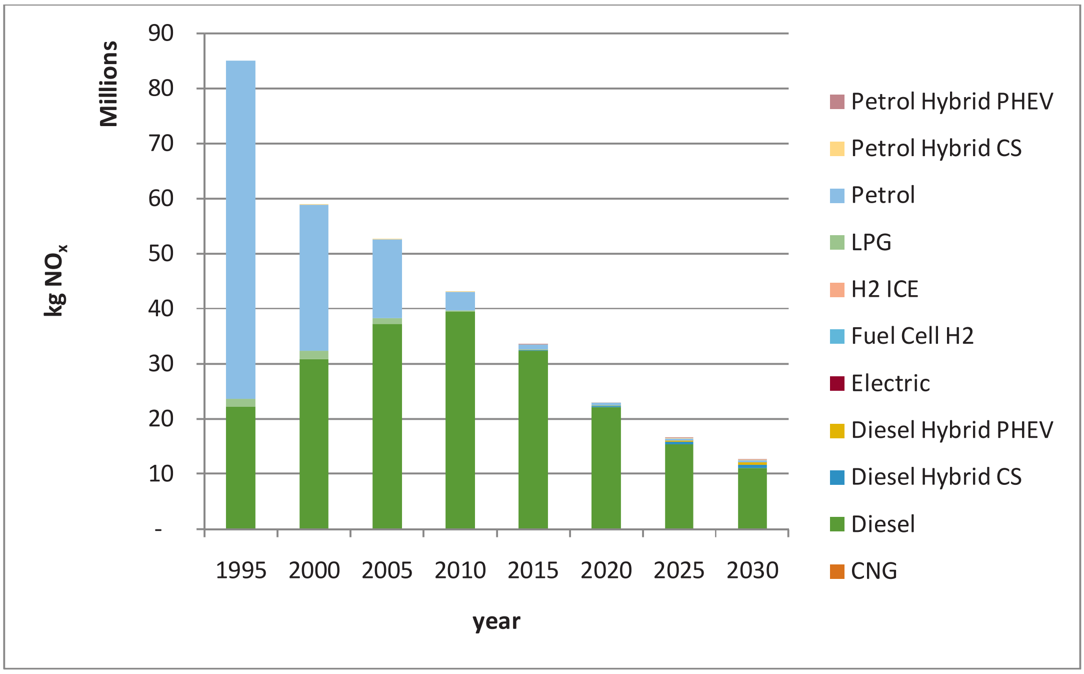

Figure 35: TTW emissions NO_x per technology

3.2. Progressive scenario

The measures introduced under the progressive scenario are very briefly repeated below. Furthermore, Table 2 provides an overview of the measure implementation period (yellow), and the period with the largest expected impact (shaded). For a detailed description of all the adopted measures, we refer to the report of task 5.3 ‘Scenario development’.

Extra measures progressive scenario (besides baseline and realistic measures):

A) Tax system based on ecoscore
B) Kilometre charge
C) Limited access environmental zones in cities based on ecoscore
D) Mandatory green private fleet quota
E) Scrappage scheme

	2000	2005	2010	2015	2020	2025
A						
B						
C						
D						
E						

Table 2: Timing of the progressive measures (yellow) and the period with their largest expected impact (shading)

3.2.1. Fleet composition

3.2.1.1. Number of cars

Under the progressive scenario, the total number of cars is expected to rise to 5.9 million in 2030, i.e. just 2% lower than under the baseline, and higher than under the realistic scenario. In what follows, we will see that this is largely due to an increase in the number of small vehicles and alternative technologies, and at the same time a decline in the number of vehicles with a conventional engine, compared to the realistic scenario. On the other hand, only looking at the years 2015 and 2020, the number of cars is expected to be lower than under the realistic scenario.

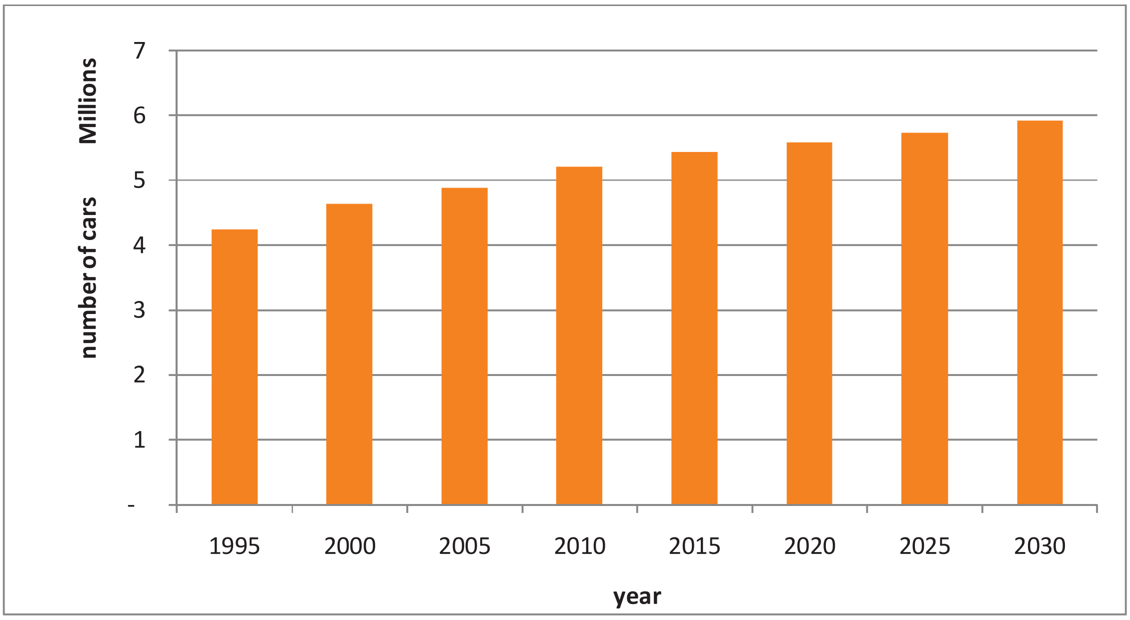

Figure 36 : Absolute amount of cars in Belgium

3.2.1.2. Technology

Figure 37 depicts the split of the fleet over the various technologies. Compared to the baseline scenario, the pace of improvement proceeds much quicker for the period 2010-2030. It is to say, petrol hybrids (+2 and +4% vs baseline, for CS and PHEV resp.), diesel hybrids (+3 and +4%, idem) and electric vehicles (+4%) are expected to fill in large parts of the share lost by conventional diesel vehicles (-17%). The additional measures in the progressive scenario seem to be effective in increasing the share of clean vehicles and removing older (and thus more polluting) vehicles.

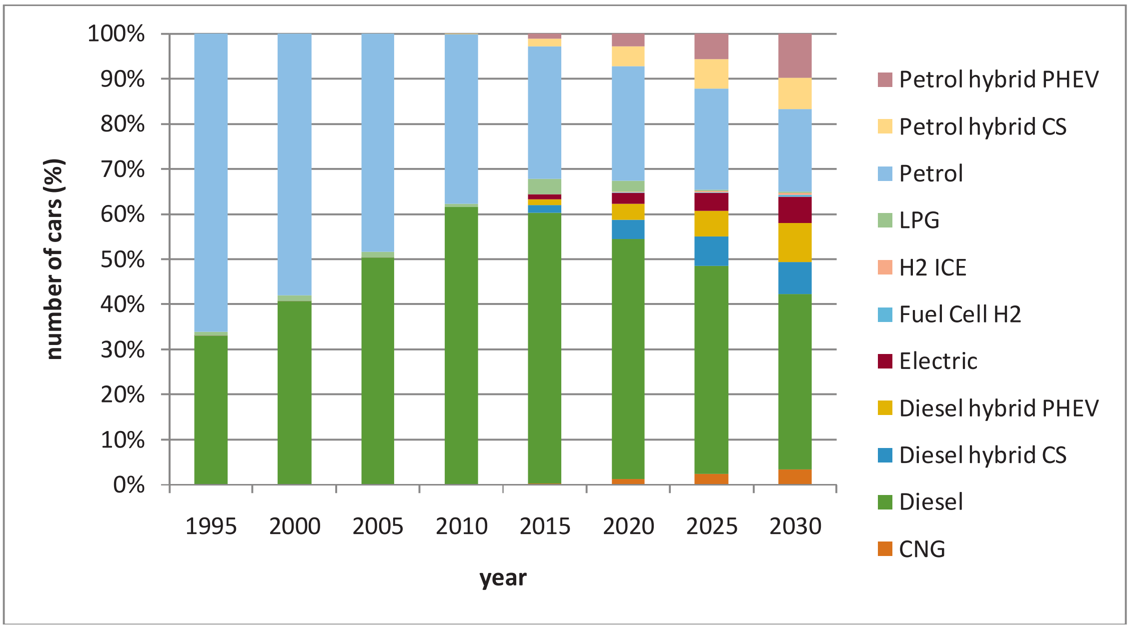

Figure 37: Relative share of cars over different technologies

3.2.1.3. Euro standard

As we could have expected, the adoption of newer euro standards is taking place much quicker than under the baseline scenario (44 vs 38% Euro 5 in 2015 and 51 vs 43% Euro 6 in 2020). See Figure 38. The difference versus the baseline survives at least until 2030 (98 vs 97% Euro 6).

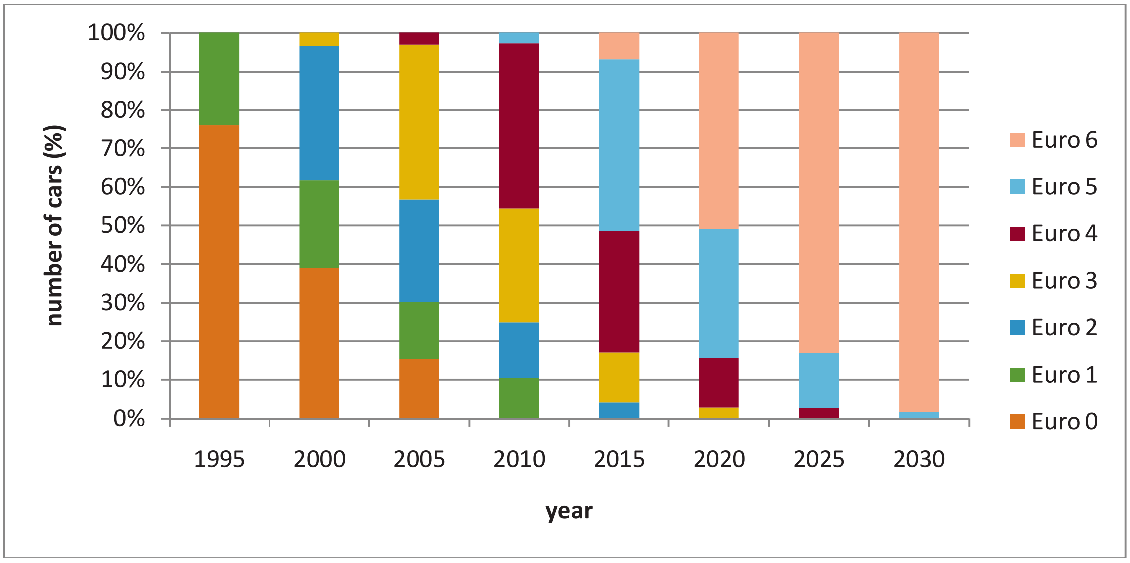

Figure 38: Relative share of cars over different euro standards

3.2.1.4. Engine size

The split over the 3 engine classes is given in Figure 39. In contract to the realistic scenario, we now observe a remarkably higher share of small engines (+5%) at the expense of the medium-sized cars (-5%), compared to the baseline in 2030. In this case, the small engine category constitutes more than half of the total fleet as from 2025 (54% in 2025), and continues to increase up to 56% in 2030.

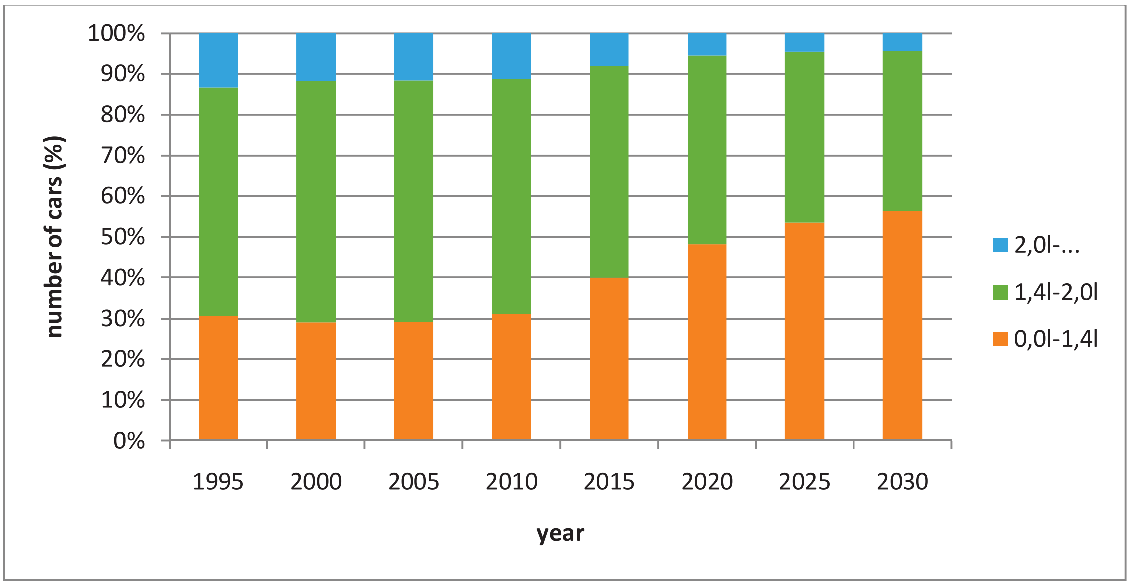

Figure 39: Relative share of cars over different engine sizes

3.2.1.5. Ecoscore

The unweighted ecoscore for the Belgian fleet is expected to rise faster than under the previous scenarios, with an average climb of 0.84 units per year. The largest jump can again be observed in the period 2010-2015 (from 58.40 to 66.01), and the average ecoscore reached in 2030 is predicted to slightly exceed 75 (75.15).

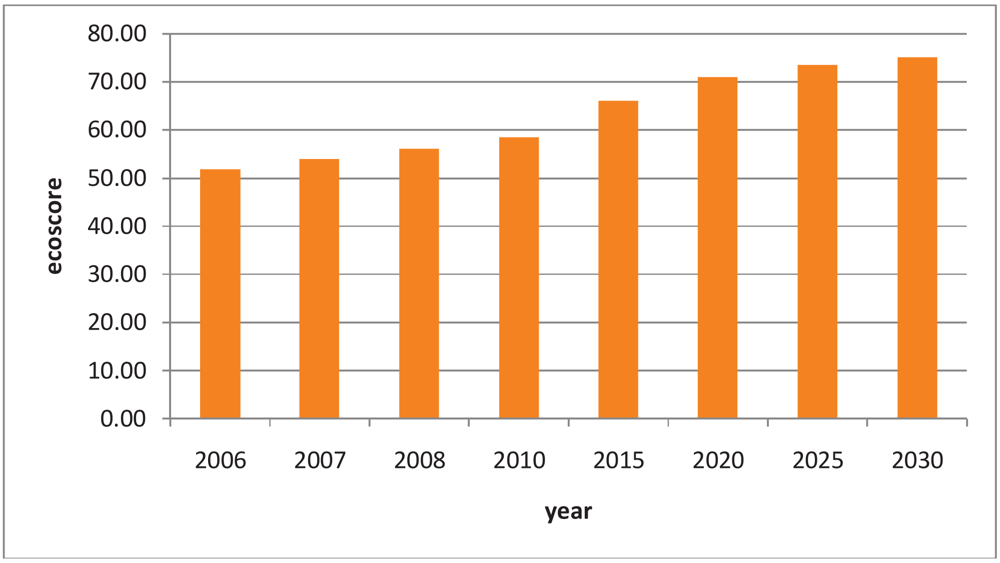

Figure 40: Average ecoscore for Belgian fleet (unweighted)

3.2.2. Vehicle use

3.2.2.1. Kilometres driven

Figure 41 displays the total amount of kilometres driven under the progressive scenario. The total distance travelled in 2030 now amounts to 85 billion kilometres. The predicted increase over the period 2010-2030 is considerably smaller than under the baseline scenario (+7 vs +18%). The substantial drop over the period 2020-2025 is almost completely compensated for by the rebound effect (Small & Van Dender, 2005) in the period 2025-2030. It is to say, the use of clean technologies (e.g., PHEV hybrids, electric, hydrogen) is increasing rapidly whereas conventional technologies (diesel, petrol) are driven less frequently. The recovery of the distance over the period 2025-2030 is thus completely attributable to a climb in clean technology utilization, as a result of the tighter policy measures. We suspect that the rising km charges (for polluting vehicles) and the limited access policy to environmental city zones have had a significant impact on the number of kilometres driven, as both measures were assumed to evolve over time.

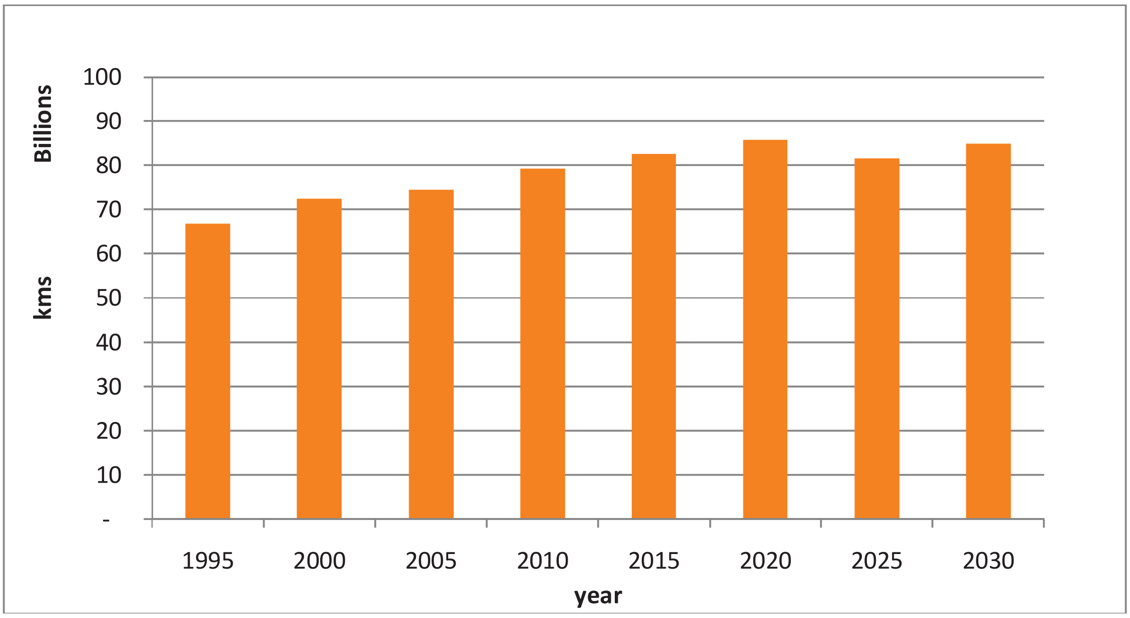

Figure 41: Kilometres driven in Belgium

3.2.2.2. Kilometres per road type

Compared to the baseline scenario, the share of kilometres travelled on rural roads and highways will be somewhat higher (+1 and +2%, respectively, in 2030) for the period 2010-2030, at the expense of the urban kilometres (-3%). This shift away from city centres is observed thanks to the limited access measure. See Figure 42.

