The Consumer Voice in Europe

CO_2 emissions target for passenger cars for 2025: delivering value to consumers

Long version

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Executive summary

In July 2012, the European Commission proposed a mandatory CO_2 emissions target of 95 g CO_2 for new passenger cars to be achieved by the year 2020. The legislative proposal confirming this target is currently going through the ordinary legislative procedure in order to become binding. In a recent BEUC position paper[1] we welcomed the 2020 emission target as we expect this target to reduce CO_2 emissions of the transport sector, reduce the dependence on foreign oil imports, protect consumers from steady increases in fuel prices and prevent further air quality pollution.

There is, however, a clear lack of a post 2020 vision in the Commission proposal. In order to protect consumers from further increases in fuel prices, and in order to ensure that manufacturers have sufficient lead time, we see value in introducing an indicative 2025 target of 70 g CO_2/km in the revision of Regulation 443/2009, which must be subject to confirmation of its feasibility on the basis of an updated impact assessment at a later stage. Fuel prices are a major worry for EU consumers and we support ambitious targets to reduce CO_2 emissions that would deliver fuel price benefits where these outweigh the additional costs linked to more expensive car technology incurred by consumers.

The target should be confirmed unless an alteration of the target is duly justified in the light of the results of the impact assessment and the modalities to reach the target should be proposed by the European Commission in the legislative proposal at a later stage. We consider that this must include a full assessment of the financial costs and benefits for consumers, which takes advantage of a transparent and reliable cost-benefit analysis preferably based on a combination of sophisticated vehicle computer simulations and tear-down cost assessments. In addition, any proposal must be prepared on the basis of an effective analysis of the social impact on different consumer segments, as well as a thorough empirical evaluation of the public acceptability of setting such targets. BEUC calls for a robust assessment based on these factors. To inform this debate, in this paper we have conducted an initial analysis on the evidence available at this stage.

Studies suggest that emissions could be lowered to 75 g CO_2/km without the need to sell ultra-low carbon vehicles. However, for a 2025 target of 70 g CO_2/km we believe a share of ultra-low carbon vehicles in new car sales of up to 10% would be required, on top of the emissions reductions from the remaining 90% of conventional powertrains down to 75 g CO_2/km. This level of market penetration is at the low end of numerous market share projections. We suggest the level of 70 g CO_2/km as an indicative target to therefore ensure that at least a small percentage of new car sales in 2025 would need to be covered by ultra-low carbon vehicles.

Our analysis, based primarily on recent work by the International Council for Clean Transportation (ICCT), suggests that, relative to the baseline of 130 g CO_2/km that manufacturers must achieve as an average CO_2 emission target by 2015, lowering emissions of cars powered by an internal combustion engine (ICE) down to 75 g would lead to average fuel savings of up to 643 Euros per year for consumers. The payback period for the additional increase in retail price of cars powered by an ICE would be approximately 3.6 years, ranging from 1.9 to 5.2 years, depending on the vehicle segment. However, the payback period for the share of the increase in purchase price that the first owner has to bear would be on average around 2.3 years, with a range of 1.2 to 3.2 years.

[1] BEUC (2012): Good for the environment and good for your pocket: Consumer benefits of CO_2 emissions target, short version: http://docshare.beuc.org/Common/GetFile.asp?ID=43390&mfd=off&LogonName=GuestEN, long version: http://docshare.beuc.org/Common/GetFile.asp?ID=43385&mfd=off&LogonName=GuestEN

Despite the higher initial purchase price of ultra-low carbon vehicles, several studies suggest that by 2025, their total cost of ownership equation could become even favourable over conventional cars. Up to 2025, demand will be driven mostly by "early adopter segments", particularly those which have a clear perspective on the vehicle's total cost of ownership such as purchasers of governmental and company fleets, taxis, car-sharing schemes, etc. The initial market pull from these market segments could provide the scale economies to make the new technologies more cost-effective also for the general consumer group in the long run.

Finally, it will be fundamental to make use of footprint as the parameter for determining the limit values in 2025, in order to encourage manufacturers to invest into light weighting, which will make the necessary CO_2 reductions achievable in a more economical way.

1. The need to set a long-term CO_2 emissions target for 2025

With large increases in fuel costs, studies show that high fuel prices and car running costs are now a significant issue to European consumers.[2] In addition, research shows that the level of fuel consumption of a car has become a highly relevant criterion in consumers' purchasing decisions.[3] However, even though consumers more and more take the level of fuel consumption of a car into account, research still shows that consumers substantially undervalue future fuel costs at the time of car purchase and often do not take account of rising fuel costs.[4]

There are several market failures discussed in literature, on both the supply and the demand side, which prevents that fuel economy improvements are valued to that extent that would easily pay for themselves through future fuel savings (see Annex 2). A package of different policies will be necessary in order to tackle such kind of market imperfections: we consider particularly CO_2 emissions standards, fiscal and information programs to be complementary measures. Taxes at the point of vehicle purchase can provide a strong signal to car buyers to opt for more fuel efficient cars. In addition, disclosing information about fuel consumption and CO_2 emissions information should help consumers to make a more informed purchase decision. However, the current implementation of Directive 1999/94/EC, which requires that buyers of new cars must be provided with information about the fuel consumption and CO_2 emissions of cars at the point of sales and through marketing materials, has not guaranteed that all European consumers are given clear and comparable information.[5] Unfortunately, any plans to improve information for car buyers by revising Directive 1999/94/EC were notably absent in the European Commission work programme for 2013.