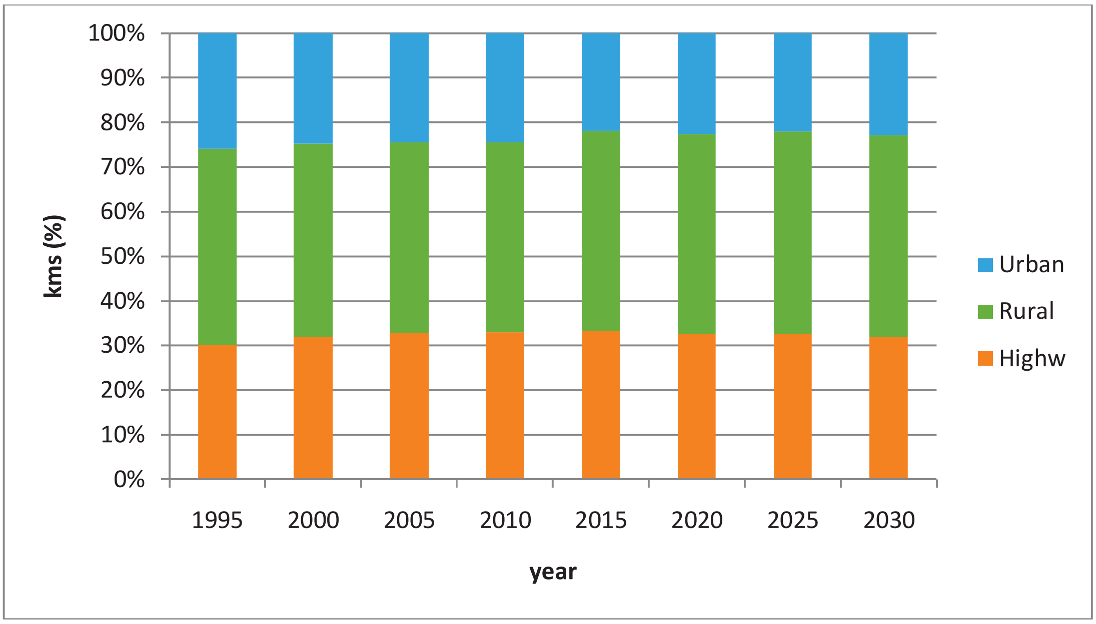

Figure 42: Relative share of kilometres driven over different road types

3.2.2.3. Kilometres per fuel technology

Focussing on the technology split of kilometres, we refer to Figure 43. In comparison with the baseline results, electric, diesel hybrid CS and PHEV, petrol hybrid CS and PHEV and LPG (2015 and 2020) and CNG (2025 and 2030) vehicles are expected to be driven (relatively) more frequently. On the other side, especially conventional diesel vehicles are losing ground (-21% in 2030 compared to baseline). This implies that the share of conventional diesel-fueled kilometres will decrease to 42% in 2030.

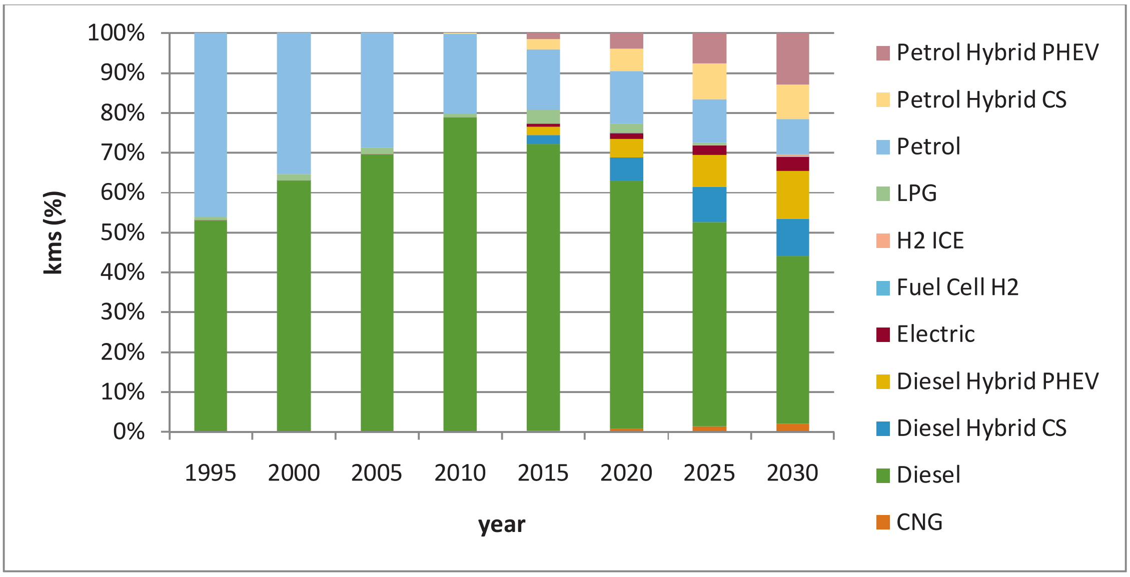

Figure 43: Relative share of kilometres driven by different technologies

3.2.2.4. Kilometres per euro standard

Concerning the split over the euro standards, we observe that the introduction of euro standards in the fleet takes place even quicker when the distance travelled is taken into account (Figure 44). Under this progressive scenario, the share of euro 5 vehicles in total distance amounts to 51% (vs 44% in baseline) in 2015, whereas the share of euro 6 cars is estimated to reach 58% (vs 51%) in 2030.

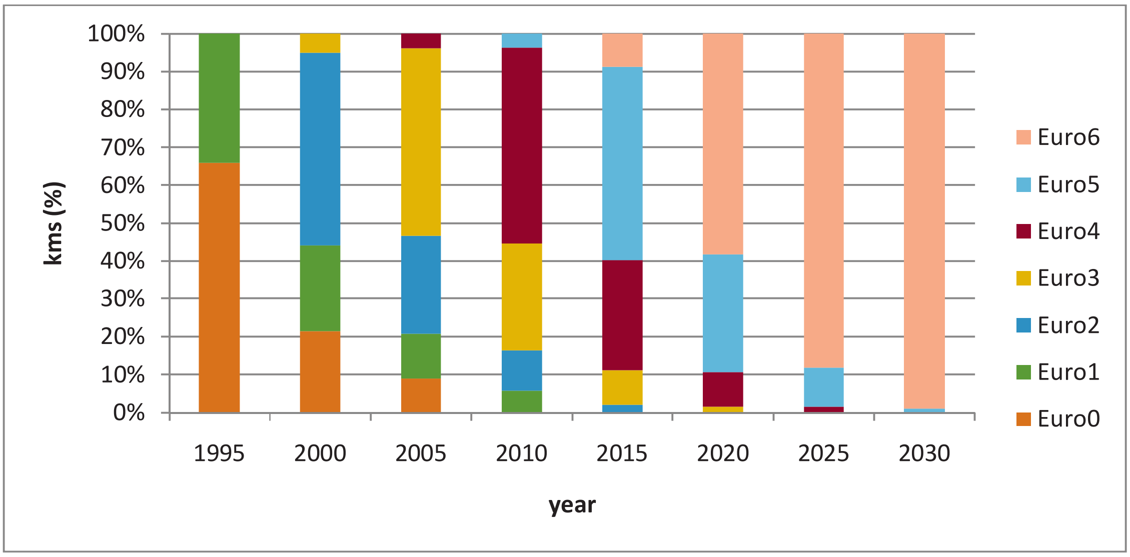

Figure 44: Relative share of kilometres driven by different euro standards

3.2.2.5. Kilometres per engine size

Based on Figure 45, we conclude that the share of small engines in total fleet kilometres is almost hitting the 50% level in 2030. Compared to the baseline shares, an increase is observed again in the share of small engine kilometres (+5% in 2030), at the expense of the medium-sized engine distance (-5% in 2030).

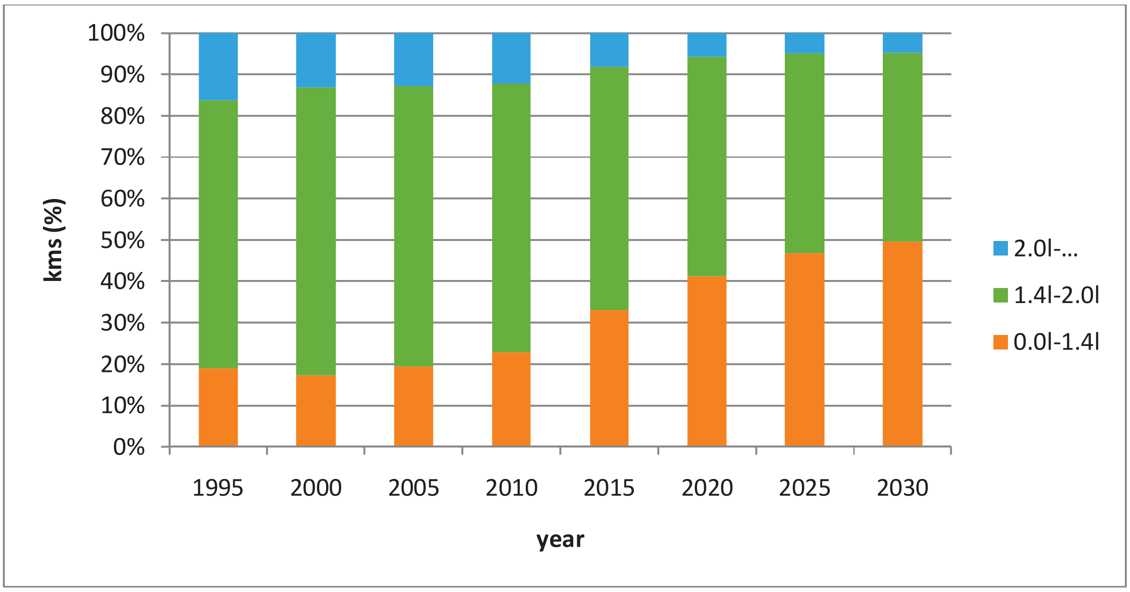

Figure 45: Relative share of kilometres driven by different engine sizes

3.2.3. Environmental impact

3.2.3.1. Ecoscore

Following the fact that the cleaner vehicles are on average driven more frequently than the older (and more polluting) ones, the average weighted ecoscore is somewhat higher than its unweighted counterpart over the period 2010-2030. However, the average annual increase remains unchanged at 0.84 units/year, as both the beginning and end position are higher than for the unweighted ecoscore (58.61 in 2010 and 75.43 in 2030 under progressive scenario). This rate of increase can be compared to the 0.76 units/year for the baseline scenario.

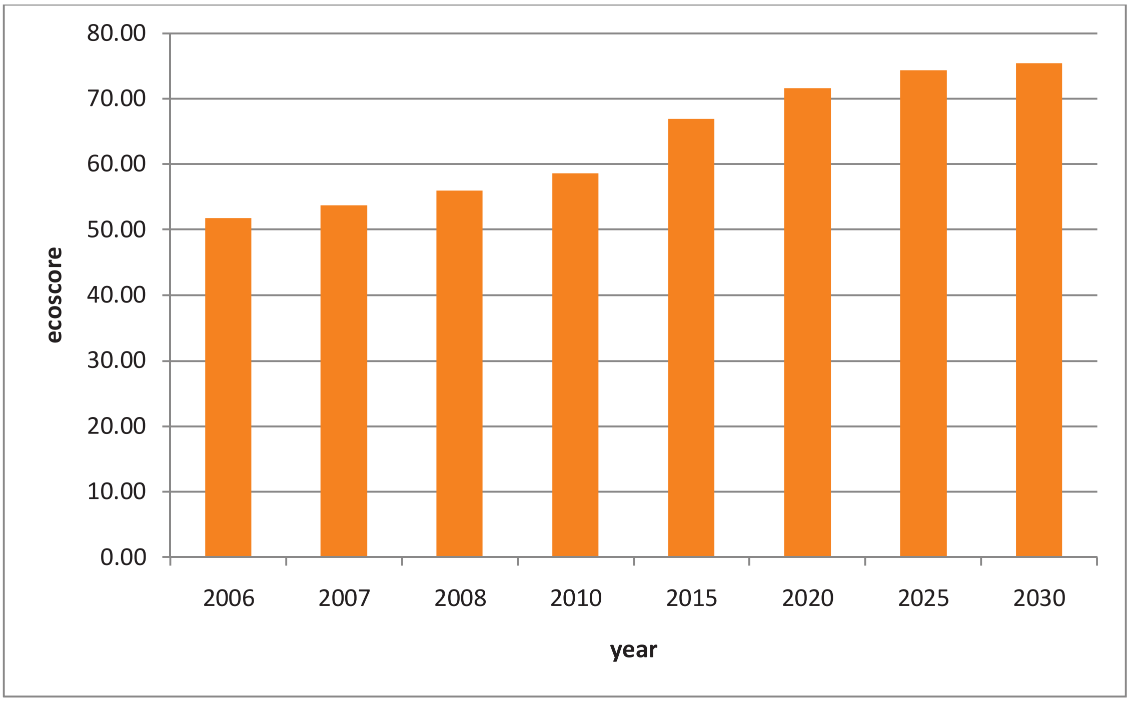

Figure 46: Average ecoscore for Belgian fleet (km weighted)

3.2.3.2. Emissions

Given the measures adopted in the progressive scenario, we see the emissions of CO_2e (Figure 47) drop to 7.2 mio tonnes in 2030 (Figure 47). This implies a 41% decrease since 2010 (vs 15% in baseline). More or less in line with the number of kilometres driven, the relative share of emissions by conventional diesel and petrol vehicles in the years after 2010 will be lower than those for the baseline. On the other hand, the share of emissions by diesel and petrol hybrids, LPG (2015 and 2020) and CNG (2025 and 2030) vehicles has increased compared to the baseline and realistic scenario.

Concerning emissions of PM2.5 and NO_x (Figure 48), the drop of the emission share for conventional diesel vehicles is especially compensated for by increased emission shares from diesel hybrids (both CS and PHEV) over the period 2010-2030. The absolute amount of PM2.5 emission is estimated at 271 tonne in 2030 (vs 380 tonne under baseline); whereas for NO_x we expect 9,127 tonne emissions (vs 12,886 tonne for baseline).

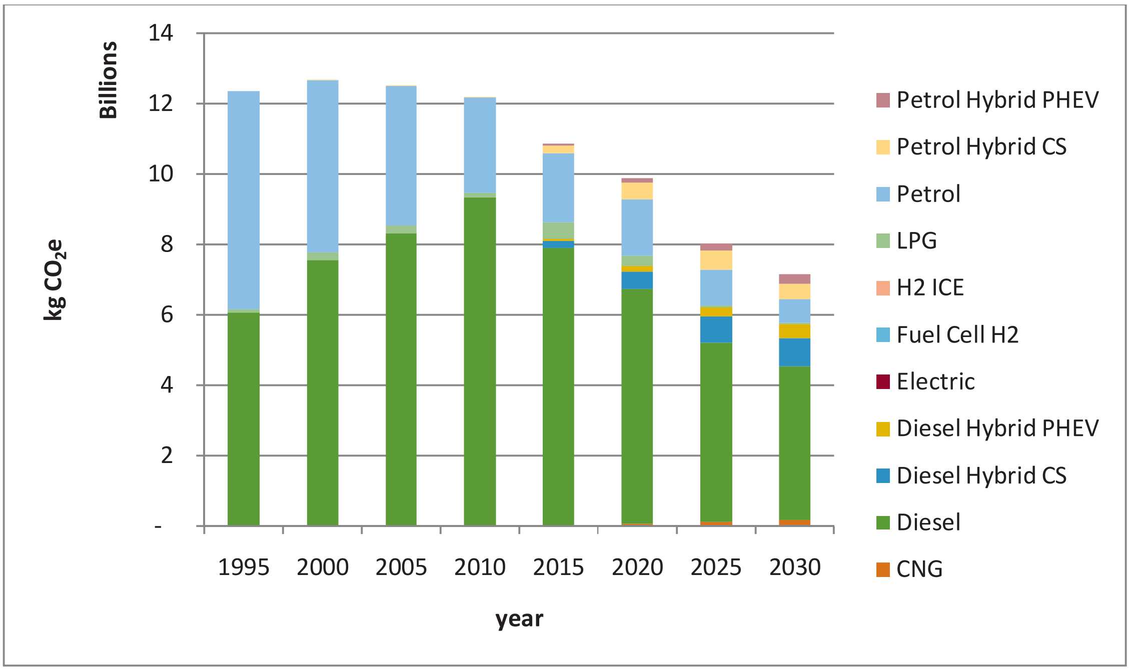

Figure 47: TTW emissions CO_2e per technology

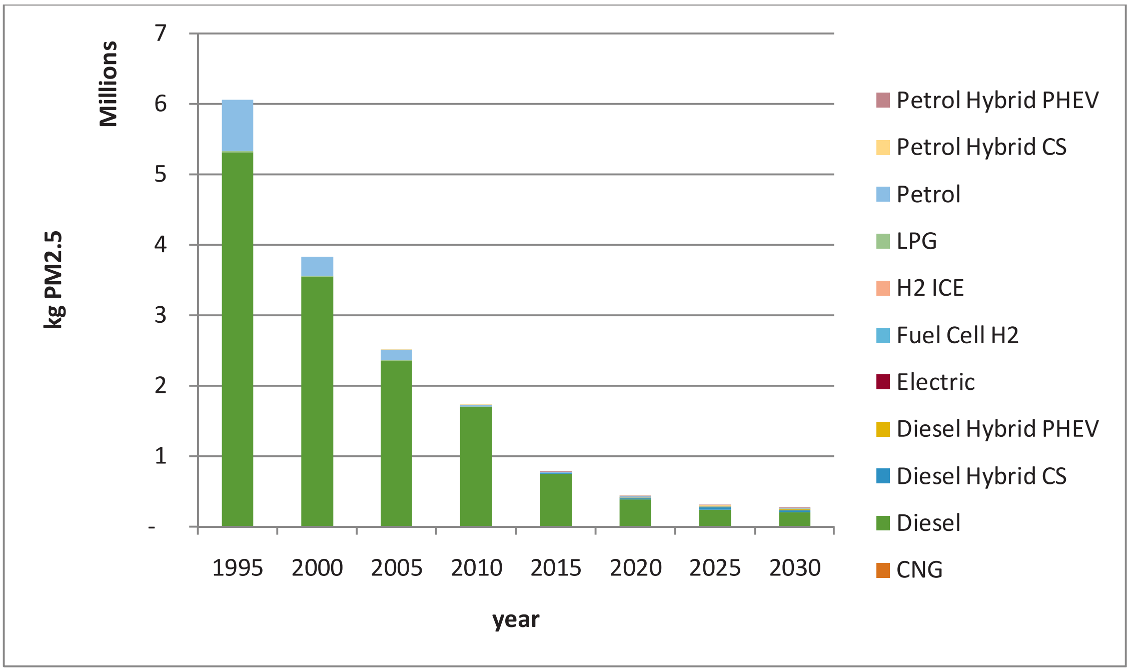

Figure 48: TTW emissions PM2.5 per technology

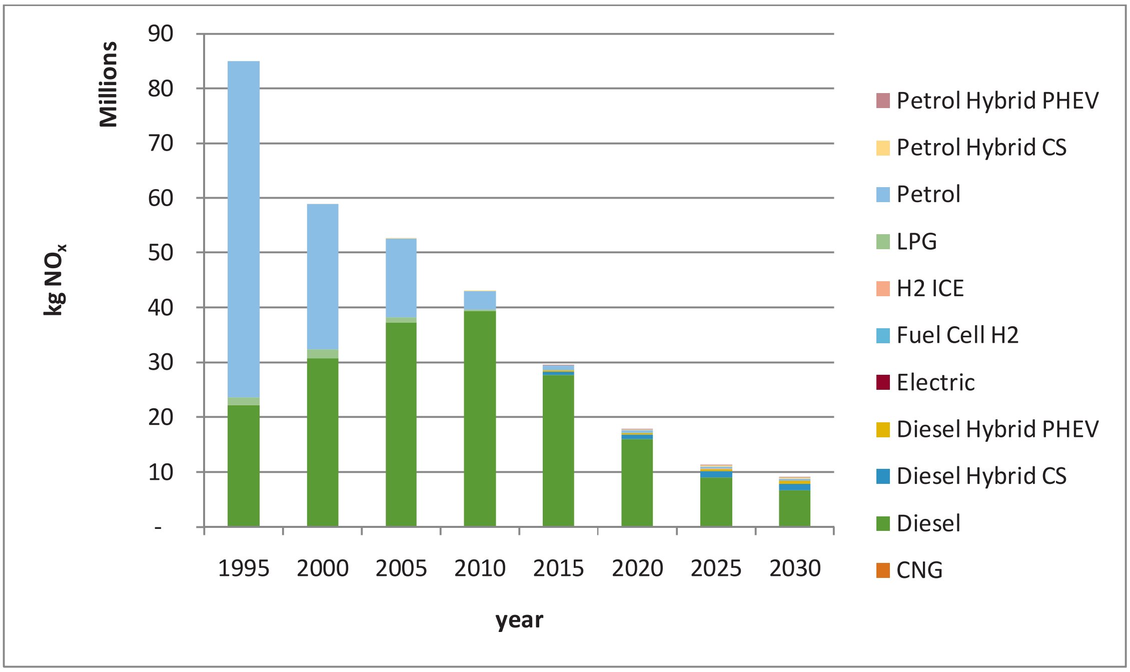

Figure 49: TTW emissions NO_x per technology

3.3. Visionary scenario

In this section, we will focus on the vehicle use and environmental impact indicators from the visionary scenario.

The most important assumptions made under this scenario were:

A) Mobility as a service instead of vehicle ownership
B) Cleanest available technology used for each trip, i.e.
    All urban trips by EVs
    All trips on rural roads by petrol hybrids (60% of kms by PHEV, 40% by CS)
    All trips on highways by diesel hybrids (40% of kms by PHEV, 60% by CS)
C) Total amount of kilometres driven assumed to decrease in line with progressive scenario

Fleet composition data (number of vehicles, unweighted ecoscore) are not discussed for this scenario, as no meaningful assumptions are made as to that.

3.3.1. Vehicle use

3.3.1.1. Kilometres driven

The number of kilometres driven in the 2060 visionary scenario is extrapolated from the progressive scenario. It is to say, we expect the distances travelled to decrease, in line with the drop in kilometres in the progressive scenario.

Unfortunately, we see that the number of kilometres driven under the progressive scenario drops for the period 2020-2025, but resumes in the years thereafter (2025-2030). As already mentioned in section 3.2, this is due to the fact that the end consumer has found its way to alternative vehicle technologies, and is using those vehicles more extensively than before, because the traditional fuel technologies are punished through all channels. In economics, the ratio of the lost benefit over the total expected benefit (decrease in kms) is called the rebound effect (Small & Van Dender, 2005).

However, we assume that the relative drop in kilometres in the progressive scenario between 2020 and 2025 could be representative for simulating a simple long-term linear decrease towards 2060 (visionary). This is depicted in Figure 50. Consequently, 52.2 billion kilometres are expected to be driven in 2060, more than 50% of which is driven on rural roads.

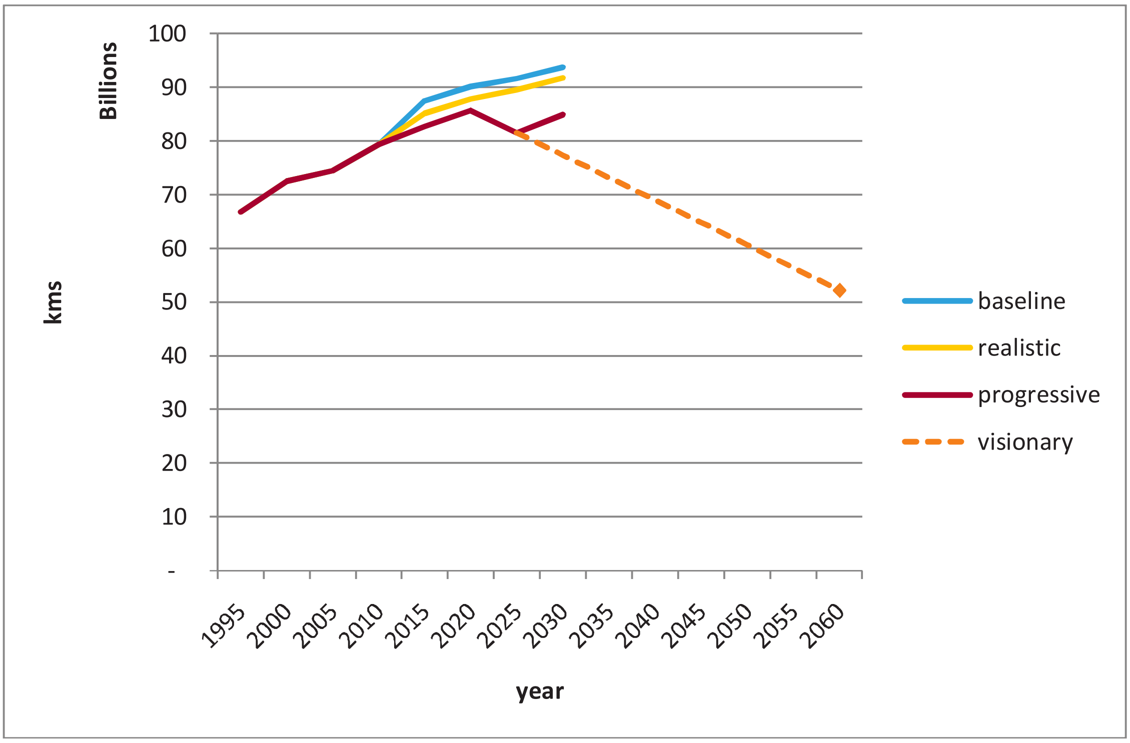

Figure 50: Total number of kilometres in the scenarios

3.3.1.2. Kilometres per road type

As already mentioned in the previous section, more than half of all distances is travelled on rural roads. Highway trips count for approximately one third of all kilometres, while urban trips constitute the remaining 15%. This is displayed in Figure 51.

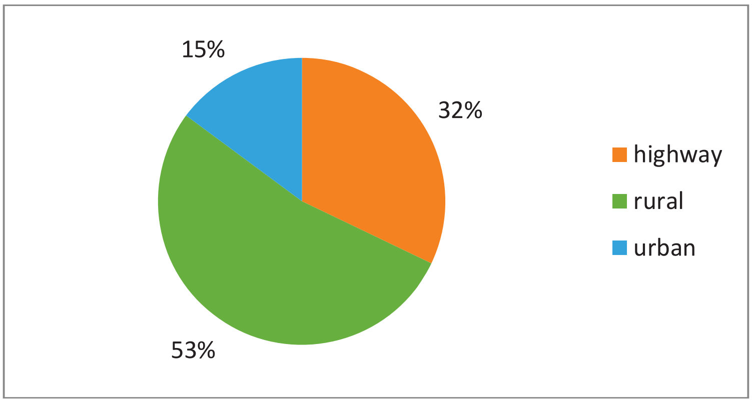

Figure 51: Distribution of kilometres over different road types

3.3.1.3. Kilometres per fuel technology

Assuming that there is no difference, on average, in the number of kilometres travelled between a CS and a PHEV vehicle, the relative share of the kilometres travelled by the various technologies is given in Figure 52. Under this scenario, approximately 15% of all kilometres is driven by full-electric vehicles in 2060. Petrol hybrids constitute another 53% of all distances travelled.

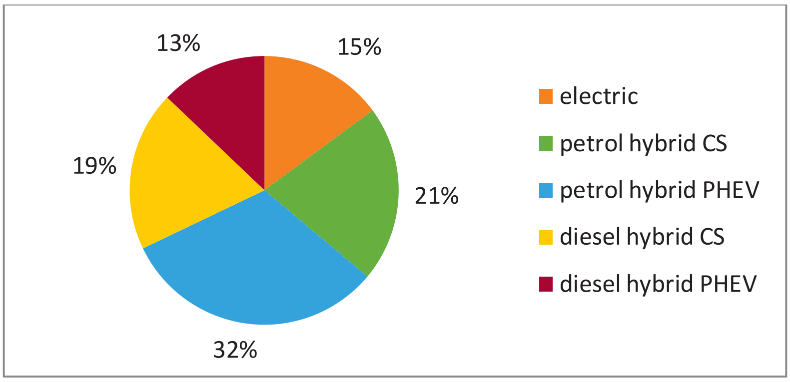

Figure 52: Distribution of kilometres over different technologies

3.3.1.4. Kilometres per euro standard

As assumed in the scenario setup, all the cars considered here comply with the euro 6 emission standard.

3.3.1.5. Kilometres per engine size

We do not provide a split of the distances over engine sizes as no scenario assumptions are made with respect to that.

3.3.2. Environmental impact

3.3.2.1. Ecoscore – km weighted

For the new vehicle fleet in 2060, we can now also calculate an average ecoscore. As we assume that, on average, there is no difference between the number of kilometres travelled by a PHEV and a CS vehicle (as mentioned in 3.3.1.3), it immediately follows that the number of cars is directly related to the number of kilometres. This implies that the weighted ecoscore exactly matches the unweighted indicator. Therefore, there is no need to distinguish between both indicators.

The resulting average ecoscore then amounts to 82.49. We found this number by searching the ecoscores for small vehicles per region in the progressive 2030 scenario, for the 5 considered car technologies in 2060. For reasons of simplification, we only focused on small vehicles, because the car was no longer considered as an individual property under this scenario, and the market is expected to tend towards using the most sustainable transport mode in each situation. As we exactly knew on which road types the different technologies are driven (according to the scenario setup), it was straightforward to find the average ecoscore by multiplying the road type ecoscores by their respective distance weights.

3.3.2.2. Emissions per fuel technology

We need to find emission factors (e.g. kg/km) and kilometres driven in order to compute the total emissions for this scenario.

We decide to perform the calculations for a small euro 6 car in the progressive 2030 scenario, for reasons mentioned under section 3.3.2.1. Of course, we take into account that emission factors (EFs) will depend on the different fuel technologies observed in the visionary scenario (electric, petrol hybrid CS and PHEV, diesel hybrid CS and PHEV), and the 3 different road types. These data are extracted from the E-motion database. Please note that the resulting EFs can be considered as an upper limit, as no additional decrease of EFs for the 5 technologies is taken into account for the period 2030-2060. We expect that EFs in 2060 will be lower than the ones applied here. However, it is impossible to make decent predictions on that. Therefore, this upper limit is our best guess.

Subsequently, the distance travelled on each of the 3 road types is taken from section 3.3.1.2.

The EFs can then be multiplied by the distances travelled on each road type, in order to retrieve the total emissions for all Belgian car transport. In Figure 53 till Figure 54 below, we present the emission totals for CO_2e, $PM_{2.5}$ and NO_x, and the contribution per fuel technology. The emission levels for the other pollutants are not depicted here. However, you can find their corresponding numbers in the annex at the end of the report.

Emissions of CO_2e are predicted to amount to 2.2 million tonnes per year in 2060. A large part (45%) of the emissions can be attributed to diesel hybrid CS vehicles. In spite of their significant share in total kilometres (Figure 52), diesel and petrol hybrid PHEV vehicles only constitute a modest share of total CO_2e emissions. This can be attributed to a pretty large share of kilometres driven by these vehicles in the electric mode, with no resulting TTW emissions at all (see Figure 53).

Regarding emissions of PM2.5 (Figure 54), the share of diesel hybrid CS cars is even higher (66%). Total emissions are only 73 tonnes/year.

We do a similar observation for emissions of NO_x (Figure 55). Diesel hybrid CS cars are expected to emit 65% of the total of 3,127 tonnes in 2060.

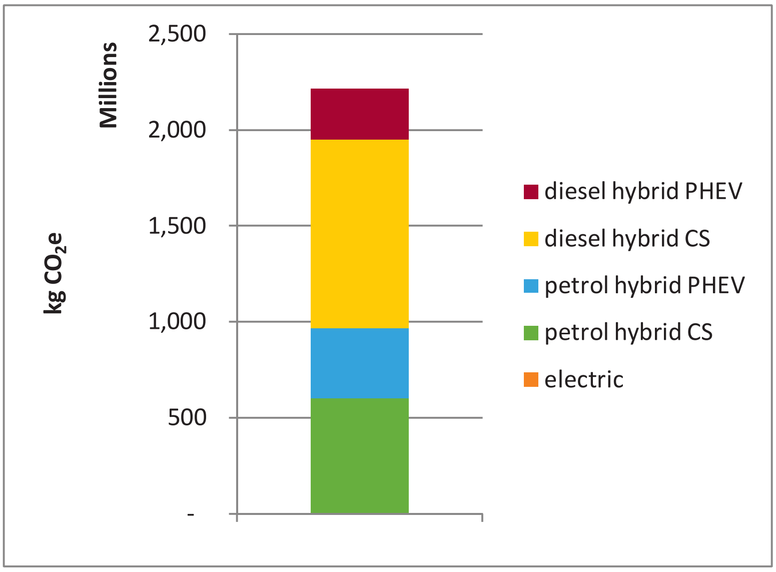

Figure 53: TTW emissions of CO_2e over the different technologies

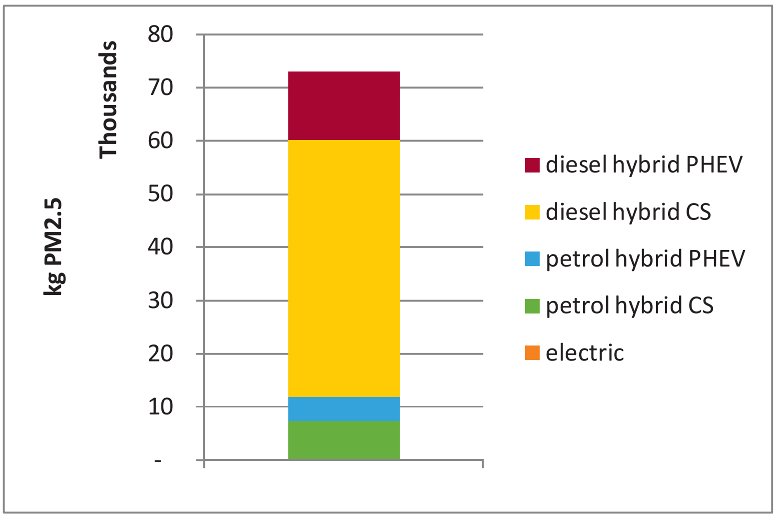

Figure 54: TTW emissions of PM2.5 over the different technologies

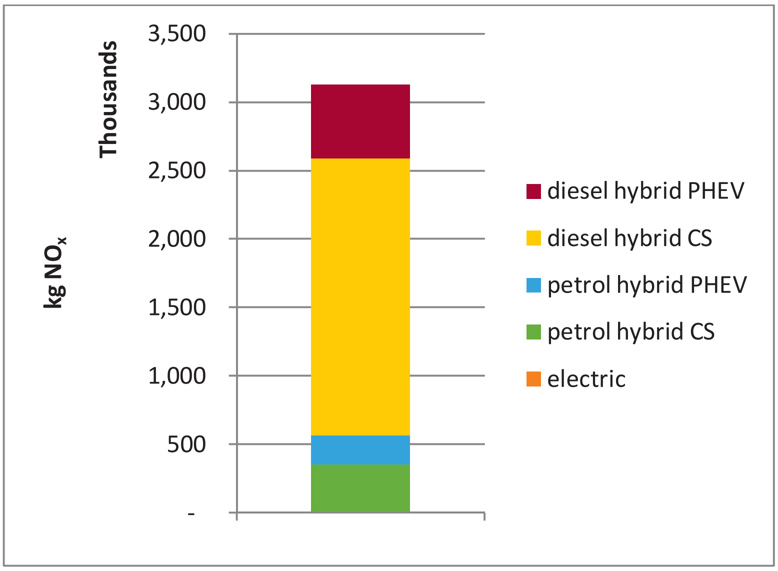

Figure 55: TTW emissions of NO_x over the different technologies

Although the assumptions made under this scenario concerning the number of kilometres driven and the fleet composition (optimal use of technologies: only electric, diesel hybrid, petrol hybrid) are quite stringent, we still observe a significant amount of direct carbon emissions. The ideal conditions would bring us to a complete decarbonisation of the fuels used. However, today this still seems to be a distant future.

4. Scenario comparison

The final chapter of this report deals with the comparison of the baseline, realistic and progressive scenario for the years 2020 and 2030. This leads to six combinations: baseline_2020, baseline_2030, realistic_2020, realistic_2030, progressive_2020 and progressive_2030. As the timeframe is different for the visionary scenario (2060), we decided not to give a broad discussion on these results in the comparison below. However, we thought it was useful to display the visionary scenario results (visionary_2060) as a seventh case in the graphs, wherever applicable (mainly vehicle use and environmental impact). This gives the opportunity to the reader to clearly see the possible improvements compared to the progressive 2030 scenario.