Even though better designed information and taxation instruments should help overcome some market failures, fuel efficiency will not be driven by consumer choice alone. We therefore consider government intervention in form of CO_2 emission standards as essential in order to drive the uptake of more fuel efficient vehicles.

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[2] A survey by Which? (February 2013), for instance showed that 86% of UK consumers are worried about the increase in fuel prices, making it their number one financial concern. See Annex 1 for more information.

[3] According to a UK study, fuel economy/running costs, size/practicality and vehicle price were the three most important factors considered among UK consumers, see LowCVP Car Buyer Survey (2010): Improved environmental information for consumers, Research conducted by Ecolane & Sustain on behalf of the Low Carbon Vehicle Partnership – June 2010. http://www.lowcvp.org.uk/assets/reports/LowCVP-Car-Buyer-Survey-2010-Final-Report-03-06-10-vFINAL.pdf). Another study by the German Energy Agency (DENA) also claims that fuel consumption is a main criterion for German car buyers, see German Energy Agency (2012): http://www.dena.de/presse-medien/pressemitteilungen/dena-umfrage-autohaendler-unterschaetzen-potenzial-des-pkw-labels.html.

[4] Research shows that consumers strive to recover any extra expenditure on fuel economy through lower fuel expenditures within three years, much shorter than the expected lifetime (or usage time plus resale value) of a car. For instance, a study by Potogloe, D and Kanaroglou, P.S. (2007) measured Canadian consumer's willingness to pay for a cleaner vehicle. This showed that consumers were willing to pay 2200-5300 dollars extra to save 1000 dollar per year on fuel. This would indicate that a payback (on fuel savings) of 2.2 – 5.3 years would be acceptable for consumers. The Consumer Federation of America has done a poll in September 2010 which showed that a majority of consumers (62%) say they would pay more for a new fuel-efficient car if they recouped the added expense within a five-year payback period. A study by Alcott and Wozny (2009) suggests that consumers consider fuel savings from efficiency improvements over approximately three years and the Energy Information Administration´s National Energy Modeling System assumes that new auto buyers use payback periods of three to five years. Finally, Greene et al. (2005 a,b) examine feebate policies using base assumptions in which consumers consider the fuel savings for just three years.

[5] See Annex 2 for more information.

In this respect, important regulatory measures have been adopted including the obligation for car manufacturers to reduce CO_2 emissions from cars in a step wise approach.[6] The EU Regulation No. 443/2009 on passenger cars sets a target of 95 g CO_2/km for the new car fleet for the year 2020. However, up to date, this target is only provisional. A review has been carried out by the European Commission in order to define the modalities of reaching this target. The legislative proposal confirming this target has been presented in 2012 and is currently going through the ordinary legislative procedure in order to become binding.

In order to achieve the goal to dramatically reduce emissions from passenger car transport by 60% by the year 2050 compared to a 1990 baseline as suggested by the new White Paper on Transport[7], it is fundamental however not only to set intermediate goals for 2020 but also for 2025 as early as possible in order to give industry enough time to prepare for the necessary changes.[8] The target of 95 g CO_2/km was already discussed and set in 2008, therefore clarified 12 years before making this limit mandatory. Technological progress in recent years has made the target of 95 g achievable with considerable financial gains for consumers. Setting a target now for 2025 would therefore follow the same logic and guarantee that manufacturers and suppliers would be provided with planning and investment certainty while consumers would be protected against the very likely increase in fuel prices. High and ever increasing fuel prices are a real threat to consumers and spikes in fuel prices cause immediate and financial pain for many consumers; a target for 2025 would therefore make consumers less vulnerable towards significant increases in fuel prices[9], if set at the appropriate level and appropriately designed.

A long-term target would:

- Provide considerable financial gains to consumers
- Provide considerable health benefits to consumers
- Protect consumers against the very likely increase in fuel prices
- Guarantee that manufacturers and suppliers would be provided with planning and investment certainty
- Incentivize the development of ultra-low carbon vehicles

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[6] Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles (23 April 2009).

[7] http://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.htm

[8] According to the impact assessment by the European Commission, "the automotive industry works to planning cycles that suggest to need to know approximately 10 years in advance the broad framework within which vehicles need to be designed, and a shorter period of around five years to more precise decisions on variants that will actually be produced", see Impact assessment accompanying the Commission proposal SWD/2012/213: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52012SC0213:EN:NOT.

[9] See Annex 3 for the development of fuel prices between 2005 and 2013.

This is of vital importance since many consumers highly depend on car transport: Passenger cars accounted for 83.3% of inland passenger transport in 2008 as measured by the number of inland passenger-kilometres travelled.[10] In countries such as Germany and the UK, more than 82% and 75%, respectively, of all households own at least one car.[11] Car dependency in rural areas, where there is a lack of public transportation infrastructure, is even higher.[12] As consumers predominantly rely on their cars for transport purposes, they see their purchasing power eroding by having to spend more and more of their income on fuel because of increases in fuel prices. This is of major concern as an increasing number of drivers are on risk to become socially excluded.[13]

2. A portfolio of technologies necessary to achieve a long-term target in 2025

Potential efficiency gains until 2025 can be brought about by:

- Further improvements of cars powered by an internal combustion engine;
- New technologies allowing extremely low emissions (“ultra-low carbon vehicles”), including plug-in hybrid electric vehicles (PHEVs)[14], battery electric vehicles (BEVs)[15], range extender electric vehicles (REEX)[16] and fuel cell electric vehicles (FCEVs).

In order to evaluate the potential for efficiency gains both approaches should be analysed in combination.

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10 Furthermore, in 2009, there were 473 passenger cars for 1000 inhabitants in the EU corresponding to a vehicle stock of 236.1 million passenger cars; see Eurostat (2012) : http://epp.eurostat.ec.europa.eu/tgm/table.do?tab?table&init=1&plugin=1&language=en&pcode=tsdpc340.

11 RAC Foundation (2013): http://www.racfoundation.org/assets/rac_foundation/content/downloadables/factsheet_on_fuel_cars_and_drivers.pdf; ADAC (2010): http://www.adac.de/_mmm/pdf/statistik_mobilitaet_in_deutschland_0111_46603.pdf.

12 In the UK for instance, 91% of rural households own at least one car, compared to 57% of households in London and 68% in other metropolitan areas. See RAC Foundation (2013) for more information. For many people living in rural areas, mobility is just not possible without a car due to a lack of sufficient infrastructure to guarantee independent travel.

13 See RAC report on motoring (2012): 9% of drivers in the UK have already restricted their social life due to rising costs and 29% of drivers would consider doing this in case motoring costs increase in the future.

14 A plug-in hybrid electric vehicle (PHEV) is a hybrid vehicle with batteries that can be recharged by connecting the car to the grid and an ICE that can be used when batteries need recharging. A PHEV can essentially be operated as an electric vehicle with an internal combustion engine as a backup.

15 A pure electric vehicle is a car equipped with a bigger sized battery and is solely operated in electric mode, i.e. run solely on an on-board rechargeable battery system. A battery-only electric vehicle therefore does not have any ICE as it only derives all its power from its battery packs, which can be recharged on the electricity grid.

16 Range extended electric vehicles are similar to plug-in hybrid electric vehicles as they also have an ICE and at least one electric motor. In the range extended electric vehicle, the ICE is used for a stabilisation of the charge of the battery.

2.1. Further improvement of cars powered by an internal combustion engine

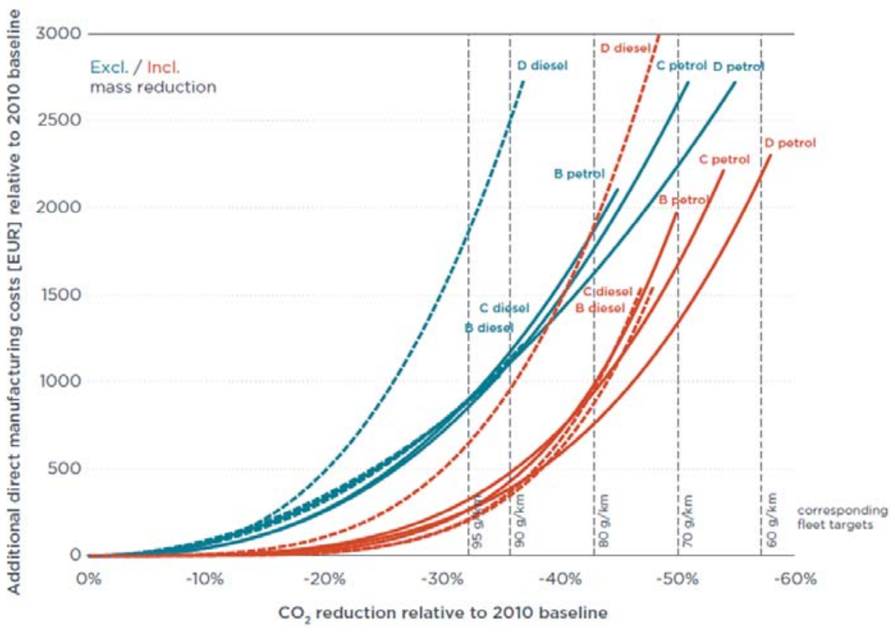
- Emissions could be brought to an average fleet level of at least 75 g CO_2/km without the necessity of a market penetration of ultra-low emitting cars.
- A further decarbonisation below 75 g CO_2/km might require the development of a range of new technologies.

A recent study by Cambridge Econometrics and Ricardo-AEA[17] showed that further improvements of combustion engines including hybridisation can lower CO_2 emissions down to 75 g CO_2/km by 2025 (i.e. no ultra-low carbon vehicles will be necessary). The analysis showed that the average cost of lowering CO_2 emissions to 75 g CO_2/km in 2025 would amount to €1494 in 2025 relative to the 2010 level of 140 g CO_2/km.

This is comparable to the results of a recent study authored by the International Council on Clean Transportation (2013)[18] which showed that when the CO_2 emission reduction benefit of mass reduction technology is fully credited, a target of 75 g CO_2/km could be achieved by applying existing technology (conventional powertrains including hybridisation) at a limited additional cost of €1600 relative to the 2010 baseline of 140 g CO_2/km.

Figure 1 shows that cost curves differ across the different vehicle segments included in the simulation model by the ICCT, which constitute distinct product markets. The maximum CO_2 reduction potential for the different segments is subject to the technologies included in the cost curve[19], leading to different endpoints. The maximum CO_2 reduction potential that all segments can simultaneously achieve is about 47% relative to the 2010 baseline.

Figure 1: Additional direct manufacturing costs (ICCT study)



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[17] Cambridge Econometrics and Ricardo-AEA (2013): An economic assessment of low carbon vehicles.