This chapter is subdivided into the three sections used before: fleet composition, vehicle use and environmental impact. For each of the indicators discussed in chapter 1 till 3, we provide a summarizing figure for the years 2020 and 2030, and briefly recapitulate the most interesting evolutions. For your information, the summarizing numbers are again provided in a separate section on detailed results.

This chapter can be considered as a conclusion to chapter 1 till 3.

4.1. Fleet composition

4.1.1. Number of cars

Figure 56 depicts the total Belgian fleet size for the three scenarios. For 2020, it is clear that the most sophisticated scenario (i.e. progressive) results in the smallest amount of cars (5.58 mio). This proposition is no longer valid for the year 2030, where the smallest fleet size (5.82 mio) is attained by the policy measures in the realistic scenario. The higher figure for the progressive scenario in 2030 is due to an increased purchase of small and clean (hybrid and electric) vehicles (see section 4.1.4 and 4.1.2), which are on average driven less frequently (see section 4.2.5 and to a lesser extent also section 4.2.3). Generally speaking, the fleet size is expected to follow an increasing trend when comparing 2030 to 2020, in spite of all the measures introduced.

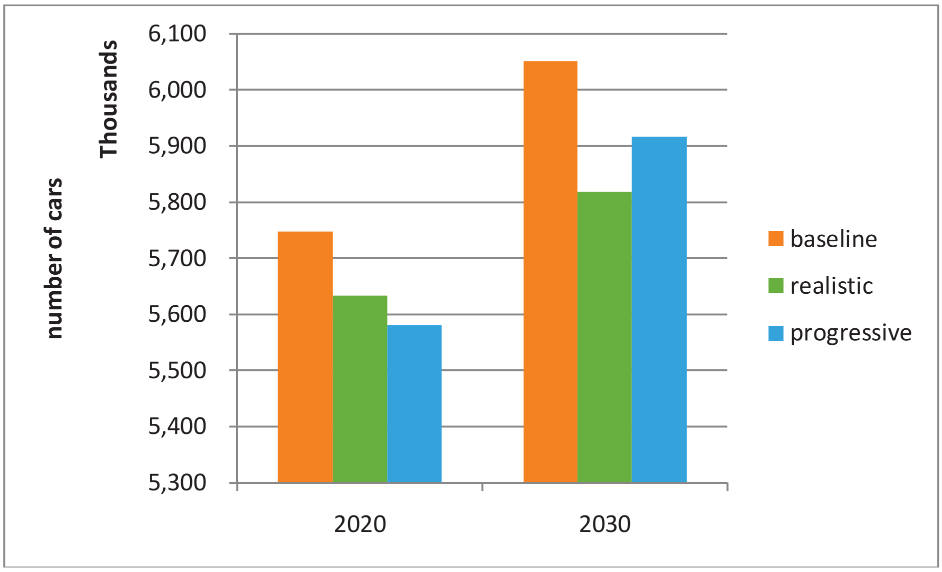

Figure 56: Absolute amount of cars in Belgium

4.1.2. Technology

We decided again to focus on the relative numbers from now on. The result for the technology split can be found in Figure 57. Some interesting trends can be derived. It seems that the more sophisticated the scenario is and the further we look into the future, the smaller the share of conventional diesel engines will be. The realistic scenario has a much smaller impact on the introduction of the cleaner technologies than the progressive scenario. If we want to facilitate the market introduction of especially hybrids and electric vehicles, it seems we will have to resort to the measures from the progressive scenario. This presumption is valid in both 2020 and 2030.

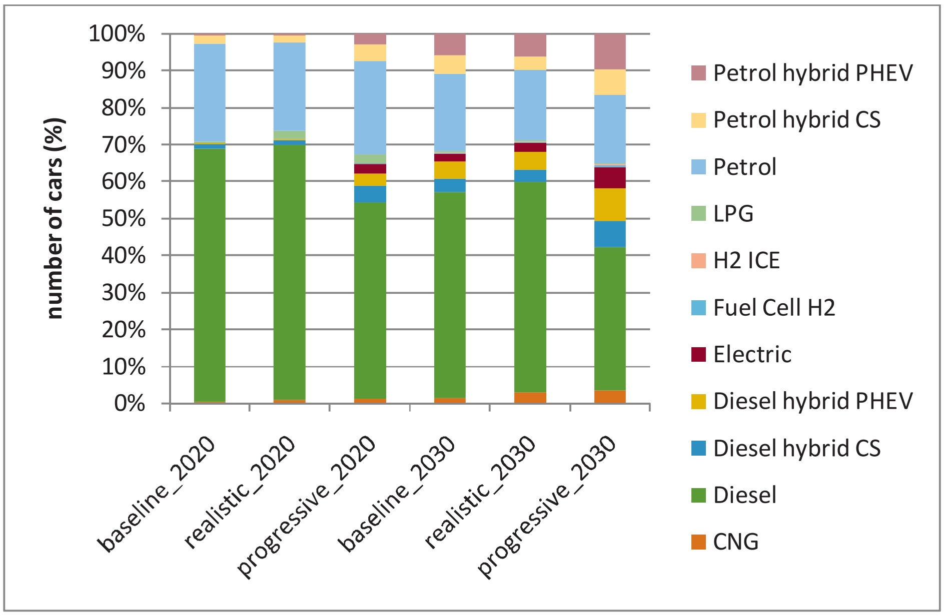

Figure 57: Relative share of cars over different technologies

4.1.3. Euro standard

Figure 58 clearly indicates that a tighter transport policy results in an accelerated adoption of the newer euro standards. For example in 2020, 51% of the whole fleet already complies with euro 6 under the progressive scenario, versus 43 and 46% under the baseline and the realistic scenario, respectively. The differences are less pronounced in 2030, as no successor for euro 6 is defined yet.

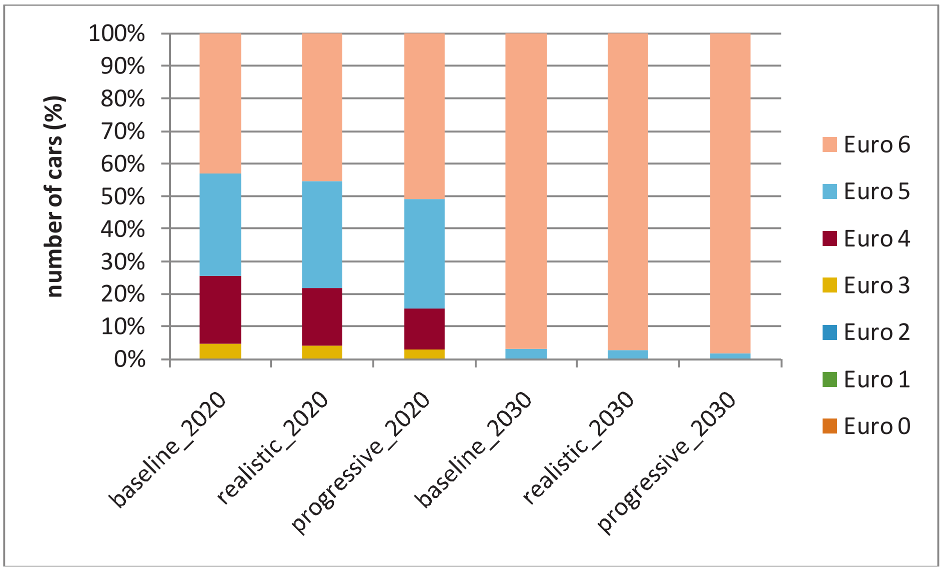

Figure 58: Relative share of cars over different euro standards

4.1.4. Engine size

Concerning the split over the engine size (Figure 59), we clearly observe a downsizing trend (i.e. the increasing popularity of smaller engines with a comparable performance as their larger predecessors) for the three scenarios. However, this trend takes place at a larger pace in the progressive scenario compared to the other two scenarios. The share of large engines (>2.0l) remains fairly constant over the scenarios within the same timeframe. Nevertheless, large engines are losing ground the further we look into the future.

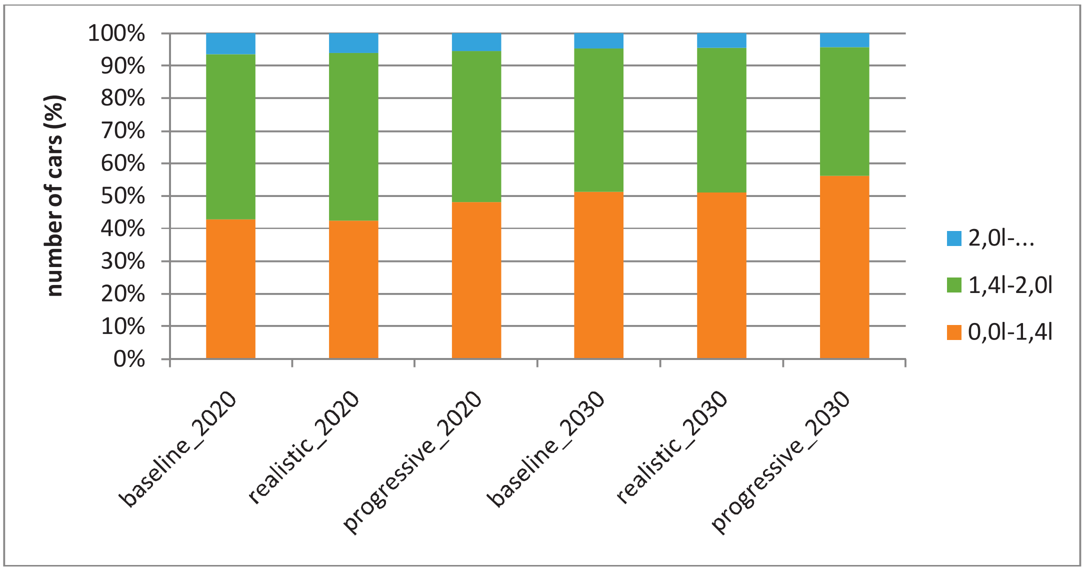

Figure 59: Relative share of cars over different engine sizes

4.1.5. Ecoscore

Figure 60 displays the unweighted ecoscore for the three scenarios. The surplus of the progressive scenario vis-à-vis the baseline and realistic scenario is remarkable (respectively 70.95 vs 68.50 and 69.08 in 2020 and 75.15 vs 73.22 and 73.37 in 2030). This also indicates that the benefit of the realistic versus the baseline scenario is rather limited.

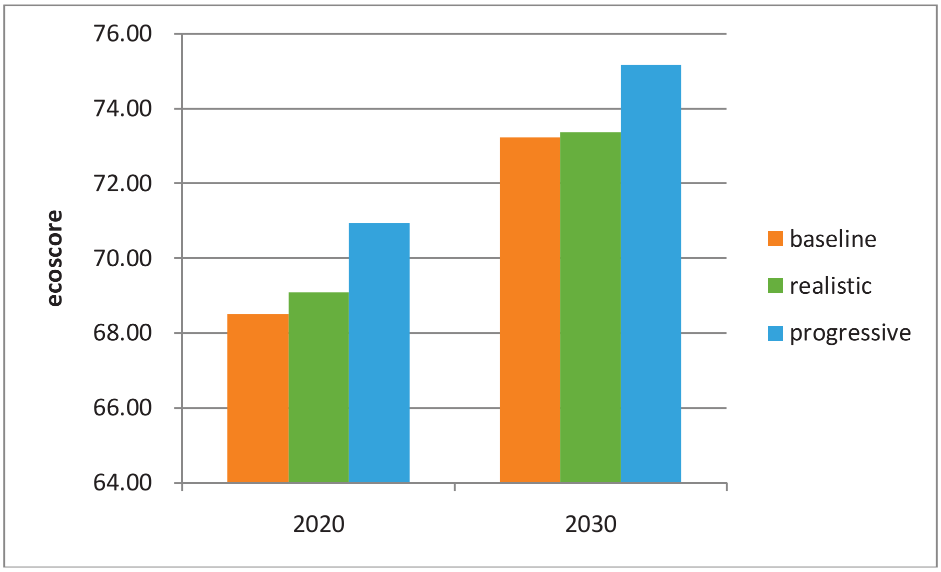

Figure 60: Average ecoscore for Belgian fleet (unweighted)

4.2. Vehicle use

4.2.1. Kilometres driven

As we can see in Figure 61, the total number of kilometres is expected to rise under the baseline and the realistic scenario over the period 2020-2030. On the other hand, the total number of kilometres under the progressive scenario is declining over this period. In 2030, the benefit from the progressive scenario is no less than 6.8 billion kilometres per year vis-à-vis the realistic scenario. Please compare those results with Figure 56: the diverging image for the progressive scenario in 2030 can most probably be attributed to the increased share of small and clean vehicles, which are driven less than the average vehicle in the fleet (see further sections 4.2.3 and 4.2.5).

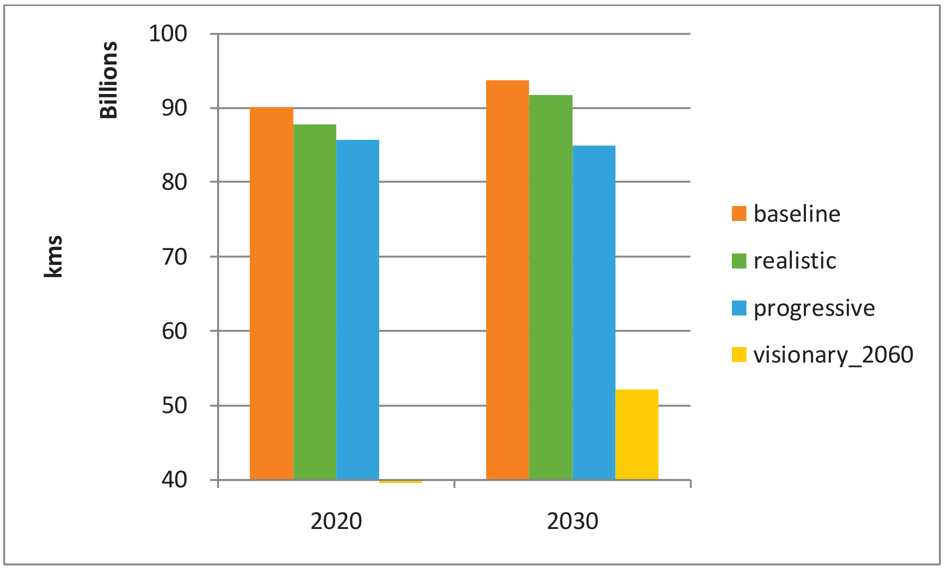

Figure 61: Kilometres driven in Belgium

4.2.2. Kilometres per road type

As shown in Figure 62, the relative difference in road type split between baseline and realistic is negligible, both for 2020 and 2030. On the other hand, for the progressive scenario, we perceive a modest shift to rural roads (+2%) and highways (+1%), away from the city centres (urban roads, -3%). This shift is mainly observed thanks to the introduction of the limited access environmental zones.

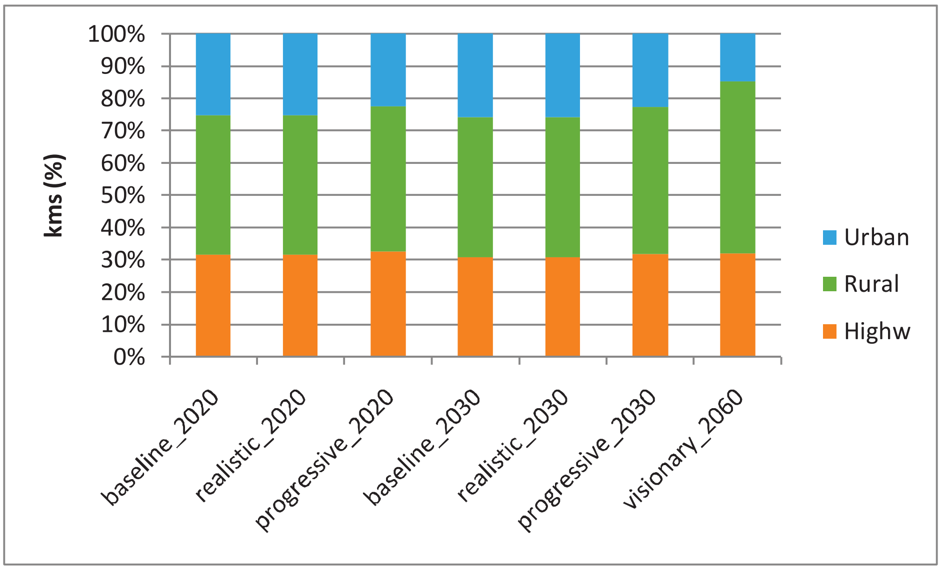

Figure 62: Relative share of kilometres driven over different road types

4.2.3. Kilometres per fuel technology

If we want to reduce the relative share of conventional diesel kilometres vis-à-vis the baseline, the only solution is to introduce the measures proposed in the progressive scenario, as the realistic scenario seems to be even slightly beneficial (especially after 2020) for the use of conventional diesel vehicles. In the realistic scenario, it appears that the increased excise duties on diesel are missing their effect. In fact, it seems that they are partly or completely offset by the consumption advantage of diesel engines, combined with lower taxes (compared to petrol) under the CO_2-based tax system. The share of kilometres driven by the newer clean vehicle technologies (diesel hybrid, petrol hybrid and electric) is strongly encouraged under the progressive scenario (see Figure 63).

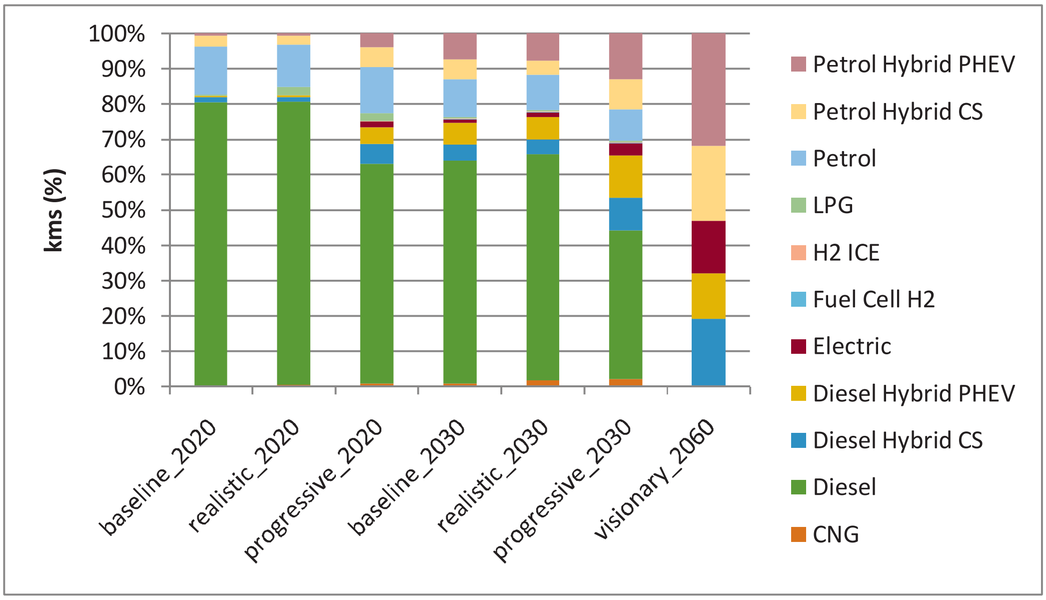

Figure 63: Relative share of kilometres driven by different technologies

4.2.4. Kilometres per euro standard

Figure 64 shows the relative split of kilometres over the euro standards. The more sophisticated the scenario, the faster the share of kilometres done by the most recent euro standards will increase. In 2020, 58% of all kilometres driven are attributable to euro 6 vehicles in the progressive scenario, versus 51 and 52% for the baseline and realistic scenario, respectively. This difference disappears towards the future (99% vs 98% and 98%), as no additional euro standard is set yet. Compared with Figure 58, the adoption of newer standards happens faster, as newer (on average, i.e. cleaner) vehicles are usually driven more intensively than older ones.