[18] ICCT (2013): CO_2 reduction technologies for the European car and van fleet, a 2020-2025 assessment – summary of mass reduction impacts on EU cost curves. Working paper 2013-1 (http://www.theicct.org/mass-reduction-impacts-eu-cost-curves).

[19] For instance, for C class petrol vehicles, P2 hybrid technology was included in the cost curve estimation as this technology proved to be a cost effective measure whereas for C class diesel vehicles, P2 hybrid technology was not included in the cost curve construction, see http://www.theicct.org/mass-reduction-impacts-eu-cost-curves.

To sum up, when assuming no market shifts, emissions could be brought to an average fleet level of at least 75 g CO_2/km without the necessity of a market penetration of ultra-low emitting cars. When assuming market shifts, such as from diesel to petrol vehicles, higher CO_2 reductions could even be possible and costs might be even lower. Assuming no market shifts, a further decarbonisation below 75 g CO_2/km however might require the development of a range of new technologies.

2.2. Forecast of the future market penetration of ultra-low carbon vehicles

The forecast of the future growth and market penetration of ultra-low carbon vehicles involves great uncertainties and is depending on a great number of different influencing factors, including the development of fuel and electricity prices, costs of battery technology, etc. The range of market shares of ultra-low carbon vehicles in the 2025 time period diverges extensively among the reviewed studies (i.e. ranging from 7.7% in the Oliver Wyman study[20] to 54% in the EV breakthrough scenario of the CE Delft study[21]), depending on the assumption regarding the development of battery prices, government support, etc. Annex 4 lists the annual sales projections of different studies, which include both market forecasts and scenarios.

3. The potential consumer benefits of a market penetration of ultra-low carbon vehicles

We suggest that an indicative target of long-term CO_2 emissions targets for new passenger cars for 2025 is included in the revision of EU Regulation No 443/2009, subject to a review clause that this target needs to be reconfirmed at a later stage. It should be subject to an impact assessment based on the most transparent, reliable, sophisticated and up-to-date evidence to assess cost implications and payback periods for consumers, as well as an thorough empirical evaluation of the public acceptability of setting such targets.

As shown above, studies by the ICCT and Cambridge Econometrics and Ricardo-AEA have shown that a target of 75 g CO_2/km could be achieved without the need to sell ultra-low carbon vehicles.[22] In this paper, we make use of the recent ICCT study to explore the cost impacts and payback periods of consumers of lowering emissions powered by conventional powertrains. When assuming no market shifts, a target of 70 g CO_2/km or below should ensure that at least a small part of the market must be covered by ultralow carbon vehicles, to spur their development.

Developing ultra-low carbon vehicles, coupled with a decarbonisation of the electricity mix, will help achieve the EU target of significantly reducing CO_2 emissions from transport by 2050. In addition, reduction in harmful substances from combustion engines would lead to significant health benefits for consumers.[23] The reason for that is that ultra-low carbon vehicles will lead to immense

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[20] Oliver Wyman (2011): E-mobility 2025 – power play with electric cars. http://www.oliverwyman.com/media/ManSum_E-Mobility_2025_e.pdf.

[21] CE Delft 2011: http://www.cedelft.eu/publicatie/impact_of_electric_vehicles/1153.

[22] However, even though manufacturers will be able to meet the standards without the need to sell ultra-low carbon vehicles, they still could decide to produce more advanced powertrains depending on the internal company strategy.

[23] Electrical vehicles do not emit any harmful particles from the tailpipe as the electricity used is usually generated further from population centres. Conventional fuel combustion on the other hand produces gases and particles that have a significant impact on consumers' health. For instance, emissions from diesel burning engines significantly increase the risk of allergic and asthmatic reactions. It was recently announced by the World Health Organisation that exhausts from diesel engines even can cause cancer, see: http://www.euro.who.int/_data/assets/pdf_file/0003/87573/E72015.pdf.

improvements in the quality of air particularly in city areas as there are no localised emissions. According to the World Health Organisation (WHO), over 80% of Europeans are exposed to particulate matter (PM) levels above the 2005 WHO Air Quality Guidelines (AQGs).[24] On average, this deprives each European citizen of 8.6 months of life. A recent study (2010 Global Burden of Disease assessment) has shown that air quality has been recognized as one of the most important risk factors for public health (ranked 11th for countries of Western Europe). According to this study, exposure to fine particulate matter leads to over 430,000 premature deaths and 7 million years of healthy life lost in Western, Central and Eastern Europe (including Russia).[25] However, depending on the type of power generation supplying the electricity for such kind of vehicles, air pollution from power plants can still occur, but are usually located outside of the urban agglomeration. Still, a decarbonisation of the electricity mix must go hand in hand with the market penetration of electric vehicles in order to achieve the full health benefits for consumers. It would also help reducing noise pollution from traffic, which is also a significant driver of health problems.

To sum up, vehicle electrification offers many advantages over conventional combustion engines, such as lower running costs and improved local air quality. Nevertheless, there is still a high number of barriers hindering a fast market expansion of ultra-low carbon vehicles. Limitations include a limited all-electric drive range, long recharging times of the battery, high initial costs of the battery and the development of charging infrastructure, as well as a lack of sufficient recharging infrastructure and the cost of any additional electricity generation. In addition, it must be taken into account that ultra-low carbon vehicles do no emit any or only few emissions at the tailpipe, but significant CO_2 emissions could arise from the production of electricity. It is therefore important that a parallel decarbonisation of the electricity mix takes place. In addition, for the period after 2025 it is thus necessary that the European Commission should take into consideration metrics that take into account also upstream greenhouse emissions.

In order to incentivize the development of ultra-low carbon vehicles, we would propose, at this stage and based on existing analysis, an indicative 2025 target of 70 g CO_2/km to be included in the revision of Regulation 443/2009. The target should be confirmed and the modalities to reach the target should be proposed by the European Commission in a legislative proposal at a later stage, subject to a thorough impact assessment, including a detailed analysis of the cost-benefit impact on consumers, as well as a thorough empirical evaluation of the public acceptability of setting such targets.

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[24] According to the World Health Organization (WHO), long-term exposure to fine particles (PM2.5) can trigger atherosclerosis, adverse birth outcomes and childhood respiratory diseases. In addition, the review by the WHO also points towards a potential relationship of air pollution to neurodevelopment, cognitive function and diabetes, and strengthens the causal link between PM2.5 and cardiovascular and respiratory deaths (http://www.euro.who.int/en/what-we-publish/information-for-the-edia/sections/latest-press-releases/newly-found-health-effects-of-air-pollution-call-for-stronger-european-union-air-policies#.UQprNBLW6yA.twitter).

[25] Global burden of disease study (2010): http://www.thelancet.com/themed/global-burden-of-disease. Health and environment alliance (2012: http://www.env-health.org/resources/press-releases/article/air-pollution-ranked-as-top-health.

We assume that conventional powertrains (including hybridisation) will need to reduce emissions down to an average emissions level of 75 g CO_2/km whereas the share of 10% of ultra-low carbon vehicles will deliver the remaining emission reduction of 5 g.[26] The share of ultra-low carbon vehicles (including plug-in hybrids, range extender and battery electric vehicles) which are necessary to meet this indicative target therefore easily fall within the scope of the market projections as outlined above.

- BEUC proposes an indicative 2025 target of 70 g CO_2/km
- The precise target should be proposed by the European Commission in a legislative proposal at a later stage, subject to a thorough impact assessment

4. Cost-benefit analysis for cars powered by an internal combustion engine

The following analysis shows that lowering emissions of cars powered by conventional powertrains down to 75 g CO_2/km relative to the baseline of 130 g CO_2/km in 2015[27] would lead to significant fuel savings for consumers: The average private European motorist driving a diesel or petrol car would benefit from fuel savings of approximately 643 Euros a year. The payback period for the additional increase in retail price would be approximately 3.6 years.

However, a typical European private motorist sells the car after a holding period of five years. Approximately a third of the higher purchase price can be passed on to the used car buyer and only two thirds of the higher price needs to be paid by the new car owner. We therefore assume that the share of the potential higher purchase price that the typical new car buyer has to bear is below 2.3 years. The average payback period for the share of the potential higher purchase price that the typical used car buyer has to bear is approximately only 1.4 years.

4.1. Additional average manufacturing costs for cars powered by an internal combustion engine

In order to calculate the additional average manufacturing costs for cars powered by an internal combustion engine (ICE) for bringing down average fleet emissions to a level of 75 g CO_2/km, we base our analysis on the data by the International Council on Clean Transportation (ICCT)[28] where in a recent published study the possibility of mass reduction was integrated into the EU cost curve analysis.[29] The cost of CO_2 standard compliance is lower when assuming that mass reduction technology is fully creditable.

The study by the ICCT for the European vehicle market is based on most recent data and assessment methodologies originally developed for the US Environmental Protection Agency (EPA). The study is based on existing technology studies that were performed in preparation for the United States 2017-2025 light duty vehicle

[26] In line with the Oliver Wyman study and the study by AEA (2013) we assume the ratio between PHEV and BEV to be in the range of 2:1 to 4:1. We therefore assume that by 2025, 4% of all vehicles sold would need to be electric vehicles whereas 6% of all vehicles sold would need to be plug-in hybrid electric vehicles. Electric vehicles do not emit any CO_2 emissions at the tailpipe whereas plug-in hybrids are expected to emit on average 40 g CO_2/km in 2025.

[27] Manufacturers must achieve an average CO_2 emission target of 130 g CO2/km by 2015.

[28] Mezler, D., German, J., Mock, P., Bandivadekar, A. (2013): CO_2 reduction technologies for the European car and van fleet, a 2020-2025 assessment – summary of mass reduction impacts on EU cost curves. Working paper 2013-1.

[29] In the U.S., the project was carried out jointly by three major agencies (EPA, NTHSA, CARB) with a total budget for technical studies of around 15 million US$.

regulation. This study makes use of extensive vehicle simulations and a so called tear-down cost assessment, both of which are very detailed and generally seen as a ground-breaking best-practice example that closely follows the industry-internal approach of vehicle development. The study by the ICCT adapts the existing data from the U.S. to the conditions of the European market in order to arrive at the CO_2 reduction cost curves. For instance, the study considers additional driving cycles, vehicle segments and technologies commonly available in the EU, and adapts underlying assumptions. For the production cost assessment, it is assumed by the study that all parts are produced in Western Europe, taking German labour costs as the basis for all calculations.