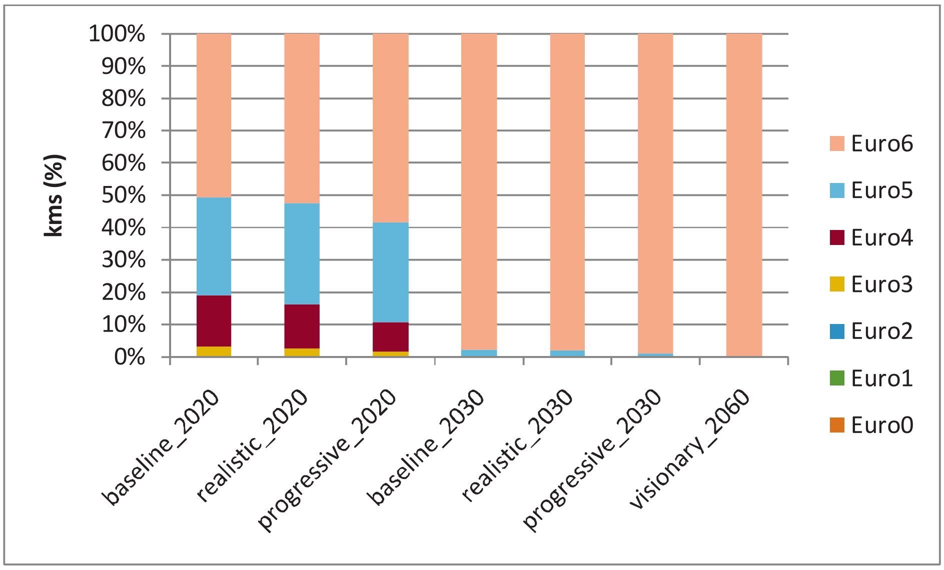

Figure 64: Relative share of kilometres driven by different euro standards

4.2.5. Kilometres per engine size

All comments given in 4.1.4 are also valid for Figure 65. Looking at the kilometres, however, the share of small engines is somewhat smaller. This is again a confirmation of the notion that smaller vehicles (<1.4l) are on average driven less kilometres than their larger counterparts (>1.4l). If we want to reach a target of 50% of all kilometres travelled by small engines in 2030, the measures proposed under the progressive scenario could offer a solution.

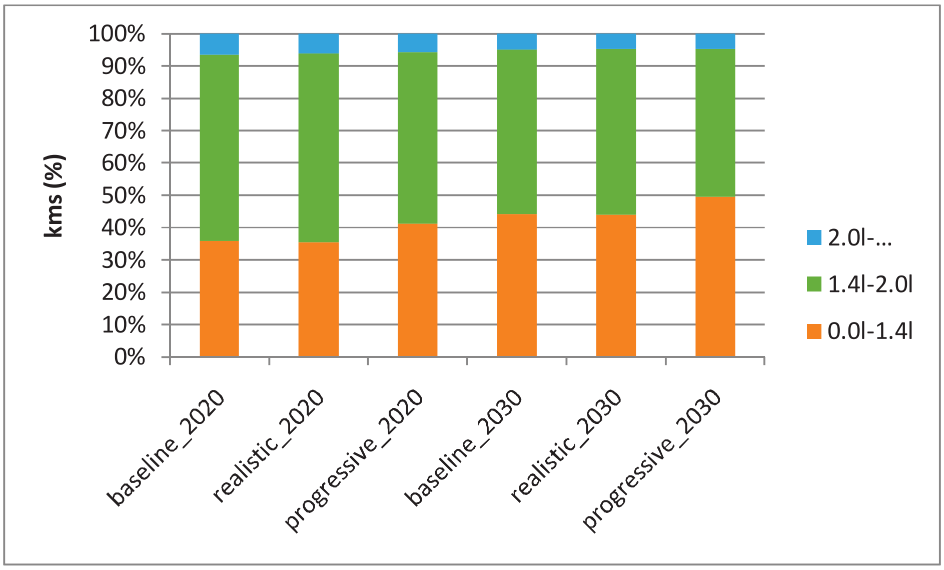

Figure 65: Relative share of kilometres driven by different engine sizes

4.3. Environmental impact

4.3.1. Ecoscore

The average ecoscore, weighted for the kilometres driven, is displayed in Figure 66. Again, it is clear that the progressive scenario provides a substantial benefit compared to the baseline and realistic scenario (71.65 vs 69.16 and 69.59 in 2020 and 75.43 vs 73.73 and 73.77 in 2030). These values are slightly above the unweighted ones observed in Figure 60, which indicates that cars with higher ecoscores are driven more kilometres compared to cars with lower ecoscores, on average.

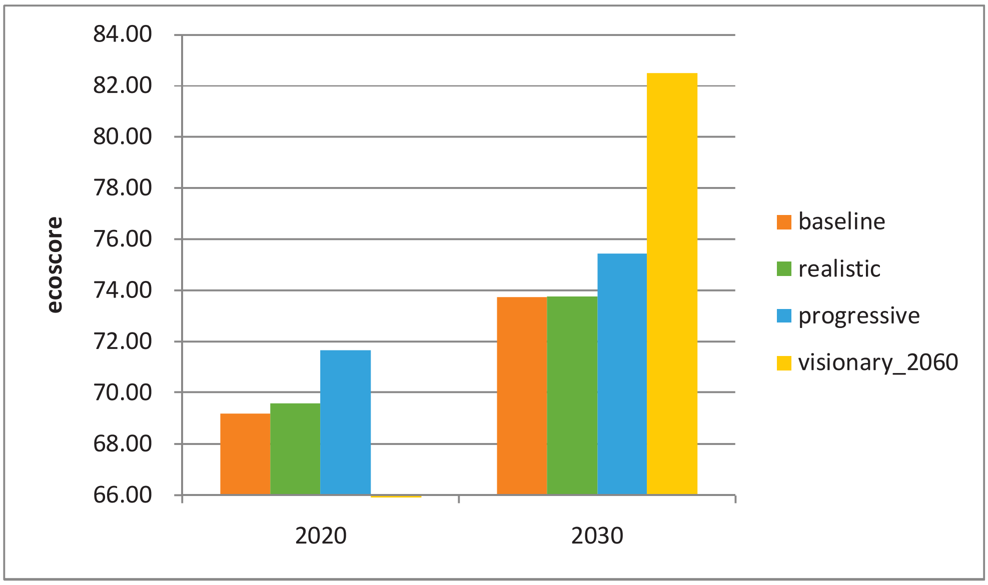

Figure 66: Average ecoscore for Belgian fleet (km weighted)

4.3.2. Emissions

Emission levels of CO_2e, PM2.5 and NO_x are displayed in Figure 67 till Figure 69. We can classify these emissions in two groups: CO_2e on the one hand and PM2.5 and NO_x on the other hand.

Concerning emissions of CO_2e, emission differences between the various technologies rule, rather than the (automatic) technological progress over time. This can be observed in Figure 67, where the baseline emissions in 2030 exceed 2020 emissions under the progressive scenario. Therefore, the importance of policy measure implementation for the benefit of lowering CO_2e emissions cannot be stressed too much. The share of CO_2e emissions originating from diesel vehicles is substantial, but not so large as for PM2.5 and NO_x.

Regarding $PM_{2.5}$ and NO_x, we conclude from Figure 68 and Figure 69 that all engine technologies seem to benefit from a large level of technological improvement. This happens automatically over the years, because we see for example that the total level of emissions under the baseline in 2030 is lower than emissions under the progressive scenario in 2020. Nevertheless, compared to the other technologies, diesel vehicles (both conventional and hybrid) relatively contribute a lot to the total emission levels of PM2.5 and NO_x.

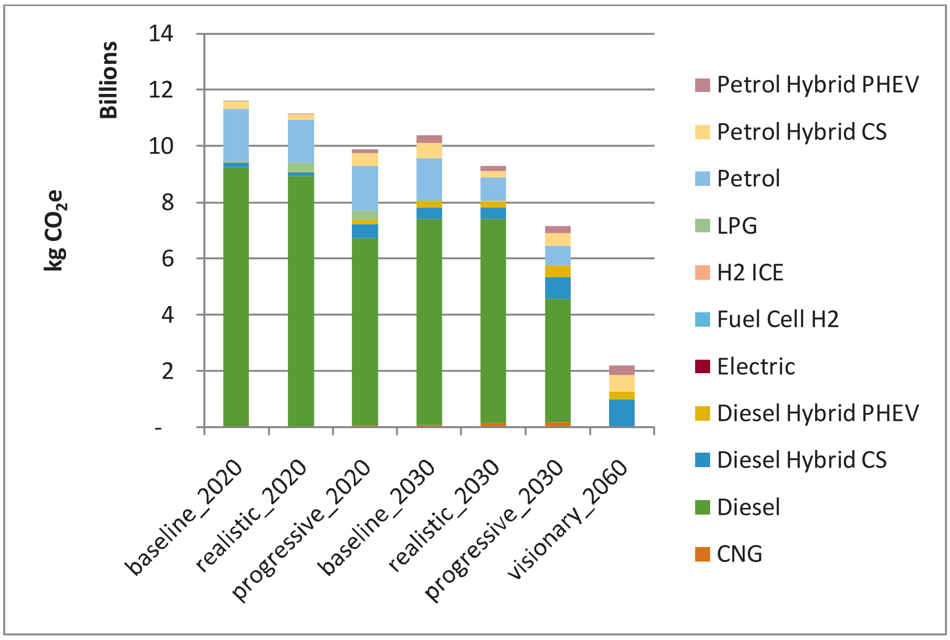

Figure 67: TTW emissions CO_2e per technology

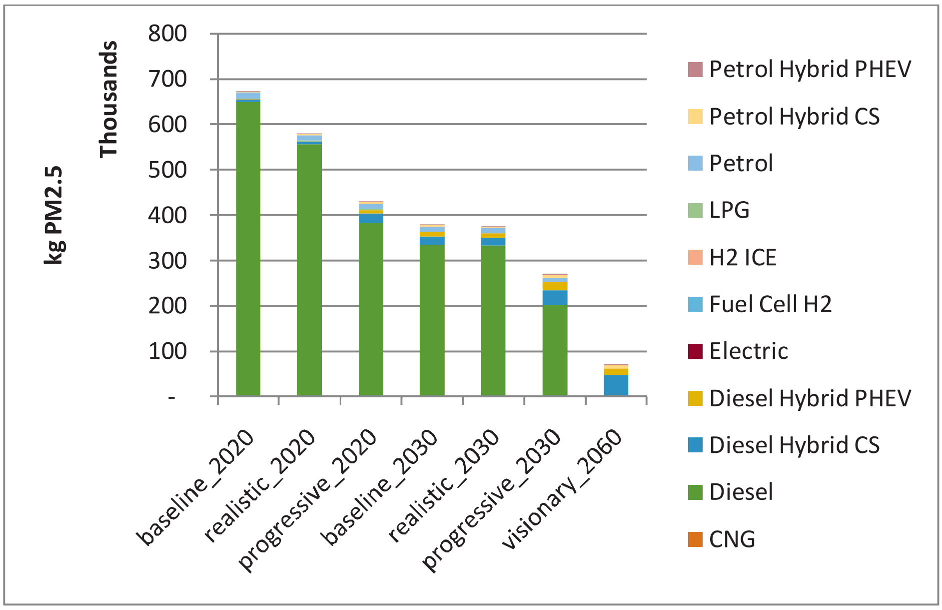

Figure 68: TTW emissions PM2.5 per technology

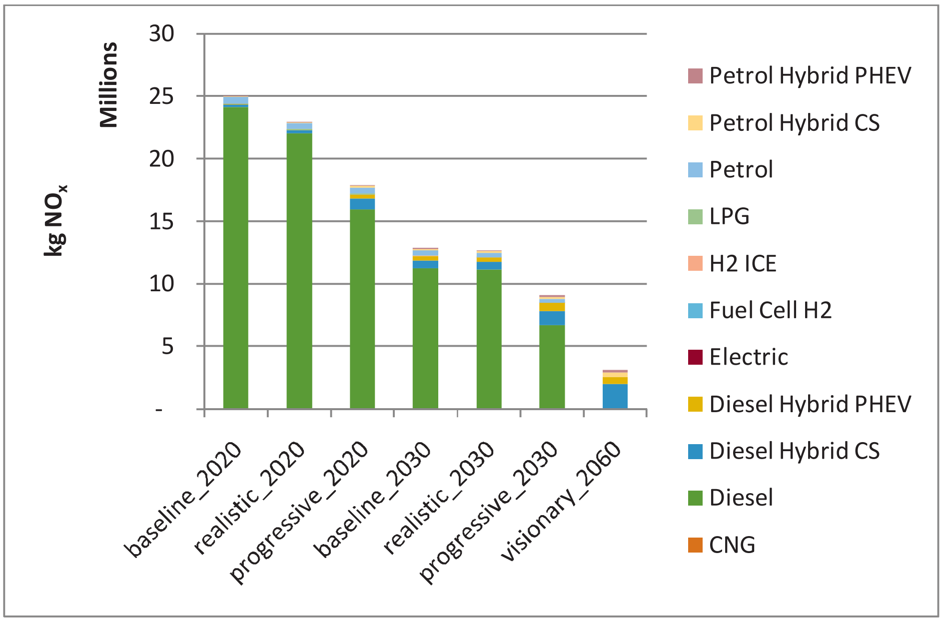

Figure 69: TTW emissions NO_x per technology

5. Conclusion

In this report, we discussed the results on fleet composition, vehicle use and environmental impact for the baseline, the realistic as well as the progressive scenario. For the visionary scenario, the evaluation was constrained to data on vehicle use and environmental impacts.

The results from the baseline scenario describe the situation if no additional measures are taken on top of the current and planned legislation. This is an interesting benchmark for the other scenario results to be compared with.

Under the realistic scenario, the modelled reforms are rather confined. Not very surprising then, the difference compared to the baseline in terms of total fleet size, distance travelled, ecoscore and emissions is quite small. However, this new tax system based on CO_2 emission and Euro standard seems to be more righteous within the scope of the ‘polluter pays principle’.

The progressive scenario adds some interesting features to the realistic setting. It is to say, a kilometre charge replaces the annual circulation tax, and is partially based on the ecoscore of the vehicle, as is the registration tax . The imposed limitation on traffic in city centres is another remarkable measure adopted in this scenario. The results show that these rather stringent policy measures will pay off, not only in terms of a massive reduction in total kilometres travelled, but also in terms of emissions and weighted ecoscores. The fact is that the results from this scenario easily tower above the resulting indicators from the other two scenarios. Therefore, it should be kept in mind that making an additional effort, as done under the progressive scenario, can make a difference in order to obtain some pretty hopeful results.

Please note that the scenario results not only depend on the type of measures introduced, but also on the specific level of each measure. From the figures given above, we can deduce that the progressive setup indeed yields better results than the realistic scenario, but this is only true for the specific levels of the simulated measures, given in report 5.3. As a consequence, the results of the realistic scenario could have been much more encouraging, for example if the excise duties on diesel had been significantly higher than those on petrol. In conclusion, we can say that we can only judge on the impact of the complete set of measures in the scenarios, as described in report 5.3.

The results from the visionary scenario indicate that there is a huge gap between the well-founded model results for 2030 and the visionary exercise for the year 2060, both in terms of the amount of kilometres travelled and environmental performance indicators. Seemingly, the predefined vehicle fleet distribution and the other assumptions made under this scenario promise to be quite beneficial for traffic intensities and the corresponding ecoscores and emissions. However, we should take account of the fact that direct carbon emissions still exist, so, even under this scenario, there is room for improvement. Finally, we should always bear in mind that this is an exercise basically founded on expert judgements.

6. Literature

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7. Annex: Detailed scenario results

7.1. Baseline scenario

This section can be considered as an annex to 2.2. The results are now displayed more thoroughly in tabular form.

7.1.1. Fleet composition

	TOTAL
1995	4,239,972
2000	4,644,944
2005	4,878,446
2010	5,207,513
2015	5,621,179
2020	5,746,763
2025	5,869,847
2030	6,051,956

Table 3: Total number of cars

	CNG	Diesel	Diesel hybrid CS	Diesel hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol hybrid CS	Petrol hybrid PHEV	TOTAL
1995	-	1,405,524	-	-	12	-	-	32,629	2,801,807	-	-	4,239,972
2000	1	1,891,009	-	-	66	-	-	64,255	2,689,597	16	-	4,644,944
2005	2	2,454,024	-	-	19	-	-	59,901	2,363,805	695	-	4,878,446
2010	39	3,203,601	-	-	-	-	-	37,520	1,958,102	8,251	-	5,207,513
2015	7,188	3,842,965	10,631	1,116	-	-	-	23,451	1,684,413	47,502	3,913	5,621,179
2020	24,372	3,939,701	64,784	18,018	-	-	-	17,220	1,519,068	134,161	29,439	5,746,763
2025	50,774	3,722,247	153,844	94,171	34,689	-	3,404	15,344	1,422,731	245,257	127,386	5,869,847
2030	83,004	3,378,335	215,426	281,198	127,957	14,351	12,597	15,041	1,262,850	308,542	352,655	6,051,956

Table 4: Total number of cars per technology

	Euro 0	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6	TOTAL
1995	3,221,408	1,018,564	-	-	-	-	-	4,239,972
2000	1,807,642	1,063,466	1,614,940	158,896	-	-	-	4,644,944
2005	748,242	723,245	1,295,406	1,964,227	147,326	-	-	4,878,446
2010	3,062	534,960	762,820	1,538,727	2,225,404	142,540	-	5,207,513
2015	-	-	279,853	999,086	1,871,827	2,138,106	332,307	5,621,179
2020	-	-	-	277,945	1,190,314	1,804,505	2,473,999	5,746,763
2025	-	-	-	-	328,801	1,185,984	4,355,062	5,869,847
2030	-	-	-	-	-	190,424	5,861,532	6,051,956

Table 5: Total number of cars per Euro standard

	0,0l-1,4l	1,4l-2,0l	2,0l-...	TOTAL
1995	1,302,352	2,373,322	564,298	4,239,972
2000	1,347,518	2,753,282	544,144	4,644,944
2005	1,429,280	2,887,121	562,045	4,878,446
2010	1,621,781	2,997,700	588,032	5,207,513
2015	2,069,403	3,060,250	491,526	5,621,179
2020	2,458,962	2,916,489	371,312	5,746,763
2025	2,812,919	2,753,733	303,195	5,869,847
2030	3,104,700	2,664,591	282,665	6,051,956

Table 6: Total number of cars per engine size

2006	2007	2008	2010	2015	2020	2025	2030
51.82	53.85	56.17	58.40	64.11	68.50	71.18	73.22

Table 7: Average ecoscore (unweighted)

	2006	2007	2008	2010	2015	2020	2025	2030
CNG	-	-	70.45	74.79	78.87	79.15	79.24	79.28
Diesel	48.56	51.01	53.47	56.69	63.80	68.19	70.62	71.77
Diesel Hybrid CS	-	-	-	-	77.82	78.28	78.66	79.01
Diesel Hybrid PHEV	-	-	-	-	79.84	80.34	80.77	81.20
Electric	-	-	-	-	-	-	83.87	84.23
Fuel Cell H2	-	-	-	-	-	-	-	82.70
H2 ICE	-	-	-	-	-	-	82.72	82.72
LPG	61.06	62.65	65.61	65.73	65.52	68.36	68.83	69.05
Petrol	55.34	57.22	59.61	61.00	64.19	67.41	68.20	68.52
Petrol Hybrid CS	70.72	70.62	71.09	73.37	78.08	79.05	79.56	79.93
Petrol Hybrid PHEV	-	-	-	-	80.85	81.31	81.75	82.17

Table 8: Average ecoscore per technology (unweighted)

7.1.2. Vehicle use

	TOTAL
1995	66,832,777,716
2000	72,487,048,804
2005	74,500,719,217
2010	79,315,275,512
2015	87,397,629,037
2020	90,104,118,929
2025	91,665,482,613
2030	93,735,449,770

Table 9: Total amount of kilometres driven

	Highw	Rural	Urban	TOTAL
1995	20,180,123,013	29,372,470,660	17,280,184,043	66,832,777,716
2000	23,126,920,622	31,342,298,555	18,017,829,627	72,487,048,804
2005	24,379,942,836	31,882,470,269	18,238,306,112	74,500,719,217
2010	26,130,753,803	33,843,702,278	19,340,819,431	79,315,275,512
2015	28,118,435,873	37,599,609,811	21,679,583,353	87,397,629,037
2020	28,538,709,235	38,845,011,636	22,720,398,058	90,104,118,929
2025	28,637,534,361	39,570,464,065	23,457,484,187	91,665,482,613
2030	28,915,939,274	40,535,617,915	24,283,892,581	93,735,449,770

Table 10: Total amount of kilometres driven per road type

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	35,398.45	-	-	0.13	-	-	604.63	30,829.56	-	-	66,832.78
2000	0.02	45,709.21	-	-	0.58	-	-	1,166.95	25,609.81	0.48	-	72,487.05
2005	0.02	51,816.93	-	-	0.17	-	-	1,249.61	21,418.61	15.39	-	74,500.72
2010	0.37	62,569.35	-	-	-	-	-	713.44	15,856.94	175.17	-	79,315.28
2015	65.83	72,094.48	233.51	24.78	-	-	-	438.45	13,490.86	967.15	82.56	87,397.63
2020	220.05	72,241.03	1,394.85	396.50	-	-	-	326.71	12,262.74	2,651.55	610.69	90,104.12
2025	444.63	66,781.66	3,132.47	2,013.10	320.52	-	31.47	291.64	11,451.62	4,618.72	2,579.65	91,665.48
2030	703.50	59,333.40	4,061.51	5,762.21	1,141.69	131.05	112.59	283.49	9,929.32	5,424.04	6,852.64	93,735.45

Table 11 : Total amount of kilometres driven per technology (mio kilometres)

	Euro0	Euro1	Euro2	Euro3	Euro4	Euro5	Euro6	TOTAL
1995	43,962,207,284	22,870,570,432	-	-	-	-	-	66,832,777,716
2000	15,533,821,791	16,485,907,640	36,847,854,405	3,619,464,968	-	-	-	72,487,048,804
2005	6,665,646,549	8,754,950,192	19,263,391,263	36,950,200,466	2,866,530,747	-	-	74,500,719,217
2010	52,829,474	4,458,471,977	8,479,542,370	22,391,535,805	40,954,819,105	2,978,076,781	-	79,315,275,512
2015	-	-	2,457,825,328	11,673,223,014	27,845,396,561	38,653,586,616	6,767,597,518	87,397,629,037
2020	-	-	-	2,746,723,333	14,512,095,294	27,291,630,235	45,553,670,067	90,104,118,929
2025	-	-	-	-	3,459,186,027	14,549,434,684	73,656,861,902	91,665,482,613
2030	-	-	-	-	-	2,040,504,851	91,694,944,919	93,735,449,770

Table 12: Total amount of kilometres driven per euro standard

	0.0l-1.4l	1.4l-2.0l	2.0l-...	TOTAL
1995	12,751,387,563	43,267,168,545	10,814,221,608	66,832,777,716
2000	12,485,109,334	50,420,615,031	9,581,324,439	72,487,048,804
2005	14,486,763,280	50,510,126,237	9,503,829,700	74,500,719,217
2010	18,111,297,712	51,621,782,252	9,582,195,548	79,315,275,512
2015	25,916,958,125	53,658,712,238	7,821,958,674	87,397,629,037
2020	32,240,500,727	52,001,886,856	5,861,731,346	90,104,118,929
2025	37,314,178,136	49,468,287,820	4,883,016,657	91,665,482,613
2030	41,409,411,368	47,698,830,305	4,627,208,097	93,735,449,770

Table 13: Total amount of kilometres driven per engine size

7.1.3. Environmental impact

2006	2007	2008	2010	2015	2020	2025	2030
51.79	53.79	55.97	58.61	64.82	69.16	71.80	73.73

Table 14: Average ecoscore (km weighted)

	2006	2007	2008	2010	2015	2020	2025	2030
CNG	-	-	68.72	74.75	78.92	79.22	79.32	79.36
Diesel	49.91	52.25	54.59	57.77	64.61	68.74	70.84	71.73
Diesel Hybrid CS	-	-	-	-	77.79	78.26	78.63	78.97
Diesel Hybrid PHEV	-	-	-	-	79.81	80.31	80.74	81.17
Electric	-	-	-	-	-	-	83.79	84.14
Fuel Cell H2	-	-	-	-	-	-	-	82.65
H2 ICE	-	-	-	-	-	-	82.67	82.67
LPG	61.35	62.81	65.54	65.69	65.58	68.24	68.65	68.84
Petrol	56.38	57.94	59.99	61.41	64.50	67.33	68.05	68.31
Petrol Hybrid CS	70.68	70.65	71.22	73.57	78.19	79.07	79.55	79.90
Petrol Hybrid PHEV	-	-	-	-	80.82	81.28	81.72	82.14

Table 15: Average ecoscore per technology (km weighted)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	6,052,616,511	-	-	-	-	-	100,218,770	6,213,950,564	-	-	12,366,785,845
2000	3,758	7,571,664,700	-	-	-	-	-	195,956,191	4,883,391,149	63,246	-	12,651,079,044
2005	2,735	8,320,179,179	-	-	-	-	-	211,148,523	3,962,190,730	2,165,671	-	12,495,686,838
2010	44,524	9,331,362,873	-	-	-	-	-	119,349,500	2,730,110,681	21,729,812	-	12,202,597,391
2015	6,901,988	9,759,495,119	24,590,626	1,039,921	-	-	-	69,340,338	2,141,092,813	103,971,403	3,513,803	12,109,946,011
2020	22,029,571	9,231,424,974	141,364,343	16,048,979	-	-	-	49,318,431	1,865,476,926	270,217,534	24,750,775	11,620,631,534
2025	44,377,206	8,322,896,487	316,352,812	81,378,046	-	-	97,575	43,178,291	1,707,134,566	467,109,573	104,334,813	11,086,859,368
2030	70,204,727	7,331,815,951	408,876,345	232,651,621	-	-	349,059	41,589,431	1,467,660,443	546,977,780	276,734,435	10,376,859,792

Table 16: CO_2e TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	5,315,141	-	-	-	-	-	17,986	720,095	-	-	6,053,222
2000	0	3,539,624	-	-	-	-	-	19,194	265,661	1	-	3,824,480
2005	0	2,349,620	-	-	-	-	-	13,556	144,850	13	-	2,508,038
2010	0	1,702,432	-	-	-	-	-	2,650	23,170	145	-	1,728,398
2015	70	1,059,851	1,002	43	-	-	-	556	15,615	796	27	1,077,959
2020	233	649,121	5,980	680	-	-	-	347	13,002	2,177	201	671,740
2025	472	422,151	13,418	3,449	-	-	7	309	12,144	3,786	846	456,582
2030	746	334,211	17,386	9,866	-	-	24	301	10,530	4,440	2,243	379,748

Table 17: PM2.5 TTW emissions per fuel technology kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	22,183,138	-	-	-	-	-	1,472,503	61,392,673	-	-	85,048,314
2000	4	30,803,906	-	-	-	-	-	1,574,784	26,526,093	50	-	58,904,837
2005	1	37,225,553	-	-	-	-	-	1,102,219	14,272,858	735	-	52,601,367
2010	14	39,457,418	-	-	-	-	-	211,135	3,360,945	5,225	-	43,034,737
2015	2,608	35,471,999	68,195	2,879	-	-	-	29,443	963,695	28,099	956	36,567,875
2020	8,767	24,114,642	232,933	24,734	-	-	-	15,432	518,985	77,120	7,104	24,999,717
2025	17,802	16,001,949	482,313	121,340	-	-	3,151	12,407	459,795	134,743	30,110	17,263,610
2030	28,288	11,239,397	610,705	345,641	-	-	11,318	12,068	399,249	158,700	80,220	12,885,586

Table 18: NO_x TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	16,683,629	-	-	-	-	-	4,690,292	292,705,606	-	-	314,079,527
2000	5	12,541,418	-	-	-	-	-	6,120,478	124,940,760	297	-	143,602,959
2005	4	7,230,994	-	-	-	-	-	5,086,080	68,301,464	9,383	-	80,627,926
2010	87	4,443,963	-	-	-	-	-	1,694,712	23,255,429	58,696	-	29,452,888
2015	14,870	4,223,842	10,621	450	-	-	-	589,812	9,335,705	306,388	10,414	14,492,103
2020	49,349	4,258,346	63,864	7,262	-	-	-	309,984	5,540,059	829,348	76,336	11,134,548
2025	99,083	4,077,547	144,212	37,081	-	-	-	242,154	4,433,336	1,433,629	320,078	10,787,120
2030	155,893	3,674,052	187,880	106,654	-	-	-	234,194	3,792,577	1,672,938	844,880	10,669,068

Table 19: CO TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	3,150,628	-	-	-	-	-	579,117	62,272,533	-	-	66,002,278
2000	0	2,134,790	-	-	-	-	-	613,777	28,397,895	20	-	31,146,483
2005	0	1,355,141	-	-	-	-	-	427,924	13,690,808	348	-	15,474,222
2010	3	674,679	-	-	-	-	-	84,615	1,809,554	3,346	-	2,572,197
2015	565	484,834	1,006	43	-	-	-	8,224	703,570	18,525	806	1,217,573
2020	1,884	399,827	6,017	684	-	-	-	2,900	480,259	51,279	6,014	948,865
2025	3,799	362,797	13,531	3,478	-	-	269	1,802	432,684	90,853	25,661	934,874
2030	6,000	325,709	17,564	9,968	-	-	960	1,757	379,350	109,712	69,631	920,650

Table 20: VOC TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	5,046,387	-	-	-	-	-	334	1,141,277	-	-	6,187,998
2000	0	1,421,124	-	-	-	-	-	647	235,907	3	-	1,657,682
2005	0	166,043	-	-	-	-	-	698	36,754	20	-	203,515
2010	0	49,324	-	-	-	-	-	394	12,100	97	-	61,916
2015	25	51,528	130	5	-	-	-	229	9,615	470	16	62,019
2020	80	48,704	746	85	-	-	-	163	8,373	1,222	112	59,484
2025	161	43,894	1,669	429	-		-	142	7,653	2,112	472	56,533
2030	255	38,662	2,157	1,228	-	-	-	136	6,578	2,474	1,252	52,741

Table 21: SO_2 TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	35,400	-	-	-	-	-	-	889,867	-	-	925,267
2000	3	45,708	-	-	-	-	-	-	2,581,614	41	-	2,627,366
2005	1	51,817	-	-	-	-	-	-	1,779,089	476	-	1,831,383
2010	14	62,571	-	-	-	-	-	-	1,182,758	5,366	-	1,250,708
2015	2,287	72,095	193	8	-	-	-	-	658,383	28,765	982	762,712
2020	7,526	72,241	1,148	131	-	-	-	-	509,273	77,625	7,148	675,093
2025	14,954	66,781	2,575	662	-	-	0	-	489,436	133,017	29,700	737,126
2030	23,252	59,335	3,336	1,893	-	-	0	-	423,881	153,599	77,579	742,876

Table 22: NH_3 TTW emissions per fuel technology (kg)

7.2. Realistic scenario

This section can be considered as an annex to section 3.1. The results are now displayed more thoroughly in a tabular form.

7.2.1. Fleet composition

	TOTAL
1995	4,239,972
2000	4,644,944
2005	4,878,446
2010	5,207,513
2015	5,576,002
2020	5,633,480
2025	5,670,240
2030	5,818,109

Table 23: Total number of cars

	CNG	Diesel	Diesel hybrid CS	Diesel hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol hybrid CS	Petrol hybrid PHEV	TOTAL
1995	-	1,405,524	-	-	12	-	-	32,629	2,801,807	-	-	4,239,972
2000	1	1,891,009	-	-	66	-	-	64,255	2,689,597	16	-	4,644,944
2005	2	2,454,024	-	-	19	-	-	59,901	2,363,805	695	-	4,878,446
2010	39	3,203,601	-	-	-	-	-	37,520	1,958,102	8,251	-	5,207,513
2015	15,436	3,728,103	10,810	1,197	-	-	-	183,078	1,592,892	40,298	4,188	5,576,002
2020	51,125	3,889,549	63,569	18,587	-	-	-	136,572	1,336,407	107,177	30,494	5,633,480
2025	104,230	3,735,130	147,188	95,380	35,211	-	3,460	21,814	1,212,259	185,832	129,736	5,670,240
2030	168,804	3,309,345	201,016	284,017	130,790	14,711	12,876	15,018	1,110,440	211,403	359,689	5,818,109

Table 24: Total number of cars per technology

	Euro 0	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6	TOTAL
1995	3,221,408	1,018,564	-	-	-	-	-	4,239,972
2000	1,807,642	1,063,466	1,614,940	158,896	-	-	-	4,644,944
2005	748,242	723,245	1,295,406	1,964,227	147,326	-	-	4,878,446
2010	3,062	534,960	762,820	1,538,727	2,225,404	142,540	-	5,207,513
2015	-	-	256,529	889,716	1,815,282	2,258,469	356,006	5,576,002
2020	-	-	-	229,476	997,969	1,839,062	2,566,973	5,633,480
2025	-	-	-	-	255,129	1,031,937	4,383,174	5,670,240
2030	-	-	-	-	-	151,914	5,666,195	5,818,109

Table 25: Total number of cars per euro standard

	0,0l-1,4l	1,4l-2,0l	2,0l-...	TOTAL
1995	1,302,352	2,373,322	564,298	4,239,972
2000	1,347,518	2,753,282	544,144	4,644,944
2005	1,429,280	2,887,121	562,045	4,878,446
2010	1,621,781	2,997,700	588,032	5,207,513
2015	2,055,367	3,051,594	469,041	5,576,002
2020	2,388,129	2,905,534	339,817	5,633,480
2025	2,681,516	2,709,929	278,795	5,670,240
2030	2,974,594	2,578,068	265,447	5,818,109

Table 26: Total number of cars per engine size

2006	2007	2008	2010	2015	2020	2025	2030
51.82	53.85	56.17	58.40	64.78	69.08	71.45	73.37

Table 27: Average ecoscore (unweighted)

	2006	2007	2008	2010	2015	2020	2025	2030
CNG	-	-	70.45	74.79	78.81	79.08	79.18	79.24
Diesel	48.56	51.01	53.47	56.69	64.70	69.03	70.90	71.83
Diesel Hybrid CS	-	-	-	-	77.82	78.28	78.67	79.04
Diesel Hybrid PHEV	-	-	-	-	79.84	80.34	80.78	81.21
Electric	-	-	-	-	-	-	83.87	84.23
Fuel Cell H2	-	-	-	-	-	-	-	82.70
H2 ICE	-	-	-	-	-	-	82.72	82.72
LPG	61.06	62.65	65.61	65.73	66.58	67.25	68.41	69.06
Petrol	55.34	57.22	59.61	61.00	64.15	67.37	68.19	68.51
Petrol Hybrid CS	70.72	70.62	71.09	73.37	77.96	79.02	79.55	79.90
Petrol Hybrid PHEV	-	-	-	-	80.85	81.30	81.74	82.17

Table 28: Average ecoscore per technology (unweighted)

7.2.2. Vehicle use

	TOTAL
1995	66,832,777,716
2000	72,487,048,804
2005	74,500,719,217
2010	79,315,275,512
2015	85,163,464,302
2020	87,812,046,627
2025	89,481,412,888
2030	91,748,869,089

Table 29: Total amount of kilometres driven

	Highw	Rural	Urban	TOTAL
1995	20,180,123,013	29,372,470,660	17,280,184,043	66,832,777,716
2000	23,126,920,622	31,342,298,555	18,017,829,627	72,487,048,804
2005	24,379,942,836	31,882,470,269	18,238,306,112	74,500,719,217
2010	26,130,753,803	33,843,702,278	19,340,819,431	79,315,275,512
2015	27,399,266,441	36,638,238,118	21,125,959,743	85,163,464,302
2020	27,811,931,394	37,855,703,422	22,144,411,811	87,812,046,627
2025	27,953,296,640	38,629,362,524	22,898,753,724	89,481,412,888
2030	28,302,696,038	39,676,325,798	23,769,847,253	91,748,869,089