We are aware of other studies that conclude that the cost of technology of lowering CO_2 emissions are much higher, including a recent published study by the German based institute “Institut für Kraftfahrzeuge” (IKA), which has been commissioned by the German Ministry of Economy. The cost estimates for this study are much higher than projected by the ICCT (e.g., for meeting the 95 g/km target in 2020, the IKA study estimates additional cost of €2000 or more on average compared to the 2010 baseline). These cost estimates, however, are based only on expert interviews with car manufacturers and suppliers. We consider this approach as being less reliable compared to the “tear down” approached followed by the ICCT.

We base our analysis on the work conducted by ICCT, as their approach is the most detailed and transparent approach available and most closely follows the car industry’s own methodology to estimate future technology cost. For our analysis, as we assume that for 2025, footprint is used as the parameter for determining the limit value curve, we use the ICCT cost curve that fully credits mass reduction potential. In comparison to the 2015 baseline, an average fleet value of 75 g CO_2/km for the conventional car fleet in 2025 would equal a 42% improvement. For our analysis, it is assumed that all vehicle segments cut CO_2 emissions by an identical percentage (i.e. 42%) and no market shift occurs (see table 1).

Table 1: Increase in retail price of cars powered by an ICE

	Average emissions in 2015	Average emissions in 2025	Additional direct manufacturing costs	Retail price incl. tax
B petrol	126 g	73 g	1350 €	1944€
C petrol	145 g	84 g	1200 €	1728 €
D petrol	165 g	96 g	1000 €	1440 €
B diesel	105 g	61 g	1350 €	1944 €
C diesel	122 g	71 g	1250 €	1800 €
D diesel	138 g	80 g	2450 €	3528 €

The cost of reaching an average fleet emissions value of 75 g CO_2/km of new vehicles powered by an internal combustion engine (incl. hybridisation) will, according to the ICCT study, involve additional manufacturing costs of approximately €1000 to €2450 per car compared to the 2015 baseline of 130 g CO_2/km. This translates into an additional retail price of €1440 to €3528 per car compared to the 2015 baseline (we follow the assumption by Smokers (2006) and translate direct manufacturing costs into additional retail price using the factor 1.44[30]) (see table 1).

However, we emphasise that in ex-ante estimates, production costs are often largely overestimated. One reason for that, as shown by a study by the Institute for Applied Environmental Economics, is that for ex-ante estimates of unit costs for the future, often no attention is given to “normal innovation” such as economies of

30 Smokers et al. (2006): Review and analysis of the reduction potential and costs of technological and other measures to reduce CO_2 emissions from passenger cars - Final report. http://ec.europa.eu/enterprise/sectors/automotive/files/projects/report_co2_reduction_en.pdf

scale or unforeseen developments resulting in cost benefits.[31] The catalytic converter technology provides a good example that the automotive industry has been significantly overestimating the costs for the new technology in the past.[32] Another study conducted by the German based institute "Institut für Kraftfahrzeuge" (IKA) and commissioned by the German Ministry of Economy showed also is a good example that ex-ante estimates of additional technology cost are often extremely overestimated. Their study on light-commercial vehicles ("vans") claimed that the cost of achieving a target of 148 g CO_2/km by 2030 would amount to €9000.[33] The European Commission however expects, based on a recent study by TNO (2012)[34] that the average additional manufacturing cost is estimated at around €450 per van in order to achieve a target of 147 g CO_2/km in 2020.[35]

In addition, estimated higher costs due to the emission targets are often not passed on to consumers via higher vehicle prices. Obviously, the development of retail prices are influenced by many other factors, including the recent financial crises, competition from outside Europe and changing consumer demands. Nevertheless, there are good reasons to assume that price increases in the future might also be lower than the current estimations as described above predict. For instance, a report by the Netherlands Organisation for Applied Scientific Research (TNO)[36] compiled in 2006 projected that the costs of reaching the goal of an average of 140 g/km in comparison to the 2002 baseline would lead to an increase in retail prices of €1200 per vehicle. However, the opposite development took place: car prices actually declined by 2.5% in 2010, by 0.6% in 2009 and by 3.1% in 2008.

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31 See http://ec.europa.eu/environment/enveco/ex_post/pdf/transport.pdf.

32 http://awsassets.panda.org/downloads/crywolf0404b.pdf

33 For a critical analysis of this study see a briefing by Transport & Environment (2013): http://www.transportenvironment.org/publications/critical-assessment-aachen-study-co2-reduction-potential-light-commercial-vehicles2.

34 http://ec.europa.eu/clima/policies/transport/vehicles/vans/docs/report_co2_lcv_en.pdf.

35 http://ec.europa.eu/clima/policies/transport/vehicles/vans/faq_en.htm.

36 Review and analysis of the reduction potential and costs of technological and other measures to reduce CO2 emisions from passenger cars. Smokers, R. et al., Delft (2006): http://ec.europa.eu/enterprise/sectors/automotive/files/projects/report_CO2_reduction_en.pdf.

4.2. Calculation of fuel savings and payback time for cars powered by an internal combustion engine

To compute the fuel savings per year, we need to take several assumptions, particularly regarding the time-evolution of fuel prices[37] and the average distance travelled per vehicle segment.[38] Reducing average fleet emissions of cars powered by an ICE down to 75 CO_2/km implies a reduction in annual fuel consumption of about 42% in comparison to the target of 130 g CO_2/km that manufacturers need to achieve in 2015.

- The average private European motorist driving a diesel or petrol car would benefit from fuel savings of approximately 643 Euros a year.
- The payback period for the additional increase in retail price would be approximately 3.6 years.