Table 30: Total amount of kilometres driven per road type

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	35,398.45	-	-	0.13	-	-	604.63	30,829.56	-	-	66,832.78
2000	0.02	45,709.21	-	-	0.58	-	-	1,166.95	25,609.81	0.48	-	72,487.05
2005	0.02	51,816.93	-	-	0.17	-	-	1,249.61	21,418.61	15.39	-	74,500.72
2010	0.37	62,569.35	-	-	-	-	-	713.44	15,856.94	175.17	-	79,315.28
2015	136.75	68,163.44	224.86	25.36	-	-	-	3,086.76	12,647.41	793.36	85.54	85,163.46
2020	449.57	70,318.42	1,301.77	391.85	-	-	-	2,030.85	10,644.58	2,060.79	614.22	87,812.05
2025	912.18	66,930.00	2,937.07	2,007.18	323.01	-	31.76	381.65	9,851.92	3,489.90	2,616.73	89,481.41
2030	1,460.20	58,966.88	3,824.34	5,852.67	1,183.22	135.54	116.63	290.69	9,069.07	3,748.50	7,101.13	91,748.87

Table 31: Total amount of kilometres driven per technology (mio kilometres)

	Euro0	Euro1	Euro2	Euro3	Euro4	Euro5	Euro6	TOTAL
1995	43,962,207,284	22,870,570,432	-	-	-	-	-	66,832,777,716
2000	15,533,821,791	16,485,907,640	36,847,854,405	3,619,464,968	-	-	-	72,487,048,804
2005	6,665,646,549	8,754,950,192	19,263,391,263	36,950,200,466	2,866,530,747	-	-	74,500,719,217
2010	52,829,474	4,458,471,977	8,479,542,370	22,391,535,805	40,954,819,105	2,978,076,781	-	79,315,275,512
2015	-	-	2,200,375,056	10,205,859,424	26,291,676,951	39,447,827,362	7,017,725,509	85,163,464,302
2020	-	-	-	2,221,989,308	12,067,764,158	27,567,413,564	45,954,879,597	87,812,046,627
2025	-	-	-	-	2,689,080,171	12,993,331,174	73,799,001,543	89,481,412,888
2030	-	-	-	-	-	1,687,985,771	90,060,883,318	91,748,869,089

Table 32: Total amount of kilometres driven per euro standard

	0.0l-1.4l	1.4l-2.0l	2.0l-…	TOTAL
1995	12,751,387,563	43,267,168,545	10,814,221,608	66,832,777,716
2000	12,485,109,334	50,420,615,031	9,581,324,439	72,487,048,804
2005	14,486,763,280	50,510,126,237	9,503,829,700	74,500,719,217
2010	18,111,297,712	51,621,782,252	9,582,195,548	79,315,275,512
2015	25,453,098,767	52,362,731,454	7,347,634,081	85,163,464,302
2020	31,224,826,800	51,195,758,397	5,391,461,430	87,812,046,627
2025	36,005,608,334	48,895,136,292	4,580,668,262	89,481,412,888
2030	40,350,695,418	46,949,036,332	4,449,137,339	91,748,869,089

Table 33: Total amount of kilometres driven per engine size

7.2.3. Environmental impact

2006	2007	2008	2010	2015	2020	2025	2030
51.79	53.79	55.97	58.61	65.44	69.59	71.93	73.77

Table 34: Average ecoscore (km weighted)

	2006	2007	2008	2010	2015	2020	2025	2030
CNG	-	-	68.72	74.75	78.85	79.15	79.26	79.31
Diesel	49.91	52.25	54.59	57.77	65.33	69.35	71.03	71.78
Diesel Hybrid CS	-	-	-	-	77.79	78.26	78.64	79.00
Diesel Hybrid PHEV	-	-	-	-	79.81	80.31	80.74	81.18
Electric	-	-	-	-	-	-	83.79	84.15
Fuel Cell H2	-	-	-	-	-	-	-	82.65
H2 ICE	-	-	-	-	-	-	82.67	82.67
LPG	61.35	62.81	65.54	65.69	66.68	67.38	68.38	68.85
Petrol	56.38	57.94	59.99	61.41	64.41	67.28	68.03	68.30
Petrol Hybrid CS	70.68	70.65	71.22	73.57	78.07	79.05	79.54	79.87
Petrol Hybrid PHEV	-	-	-	-	80.82	81.28	81.72	82.14

Table 35: Average ecoscore per technology (km weighted)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Elec tric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	6,052,616,511	-	-	-	-	-	100,218,770	6,213,950,564	-	-	12,366,785,845
2000	3,758	7,571,664,700	-	-	-	-	-	195,956,191	4,883,391,149	63,246	-	12,651,079,044
2005	2,735	8,320,179,179	-	-	-	-	-	211,148,523	3,962,190,730	2,165,671	-	12,495,686,838
2010	44,524	9,331,362,873	-	-	-	-	-	119,349,500	2,730,110,681	21,729,812	-	12,202,597,391
2015	14,344,011	9,141,187,620	23,678,444	1,064,153	-	-	-	477,052,623	2,007,985,530	85,481,464	3,640,079	11,754,433,924
2020	45,043,924	8,892,225,802	131,913,896	15,861,583	-	-	-	314,205,999	1,534,661,727	198,708,357	23,533,950	11,156,155,237
2025	91,083,816	8,308,941,629	296,520,094	81,135,091	-	-	98,462	57,313,724	1,114,987,217	267,072,837	80,085,865	10,297,238,734
2030	145,763,971	7,272,648,840	384,701,819	236,237,465	-	-	361,546	42,637,111	813,527,344	228,008,551	173,042,389	9,296,929,036

Table 36: CO_2e TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	5,315,141	-	-	-	-	-	17,986	720,095	-	-	6,053,222
2000	0	3,539,624	-	-	-	-	-	19,194	265,661	1	-	3,824,480
2005	0	2,349,620	-	-	-	-	-	13,556	144,850	13	-	2,508,038
2010	0	1,702,432	-	-	-	-	-	2,650	23,170	145	-	1,728,398
2015	145	897,276	965	44	-	-	-	3,363	14,675	653	28	917,149
2020	477	555,387	5,581	672	-	-	-	2,155	11,287	1,692	202	577,453
2025	967	409,615	12,582	3,439	-	-	7	405	10,448	2,861	858	441,184
2030	1,549	332,129	16,371	10,021	-	-	25	308	9,618	3,069	2,325	375,413

Table 37: PM2.5 TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	22,183,138	-	-	-	-	-	1,472,503	61,392,673	-	-	85,048,314
2000	4	30,803,906	-	-	-	-	-	1,574,784	26,526,093	50	-	58,904,837
2005	1	37,225,553	-	-	-	-	-	1,102,219	14,272,858	735	-	52,601,367
2010	14	39,457,418	-	-	-	-	-	211,135	3,360,945	5,225	-	43,034,737
2015	5,417	32,409,351	65,742	2,949	-	-	-	173,365	912,721	23,059	991	33,593,595
2020	17,911	22,053,751	218,071	24,483	-	-	-	95,891	452,039	59,934	7,145	22,929,224
2025	36,520	15,443,878	451,385	120,972	-	-	3,179	16,237	395,589	101,801	30,540	16,600,101
2030	58,708	11,104,342	574,757	351,077	-	-	11,721	12,374	364,606	109,649	83,114	12,670,347

Table 38: NO_x TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	16,683,629	-	-	-	-	-	4,690,292	292,705,606	-	-	314,079,527
2000	5	12,541,418	-	-	-	-	-	6,120,478	124,940,760	297	-	143,602,959
2005	4	7,230,994	-	-	-	-	-	5,086,080	68,301,464	9,383	-	80,627,926
2010	87	4,443,963	-	-	-	-	-	1,694,712	23,255,429	58,696	-	29,452,888
2015	30,903	3,970,399	10,225	461	-	-	-	3,590,624	8,834,094	251,724	10,797	16,699,228
2020	100,832	4,185,369	59,606	7,177	-	-	-	1,933,607	4,857,491	644,782	76,783	11,865,648
2025	203,331	4,094,800	135,216	36,970	-	-	-	317,351	3,817,483	1,083,733	324,820	10,013,704
2030	323,643	3,651,431	176,896	108,317	-	-	-	240,205	3,464,587	1,156,714	875,787	9,997,580

Table 39: CO TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	3,150,628	-	-	-	-	-	579,117	62,272,533	-	-	66,002,278
2000	0	2,134,790	-	-	-	-	-	613,777	28,397,895	20	-	31,146,483
2005	0	1,355,141	-	-	-	-	-	427,924	13,690,808	348	-	15,474,222
2010	3	674,679	-	-	-	-	-	84,615	1,809,554	3,346	-	2,572,197
2015	1,174	434,720	969	44	-	-	-	42,864	666,123	15,410	850	1,162,153
2020	3,850	385,735	5,616	676	-	-	-	18,287	420,682	40,312	6,145	881,302
2025	7,795	364,313	12,688	3,468	-	-	271	2,374	370,456	68,737	26,089	856,191
2030	12,454	323,685	16,538	10,124	-	-	995	1,801	339,765	75,542	71,530	852,433

Table 40: VOC TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	5,046,387	-	-	-	-	-	334	1,141,277	-	-	6,187,998
2000	0	1,421,124	-	-	-	-	-	647	235,907	3	-	1,657,682
2005	0	166,043	-	-	-	-	-	698	36,754	20	-	203,515
2010	0	49,324	-	-	-	-	-	394	12,100	97	-	61,916
2015	52	48,258	125	6	-	-	-	1,586	9,018	386	16	59,447
2020	163	46,908	696	84	-	-	-	1,044	7,359	960	114	57,328
2025	331	43,819	1,565	428	-	-	-	189	6,890	1,669	500	55,390
2030	529	38,349	2,030	1,246	-	-	-	140	6,455	1,836	1,394	51,979

Table 41: SO_2 TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	35,400	-	-	-	-	-	-	889,867	-	-	925,267
2000	3	45,708	-	-	-	-	-	-	2,581,614	41	-	2,627,366
2005	1	51,817	-	-	-	-	-	-	1,779,089	476	-	1,831,383
2010	14	62,571	-	-	-	-	-	-	1,182,758	5,366	-	1,250,708
2015	4,750	68,164	185	8	-	-	-	-	618,316	23,599	1,018	716,041
2020	15,372	70,319	1,072	129	-	-	-	-	440,288	60,325	7,187	594,693
2025	30,688	66,933	2,415	660	-	-	0	-	420,902	100,549	30,139	652,287
2030	48,269	58,966	3,141	1,923	-	-	0	-	387,160	106,192	80,410	686,061

Table 42: NH_3 TTW emissions per fuel technology (kg)

7.3. Progressive scenario

This section can be considered as an annex to 3.2. The results are now displayed more thoroughly in a tabular form.

7.3.1. Fleet composition

	TOTAL
1995	4,239,972
2000	4,644,944
2005	4,878,446
2010	5,207,513
2015	5,437,851
2020	5,580,439
2025	5,742,004
2030	5,916,124

Table 43: Total number of cars

	CNG	Diesel	Diesel hybrid CS	Diesel hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol hybrid CS	Petrol hybrid PHEV	TOTAL
1995	-	1,405,524	-	-	12	-	-	32,629	2,801,807	-	-	4,239,972
2000	1	1,891,009	-	-	66	-	-	64,255	2,689,597	16	-	4,644,944
2005	2	2,454,024	-	-	19	-	-	59,901	2,363,805	695	-	4,878,446
2010	39	3,203,601	-	-	-	-	-	37,520	1,958,102	8,251	-	5,207,513
2015	23,540	3,257,901	86,123	75,808	58,164	2,056	2,056	181,821	1,597,328	95,706	57,348	5,437,851
2020	73,138	2,966,632	240,334	191,149	142,489	4,972	4,972	136,401	1,410,806	246,357	163,189	5,580,439
2025	137,657	2,652,234	373,059	318,925	236,570	6,849	10,735	22,369	1,278,913	382,093	322,600	5,742,004
2030	205,857	2,302,420	415,220	511,916	346,130	22,980	21,260	15,725	1,088,254	411,002	575,360	5,916,124

Table 44: Total number of cars per technology

	Euro 0	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6	TOTAL
1995	3,221,408	1,018,564	-	-	-	-	-	4,239,972
2000	1,807,642	1,063,466	1,614,940	158,896	-	-	-	4,644,944
2005	748,242	723,245	1,295,406	1,964,227	147,326	-	-	4,878,446
2010	3,062	534,960	762,820	1,538,727	2,225,404	142,540	-	5,207,513
2015	-	-	219,657	711,382	1,716,121	2,411,659	379,032	5,437,851
2020	-	-	-	157,456	712,943	1,875,592	2,834,448	5,580,439
2025	-	-	-	-	153,267	819,298	4,769,439	5,742,004
2030	-	-	-	-	-	101,187	5,814,937	5,916,124

Table 45: Total number of cars per euro standard

	0,0l-1,4l	1,4l-2,0l	2,0l-...	TOTAL
1995	1,302,352	2,373,322	564,298	4,239,972
2000	1,347,518	2,753,282	544,144	4,644,944
2005	1,429,280	2,887,121	562,045	4,878,446
2010	1,621,781	2,997,700	588,032	5,207,513
2015	2,172,307	2,830,235	435,309	5,437,851
2020	2,693,678	2,579,814	306,947	5,580,439
2025	3,080,533	2,398,299	263,172	5,742,004
2030	3,331,042	2,325,184	259,898	5,916,124

Table 46: Total number of cars per engine size

2006	2007	2008	2010	2015	2020	2025	2030
51.82	53.85	56.17	58.40	66.01	70.95	73.41	75.15

Table 47: Average ecoscore (unweighted)

	2006	2007	2008	2010	2015	2020	2025	2030
CNG	-	-	70.45	74.79	78.86	79.12	79.23	79.28
Diesel	48.56	51.01	53.47	56.69	65.07	69.49	71.18	71.90
Diesel Hybrid CS	-	-	-	-	77.82	78.20	78.62	79.07
Diesel Hybrid PHEV	-	-	-	-	79.82	80.19	80.64	81.16
Electric	-	-	-	-	82.82	83.14	83.54	84.03
Fuel Cell H2	-	-	-	-	82.70	82.74	82.77	82.73
H2 ICE	-	-	-	-	82.70	82.74	82.75	82.73
LPG	61.06	62.65	65.61	65.73	66.61	67.26	68.44	69.05
Petrol	55.34	57.22	59.61	61.00	64.44	67.55	68.27	68.52
Petrol Hybrid CS	70.72	70.62	71.09	73.37	78.45	79.10	79.52	79.90
Petrol Hybrid PHEV	-	-	-	-	80.82	81.17	81.60	81.92

Table 48: Average ecoscore per technology (unweighted)

7.3.2. Vehicle use

	TOTAL
1995	66,832,777,716
2000	72,487,048,804
2005	74,500,719,217
2010	79,315,275,512
2015	82,627,531,170
2020	85,714,987,302
2025	81,526,667,867
2030	84,941,314,028

Table 49: Total amount of kilometres driven

	Highw	Rural	Urban	TOTAL
1995	20,180,123,013	29,372,470,660	17,280,184,043	66,832,777,716
2000	23,126,920,622	31,342,298,555	18,017,829,627	72,487,048,804
2005	24,379,942,836	31,882,470,269	18,238,306,112	74,500,719,217
2010	26,130,753,803	33,843,702,278	19,340,819,431	79,315,275,512
2015	27,431,756,361	37,151,067,559	18,044,707,250	82,627,531,170
2020	27,904,823,056	38,472,126,193	19,338,038,053	85,714,987,302
2025	26,510,171,551	37,126,989,254	17,889,507,062	81,526,667,867
2030	27,094,283,925	38,495,079,835	19,351,950,268	84,941,314,028

Table 50: Total amount of kilometres driven per road type

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	35,398.45	-	-	0.13	-	-	604.63	30,829.56	-	-	66,832.78
2000	0.02	45,709.21	-	-	0.58	-	-	1,166.95	25,609.81	0.48	-	72,487.05
2005	0.02	51,816.93	-	-	0.17	-	-	1,249.61	21,418.61	15.39	-	74,500.72
2010	0.37	62,569.35	-	-	-	-	-	713.44	15,856.94	175.17	-	79,315.28
2015	220.89	59,418.95	1,893.34	1,682.45	545.75	19.30	19.30	2,968.81	12,594.11	2,027.71	1,236.92	82,627.53
2020	668.71	53,381.82	4,964.17	3,955.59	1,291.83	45.24	45.24	1,961.77	11,219.19	4,906.73	3,274.69	85,714.99
2025	1,215.83	41,603.81	7,336.88	6,397.21	2,062.12	59.01	95.71	338.36	9,016.93	7,157.40	6,243.39	81,526.67
2030	1,773.36	35,731.58	7,818.25	10,218.16	2,979.86	207.84	188.19	260.08	7,520.97	7,240.18	11,002.84	84,941.31

Table 51: Total amount of kilometres driven per technology (mio kilometres)

	Euro0	Euro1	Euro2	Euro3	Euro4	Euro5	Euro6	TOTAL
1995	43,962,207,284	22,870,570,432	-	-	-	-	-	66,832,777,716
2000	15,533,821,791	16,485,907,640	36,847,854,405	3,619,464,968	-	-	-	72,487,048,804
2005	6,665,646,549	8,754,950,192	19,263,391,263	36,950,200,466	2,866,530,747	-	-	74,500,719,217
2010	52,829,474	4,458,471,977	8,479,542,370	22,391,535,805	40,954,819,105	2,978,076,781	-	79,315,275,512
2015	-	-	1,720,730,414	7,467,526,588	24,015,778,759	42,067,748,070	7,355,747,339	82,627,531,170
2020	-	-	-	1,306,582,666	7,802,397,041	26,550,190,539	50,055,817,056	85,714,987,302
2025	-	-	-	-	1,219,797,269	8,305,468,030	72,001,402,568	81,526,667,867
2030	-	-	-	-	-	863,409,691	84,077,904,337	84,941,314,028

Table 52: Total amount of kilometres driven per euro standard

	0.0l-1.4l	1.4l-2.0l	2.0l-...	TOTAL
1995	12,751,387,563	43,267,168,545	10,814,221,608	66,832,777,716
2000	12,485,109,334	50,420,615,031	9,581,324,439	72,487,048,804
2005	14,486,763,280	50,510,126,237	9,503,829,700	74,500,719,217
2010	18,111,297,712	51,621,782,252	9,582,195,548	79,315,275,512
2015	27,270,537,602	48,566,635,921	6,790,357,647	82,627,531,170
2020	35,309,233,729	45,542,569,884	4,863,183,689	85,714,987,302
2025	38,119,528,457	39,431,237,916	3,975,901,494	81,526,667,867
2030	42,102,956,020	38,806,678,787	4,031,679,221	84,941,314,028

Table 53: Total amount of kilometres driven per engine size

7.3.3. Environmental impact

2006	2007	2008	2010	2015	2020	2025	2030
51.79	53.79	55.97	58.61	66.87	71.65	74.27	75.43

Table 54: Average ecoscore (km weighted)

	2006	2007	2008	2010	2015	2020	2025	2030
CNG	-	-	68.72	74.75	78.91	79.21	79.32	79.35
Diesel	49.91	52.25	54.59	57.77	65.73	69.79	71.29	71.51
Diesel Hybrid CS	-	-	-	-	77.79	78.18	78.59	78.29
Diesel Hybrid PHEV	-	-	-	-	79.79	80.17	80.61	80.26
Electric	-	-	-	-	82.74	83.07	83.48	83.18
Fuel Cell H2	-	-	-	-	82.65	82.69	82.72	80.33
H2 ICE	-	-	-	-	82.65	82.69	82.69	80.45
LPG	61.35	62.81	65.54	65.69	66.72	67.39	68.40	68.84
Petrol	56.38	57.94	59.99	61.41	64.75	67.46	68.10	68.32
Petrol Hybrid CS	70.68	70.65	71.22	73.57	78.50	79.10	79.51	79.25
Petrol Hybrid PHEV	-	-	-	-	80.80	81.16	81.58	81.23

Table 55: Average ecoscore per technology (km weighted)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Elec tric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	6,052,616,511	-	-	-	-	-	100,218,770	6,213,950,564	-	-	12,366,785,845
2000	3,758	7,571,664,700	-	-	-	-	-	195,956,191	4,883,391,149	63,246	-	12,651,079,044
2005	2,735	8,320,179,179	-	-	-	-	-	211,148,523	3,962,190,730	2,165,671	-	12,495,686,838
2010	44,524	9,331,362,873	-	-	-	-	-	119,349,500	2,730,110,681	21,729,812	-	12,202,597,391
2015	22,985,966	7,871,818,225	200,020,347	71,103,108	-	-	59,824	457,316,136	1,971,117,244	217,133,086	52,850,130	10,864,404,065
2020	66,546,010	6,657,111,171	504,664,834	160,895,596	-	-	140,257	302,577,777	1,595,634,444	472,939,491	126,034,494	9,886,544,075
2025	120,231,114	5,098,827,237	741,604,741	258,738,866	-	-	296,734	50,486,341	1,006,998,820	548,863,459	191,528,407	8,017,575,718
2030	175,559,453	4,367,680,610	786,799,146	412,468,048	-	-	583,425	37,998,678	668,510,559	441,482,884	268,688,359	7,159,771,163

Table 56: CO_2e TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	5,315,141	-	-	-	-	-	17,986	720,095	-	-	6,053,222
2000	0	3,539,624	-	-	-	-	-	19,194	265,661	1	-	3,824,480
2005	0	2,349,620	-	-	-	-	-	13,556	144,850	13	-	2,508,038
2010	0	1,702,432	-	-	-	-	-	2,650	23,170	145	-	1,728,398
2015	232	743,939	8,146	2,895	-	-	4	3,197	14,321	1,671	408	774,812
2020	703	382,095	21,329	6,798	-	-	10	2,065	11,800	4,033	1,077	429,910
2025	1,275	245,261	31,530	10,997	-	-	20	355	9,457	5,879	2,051	306,824
2030	1,863	199,880	33,557	17,542	-	-	40	273	7,900	5,935	3,607	270,597

Table 57: PM2.5 TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	22,183,138	-	-	-	-	-	1,472,503	61,392,673	-	-	85,048,314
2000	4	30,803,906	-	-	-	-	-	1,574,784	26,526,093	50	-	58,904,837
2005	1	37,225,553	-	-	-	-	-	1,102,219	14,272,858	735	-	52,601,367
2010	14	39,457,418	-	-	-	-	-	211,135	3,360,945	5,225	-	43,034,737
2015	8,523	27,732,100	555,660	197,506	-	-	1,860	164,637	843,387	57,978	14,128	29,575,781
2020	26,031	15,902,076	919,725	299,443	-	-	4,399	91,809	458,529	140,909	37,614	17,880,536
2025	47,126	8,957,103	1,161,203	405,342	-	-	9,270	14,274	350,097	205,143	71,587	11,221,144
2030	69,382	6,603,044	1,179,621	615,814	-	-	18,403	10,991	294,226	208,709	126,900	9,127,090

Table 58: NO_x TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	16,683,629	-	-	-	-	-	4,690,292	292,705,606	-	-	314,079,527
2000	5	12,541,418	-	-	-	-	-	6,120,478	124,940,760	297	-	143,602,959
2005	4	7,230,994	-	-	-	-	-	5,086,080	68,301,464	9,383	-	80,627,926
2010	87	4,443,963	-	-	-	-	-	1,694,712	23,255,429	58,696	-	29,452,888
2015	50,797	3,267,437	83,206	29,575	-	-	-	3,457,741	8,250,863	655,304	159,538	15,954,462
2020	152,295	3,078,702	220,479	70,267	-	-	-	1,872,443	4,956,798	1,565,075	417,716	12,333,776
2025	277,122	2,412,231	323,861	112,958	-	-	-	283,753	3,542,021	2,286,217	797,472	10,035,636
2030	400,471	2,109,561	349,064	182,521	-	-	-	216,283	2,914,694	2,287,585	1,389,728	9,849,907

Table 59: CO TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	3,150,628	-	-	-	-	-	579,117	62,272,533	-	-	66,002,278
2000	0	2,134,790	-	-	-	-	-	613,777	28,397,895	20	-	31,146,483
2005	0	1,355,141	-	-	-	-	-	427,924	13,690,808	348	-	15,474,222
2010	3	674,679	-	-	-	-	-	84,615	1,809,554	3,346	-	2,572,197
2015	1,909	349,351	8,064	2,866	-	-	167	39,236	627,097	38,542	12,021	1,079,252
2020	5,759	285,084	21,199	6,757	-	-	390	16,947	434,475	95,293	33,021	898,924
2025	10,475	220,952	31,254	10,900	-	-	825	2,012	361,048	142,561	64,179	844,206
2030	15,229	191,614	33,408	17,465	-	-	1,616	1,550	304,870	147,551	113,552	826,856

Table 60: VOC TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	5,046,387	-	-	-	-	-	334	1,141,277	-	-	6,187,998
2000	0	1,421,124	-	-	-	-	-	647	235,907	3	-	1,657,682
2005	0	166,043	-	-	-	-	-	698	36,754	20	-	203,515
2010	0	49,324	-	-	-	-	-	394	12,100	97	-	61,916
2015	83	41,566	1,056	375	-	-	-	1,520	8,852	982	239	54,673
2020	242	35,123	2,664	849	-	-	-	1,005	7,648	2,285	609	50,425
2025	436	26,897	3,914	1,366	-	-	-	166	6,222	3,431	1,197	43,630
2030	637	23,037	4,152	2,177	-	-	-	125	5,305	3,556	2,164	41,154

Table 61: SO_2 TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
1995	-	35,400	-	-	-	-	-	-	889,867	-	-	925,267
2000	3	45,708	-	-	-	-	-	-	2,581,614	41	-	2,627,366
2005	1	51,817	-	-	-	-	-	-	1,779,089	476	-	1,831,383
2010	14	62,571	-	-	-	-	-	-	1,182,758	5,366	-	1,250,708
2015	7,930	59,420	1,574	559	-	-	0	-	620,243	62,352	15,211	767,290
2020	23,550	53,383	4,116	1,312	-	-	0	-	482,166	148,007	39,510	752,045
2025	42,607	41,605	6,093	2,125	-	-	0	-	399,387	214,944	74,982	781,743
2030	60,800	35,733	6,476	3,386	-	-	0	-	330,397	212,771	129,275	778,838

Table 62: NH_3 TTW emissions per fuel technology (kg)

7.4. Visionary scenario

7.4.1. Vehicle use

Highw	Rural	Urban	TOTAL
16,747,611,016	27,711,030,681	7,749,790,125	52,208,431,822

Table 63: Total amount of kilometres driven per road type

electric	petrol hybrid CS	petrol hybrid PHEV	diesel hybrid CS	diesel hybrid PHEV	TOTAL
7,749,790,125	11,084,412,272	16,626,618,409	10,048,566,610	6,699,044,406	52,208,431,822

Table 64: Total amount of kilometres driven per technology

7.4.2. Environmental impact

2060
82.49

Table 65: Average ecoscore (km weighted)

	CO2e	PM2,5	NOx	CO	VOC	SO2	NH3
electric	-	-	-	-	-	-	-
petrol hybrid CS	603,465,740	7,414	352,825	2,082,614	216,639	4,864	260,053
petrol hybrid PHEV	362,119,411	4,448	211,695	1,249,570	167,943	2,919	156,042
diesel hybrid CS	985,728,418	48,354	2,023,131	188,298	39,955	5,206	9,295
diesel hybrid PHEV	262,882,627	12,894	539,502	50,208	10,654	1,388	2,479
TOTAL	2,214,196,196	73,110	3,127,154	3,570,689	435,191	14,377	427,869

Table 66: TTW emissions per fuel technology (kg)

7.5. Scenario comparison

This section can be considered as an annex to chapter 4.

7.5.1. Fleet composition

	baseline	realistic	progressive
2020	5,746,763	5,633,480	5,580,439
2030	6,051,956	5,818,109	5,916,124

Table 67: Total number of cars

	CNG	Diesel	Diesel hybrid CS	Diesel hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol hybrid CS	Petrol hybrid PHEV	TOTAL
baseline_2020	24,372	3,939,701	64,784	18,018	-	-	-	17,220	1,519,068	134,161	29,439	5,746,763
realistic_2020	51,125	3,889,549	63,569	18,587	-	-	-	136,572	1,336,407	107,177	30,494	5,633,480
progressive_2020	73,138	2,966,632	240,334	191,149	142,489	4,972	4,972	136,401	1,410,806	246,357	163,189	5,580,439
baseline_2030	83,004	3,378,335	215,426	281,198	127,957	14,351	12,597	15,041	1,262,850	308,542	352,655	6,051,956
realistic_2030	168,804	3,309,345	201,016	284,017	130,790	14,711	12,876	15,018	1,110,440	211,403	359,689	5,818,109
progressive_2030	205,857	2,302,420	415,220	511,916	346,130	22,980	21,260	15,725	1,088,254	411,002	575,360	5,916,124

Table 68: Total number of cars per technology

	Euro 0	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6	TOTAL
baseline_2020	-	-	-	277,945	1,190,314	1,804,505	2,473,999	5,746,763
realistic_2020	-	-	-	229,476	997,969	1,839,062	2,566,973	5,633,480
progressive_2020	-	-	-	157,456	712,943	1,875,592	2,834,448	5,580,439
baseline_2030	-	-	-	-	-	190,424	5,861,532	6,051,956
realistic_2030	-	-	-	-	-	151,914	5,666,195	5,818,109
progressive_2030	-	-	-	-	-	101,187	5,814,937	5,916,124

Table 69: Total number of cars per euro standard

	0,0l-1,4l	1,4l-2,0l	2,0l-...	TOTAL
baseline_2020	2,458,962	2,916,489	371,312	5,746,763
realistic_2020	2,388,129	2,905,534	339,817	5,633,480
progressive_2020	2,693,678	2,579,814	306,947	5,580,439
baseline_2030	3,104,700	2,664,591	282,665	6,051,956
realistic_2030	2,974,594	2,578,068	265,447	5,818,109
progressive_2030	3,331,042	2,325,184	259,898	5,916,124

Table 70: Total number of cars per engine size

	baseline	realistic	progressive
2020	68.50	69.08	70.95
2030	73.22	73.37	75.15

Table 71: Average ecoscore (unweighted)

7.5.2. Vehicle use

	baseline	realistic	progressive	visionary
2020	90,104,118,929	87,812,046,627	85,714,987,302	-
2030	93,735,449,770	91,748,869,089	84,941,314,028	-
2060	-	-	-	52,208,431,822

Table 72: Total amount of kilometres driven

	Highw	Rural	Urban	TOTAL
baseline_2020	28,538,709,235	38,845,011,636	22,720,398,058	90,104,118,929
realistic_2020	27,811,931,394	37,855,703,422	22,144,411,811	87,812,046,627
progressive_2020	27,904,823,056	38,472,126,193	19,338,038,053	85,714,987,302
baseline_2030	28,915,939,274	40,535,617,915	24,283,892,581	93,735,449,770
realistic_2030	28,302,696,038	39,676,325,798	23,769,847,253	91,748,869,089
progressive_2030	27,094,283,925	38,495,079,835	19,351,950,268	84,941,314,028
visionary_2060	16,747,611,016	27,711,030,681	7,749,790,125	52,208,431,822

Table 73: Total amount of kilometres driven per road type

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
baseline_2020	220.05	72,241.03	1,394.85	396.50	-	-	-	326.71	12,262.74	2,651.55	610.69	90,104.12
realistic_2020	449.57	70,318.42	1,301.77	391.85	-	-	-	2,030.85	10,644.58	2,060.79	614.22	87,812.05
progressive_2020	668.71	53,381.82	4,964.17	3,955.59	1,291.83	45.24	45.24	1,961.77	11,219.19	4,906.73	3,274.69	85,714.99
baseline_2030	703.50	59,333.40	4,061.51	5,762.21	1,141.69	131.05	112.59	283.49	9,929.32	5,424.04	6,852.64	93,735.45
realistic_2030	1,460.20	58,966.88	3,824.34	5,852.67	1,183.22	135.54	116.63	290.69	9,069.07	3,748.50	7,101.13	91,748.87
progressive_2030	1,773.36	35,731.58	7,818.25	10,218.16	2,979.86	207.84	188.19	260.08	7,520.97	7,240.18	11,002.84	84,941.31
visionary_2060	-	-	10,048.57	6,699.04	7,749.79	-	-	-	-	11,084.41	16,626.62	52,208.43

Table 74: Total amount of kilometres driven per technology (mio kilometres)

	Euro0	Euro1	Euro2	Euro3	Euro4	Euro5	Euro6	TOTAL
baseline_2020	-	-	-	2,746,723,333	14,512,095,294	27,291,630,235	45,553,670,067	90,104,118,929
realistic_2020	-	-	-	2,221,989,308	12,067,764,158	27,567,413,564	45,954,879,597	87,812,046,627
progressive_2020	-	-	-	1,306,582,666	7,802,397,041	26,550,190,539	50,055,817,056	85,714,987,302
baseline_2030	-	-	-	-	-	2,040,504,851	91,694,944,919	93,735,449,770
realistic_2030	-	-	-	-	-	1,687,985,771	90,060,883,318	91,748,869,089
progressive_2030	-	-	-	-	-	863,409,691	84,077,904,337	84,941,314,028
visionary_2060	-	-	-	-	-	-	52,208,431,822	52,208,431,822

Table 75: Total amount of kilometres driven per euro standard

	0.0l-1.4l	1.4l-2.0l	2.0l-...	TOTAL
baseline_2020	32,240,500,727	52,001,886,856	5,861,731,346	90,104,118,929
realistic_2020	31,224,826,800	51,195,758,397	5,391,461,430	87,812,046,627
progressive_2020	35,309,233,729	45,542,569,884	4,863,183,689	85,714,987,302
baseline_2030	41,409,411,368	47,698,830,305	4,627,208,097	93,735,449,770
realistic_2030	40,350,695,418	46,949,036,332	4,449,137,339	91,748,869,089
progressive_2030	42,102,956,020	38,806,678,787	4,031,679,221	84,941,314,028

Table 76: Total amount of kilometres driven per engine size

7.5.3. Environmental impact

	baseline	realistic	progressive	visionary
2020	69.16	69.59	71.65	-
2030	73.73	73.77	75.43	-
2060	-	-	-	82.49

Table 77: Average ecoscore (km weighted)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Elec tric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
baseline_2020	22,029,571	9,231,424,974	141,364,343	16,048,979	-	-	-	49,318,431	1,865,476,926	270,217,534	24,750,775	11,620,631,534
realistic_2020	45,043,924	8,892,225,802	131,913,896	15,861,583	-	-	-	314,205,999	1,534,661,727	198,708,357	23,533,950	11,156,155,237
progressive_2020	66,546,010	6,657,111,171	504,664,834	160,895,596	-	-	140,257	302,577,777	1,595,634,444	472,939,491	126,034,494	9,886,544,075
baseline_2030	70,204,727	7,331,815,951	408,876,345	232,651,621	-	-	349,059	41,589,431	1,467,660,443	546,977,780	276,734,435	10,376,859,792
realistic_2030	145,763,971	7,272,648,840	384,701,819	236,237,465	-	-	361,546	42,637,111	813,527,344	228,008,551	173,042,389	9,296,929,036
progressive_2030	175,559,453	4,367,680,610	786,799,146	412,468,048	-	-	583,425	37,998,678	668,510,559	441,482,884	268,688,359	7,159,771,163
visionary_2060	-	-	985,728,418	262,882,627	-	-	-	-	-	603,465,740	362,119,411	2,214,196,196

Table 78: CO_2e TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
baseline_2020	233	649,121	5,980	680	-	-	-	347	13,002	2,177	201	671,740
realistic_2020	477	555,387	5,581	672	-	-	-	2,155	11,287	1,692	202	577,453
progressive_2020	703	382,095	21,329	6,798	-	-	10	2,065	11,800	4,033	1,077	429,910
baseline_2030	746	334,211	17,386	9,866	-	-	24	301	10,530	4,440	2,243	379,748
realistic_2030	1,549	332,129	16,371	10,021	-	-	25	308	9,618	3,069	2,325	375,413
progressive_2030	1,863	199,880	33,557	17,542	-	-	40	273	7,900	5,935	3,607	270,597
visionary_2060	-	-	48,354	12,894	-	-	-	-	-	7,414	4,448	73,110

Table 79: PM2.5 TTW emissions per fuel technology (kg)

	CNG	Diesel	Diesel Hybrid CS	Diesel Hybrid PHEV	Electric	Fuel Cell H2	H2 ICE	LPG	Petrol	Petrol Hybrid CS	Petrol Hybrid PHEV	TOTAL
baseline_2020	8,767	24,114,642	232,933	24,734	-	-	-	15,432	518,985	77,120	7,104	24,999,717
realistic_2020	17,911	22,053,751	218,071	24,483	-	-	-	95,891	452,039	59,934	7,145	22,929,224
progressive_2020	26,031	15,902,076	919,725	299,443	-	-	4,399	91,809	458,529	140,909	37,614	17,880,536
baseline_2030	28,288	11,239,397	610,705	345,641	-	-	11,318	12,068	399,249	158,700	80,220	12,885,586
realistic_2030	58,708	11,104,342	574,757	351,077	-	-	11,721	12,374	364,606	109,649	83,114	12,670,347

progressive_2030	69,382	6,603,044	1,179,621	615,814	-	-	18,403	10,991	294,226	208,709	126,900	9,127,090
visionary_2060	-	-	2,023,131	539,502	-	-	-	-	-	352,825	211,695	3,127,154

Table 80: NO_x TTW emissions per fuel technology (kg)