The private motorist buying a new petrol car in 2025 would benefit from fuel savings of approximately 512-778€ in the first year of ownership, compared to the 2015 baseline. The private motorist buying a new diesel car would benefit from fuel savings of approximately 544-818€ in the first year of ownership, compared to the 2015 baseline. Taking into account the market share of the different segments as used by the ICCT in calculating the cost curve for the average market[39], and assuming no shift in market shares, the average savings in the first year across all segments would be approximately **643€** (see table 2).

Table 2: Savings in the first year for a private buyer of a new conventionally driven car compared to 130 g CO2/km baseline

	Average emissions in 2015	Average emissions in 2025	Difference in emissions	Savings in litres	Mileage in km/ year	Savings in € in the first year
B petrol	126 g	73 g	53 g	2.3 l	10.829 km	€ 512
C petrol	145 g	84 g	61 g	2.7 l	12.579 km	€ 685
D petrol	165 g	96 g	69 g	3.0 l	12.629 km	€ 778
B diesel	105 g	61 g	44 g	1.7 l	17.281 km	€ 544
C diesel	122 g	71 g	51 g	1.9 l	18.431 km	€ 672
D diesel	138 g	80 g	58 g	2.2 l	19.739 km	€ 818
Average						**€ 643**

37 It is obviously very difficult to predict future fuel prices as they depend on a high number of factors. There is also a considerable disagreement between academic and industry experts about how to best predict future prices. Nevertheless, the past has shown that most predictions of future fuel prices tend to be highly underestimated. Many assumptions for fuel prices are over optimistic and quickly overtaken by time. For instance, the study by CE Delft (published in March 2011) assumed a petrol price of €1.52 in 2015, of €1.70 in 2020 and of €1.87 in 2025. The price per one litre of petrol has already reached the €1.52 mark at the beginning of 2012 and hit a record price of €1.70 already in August 2012. We therefore decided to follow the route of Plötz et al. (2012) (http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_wirtschaftswissenschaften/bwl/ee2/lehrstuhlseiten/ordner_veranstaltungen/ordner_enerday/Enerday%202012/ed2012download/Ploetz_Paper.pdf). Based on this study, we assume an annual increase in fuel price of 2% annually for the future fuel prices. We assume a price of one litre of petrol of €2.05 in 2025 and of one litre of diesel of €1.89 in 2025.

38 We make use of the assumptions by the FLEETS study that provides the distance travelled for new vehicles in the first year (split by vehicle size and fuel price). The FLEETS study reports on the average distance travelled of all cars, i.e. the values presented in the FLEETS study represents the data for all car drivers, including drivers of company cars. As approximately 50% of all new vehicles sold in the European Union are registered as company cars, we therefore adapt the FLEETS study accordingly. We assume that company cars on average drive nearly twice as much per year than private cars (see Annex 5). See Annex 6 for the precise figures of the average mileage travelled per car segment.

39 B petrol 24%, B diesel 16%, C petrol 16%, C diesel 24%, D petrol 4%, D diesel 16%.

We make use of a discounted pay-back analysis in order to calculate the period it takes to recover the amount invested in fuel-efficiency technology.[40] The analysis shows that the total payback period for the increase in retail price incl. VAT is assumed to be in the range of 1.9 to 5.2 years, depending on the car segment (see table 3). The analysis shows that car buyers see a net saving from the new standards within an acceptable time range. Assuming no shift in market shares, the average total payback period across all segments would be approximately **3.6 years.**

- After a holding period of five years, the average vehicle is commonly sold at around a third of its original value.
- The payback period for the additional increase in retail price that the first owner has to pay would be approximately 2.3 years.

Table 3: Total number of years required for the fuel savings to equal the increase in retail price

	Increase in retail price incl. VAT	Total payback period
B petrol	1944 €	4.0 years
C petrol	1728 €	2.5 years
D petrol	1440 €	1.9 years
B diesel	1944 €	3.9 years
C diesel	1800 €	2.9 years
D diesel	3528 €	5.2 years
Average		**3.6 years**

Finally, it is important to take into account that those consumers who buy a new vehicle with a typical five-year loan will benefit also from average monthly cash flow savings during the loan period as the monthly fuel savings more than offset the higher monthly payment due to the higher incremental vehicle cost.

[40] We assume an increase in fuel price of 2% annually and a discount rate of 5%. In addition, we take account of the decrease in annual kilometres travelled per year as indicated in the TREMOD (Transport Emission Model) 4.17 model.
The discount rate is used to determine the present value of future benefits. The discount rate represents the opportunity costs of what else the consumer could accomplish with the same fund:

- For vehicle buyers who buy the car through a loan or lease, the opportunity cost of paying more to purchase a vehicle in the present is the borrowing rate (i.e. when money is borrowed from the bank, interest is typically paid as percentage of the amount owed to the consumer). We take the MFI interest rates on euro-denominated loans to euro area residents for consumer credit by initial rate fixation of over 1 and up to 5 years which amounts to **6.11%** by 2013 January 2013 (http://sdw.ecb.europa.eu/reports.do?node=100000173).
- For consumers who pay the car from their savings (i.e. "in cash"), the opportunity cost is the return (i.e. lending rate) that could be realized on savings. We take the interest rates on deposits with an agreed maturity of over 2 years, amounting to **2.42%** (as of 2013 January) (see http://sdw.ecb.europa.eu/reports.do?node=100000173).
- A study by the German based Leasetrend AG with 500 German private car buyers showed that 68% of all private car buyers paid their recent car in cash and did not make use of borrowed capital (http://www.automobilwoche.de/article/20111006/NACHRICHTEN/111009956/1330#.UTcZAdXc6-U). Another study by Aral with German private car buyers however showed that only 35% of car buyers are planning to buy their next car with cash (http://www.aral.de/liveassets/bp_internet/aral/aral_de/STAGING/local_assets/downloads_pdfs/t/broschuere_aral_studie_trends_beim_autokauf_2011.pdf). In addition, in the UK, data by the Finance and leasing association in October 2012 with 1158 private car buyers showed that 70% of new cars bought in the UK dealerships by private car buyers were partly or wholly funded through car credits (http://www.financecar.co.uk/blog/2013/01/02/70-of-new-cars-are-bought-with-finance-are-you-prepared). To be on the more conservative side, we assume that 30% of private vehicle buyers pay in cash whereas 70% of car buyers partly or fully fund their purchase through loans. By weighting the lending and borrowing rate by the percentage of cash/loan car buyers, we arrive at a discount rate of 5%.

4.4. Calculation of pay-back period for first owners of cars powered by an internal combustion engine

As most consumers do not own a car over its entire lifetime but sell it after few years, we feel that for this specific exercise it is much more suitable to calculate the payback period on the basis of the share of the higher purchase price that the first car owner has to bear. After a holding period of five years, the average vehicle is commonly sold at around a third of its original value.[41] Therefore, it is expected that approximately two thirds of the higher initial purchase price has to be paid by the first owner of a new car. The remaining part of the higher costs for meeting the CO_2/km standard can thus be passed on to the used car buyer. The payback period for the share that the buyer of a new car has to pay for the initial higher purchase price is assumed to be in the range of 1.2 to 3.2 years, with significant fuel savings over the remaining holding period.[42]

Assuming no shift in market shares, the average payback period for the additional increase in retail price that the first car owner has to bear across all segments would be approximately **2.3 years.** This analysis shows that car buyers see a net saving from the new standards relatively quickly and well before they typically sell the car (see table 4).

Table 4: Number of years required for the fuel savings to equal the increase in retail price the first owner has to pay

	Increase in retail price incl. VAT born by first owner	Payback period for first owner
B petrol	€ 1296	2.7 years
C petrol	€ 1152	1.7 years
D petrol	€ 960	1.2 years
B diesel	€ 1296	2.6 years
C diesel	€ 1200	1.9 years
D diesel	€ 2352	3.2 years
Average		**2.3 years**

4.5. Calculation of pay-back period for second-hand owners of cars powered by an internal combustion engine

A big share of new passenger cars is not purchased by private motorists but by firms. More specifically, 42% of all new passenger cars sold in European Union are purchased by companies[43], who later sell the used cars mostly to private motorists. In many countries of the European Union the used car volumes exceed the sales of new cars.

As described above, approximately one third of the higher costs for meeting the CO_2/km standard needs to be paid by the driver who buys a 5-year old second-hand vehicle. The payback period for the share that the used car buyer has to pay

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[41] According to Kelley Blue Book research in 2010, an average vehicle in the United States retains 32.6% of its original value after five years of ownership. We assume similar values for the European market.

[42] When the car is purchased at a time when fuel costs are even higher, consumers would be able to recoup their investment even within a shorter period of time. In addition, this analysis is based on the assumption that the consumer holds the car for 5 years. For consumers who sell their cars sooner, the payback period is still likely to be shorter than the buyers' holding period of the car. Although those owners will see lower fuel savings in total, they will be able to pass on a higher amount of resale value to the second hand buyer. Finally, those consumers who buy a new vehicle with a typical five-year loan will benefit also from average monthly cash flow savings during the loan period as the monthly fuel savings more than offset the higher monthly payment due to the higher incremental vehicle cost.

[43] Gutiérrez Puigarnau, E. and Van Ommeren, J. (2008) Welfare Effects of Distortionary Company Car Taxation. TI 2007-060/3, Tinbergen Institute Discussion Paper.

for the potential higher purchase price of a car purchased five years later for meeting the CO_2/km standard in 2025 is assumed to range between approximately **0.7 to 1.9 years** (see table 5), with significant fuel savings over the remaining holding period. Assuming no shift in market shares, the average payback period for the second hand car owner across all segments would be approximately **1.3 years.** This analysis shows that used car buyers see a net saving from the new standards extremely quickly.

Table 5: Number of years required for the fuel savings to equal the increase in retail price the second owner has to pay

	Increase in retail price incl. VAT born by second owner	Payback period for second owner
B petrol	€ 648	1.3 years
C petrol	€ 576	0.7 years
D petrol	€ 480	0.7 years
B diesel	€ 648	1.5 years
C diesel	€ 600	1.1 years
D diesel	€ 1176	1.9 years
Average		**1.3 years**

Low-income households pay a disproportionally large portion of their income on fuel and are therefore most vulnerable to fuel price spikes. We therefore consider setting a standard for 2025 as an especially effective tool to combat vulnerability to fuel price increases. The reason is that particularly those households with a very low income who wish to own a car are often not in the new car market but they buy very often used cars. Improving the fuel efficiency of cars is therefore likely to have only a modest price impact on the second hand car vehicle. A big part of the possible higher initial purchase price is anyway paid by the first car owner, while the savings will be significant and the payback period will be relatively short.

5. Cost-benefit analysis for purchasers of ultra-low carbon vehicles

As described above, we expect that in order to reach the indicative target of 70 g CO_2/km by 2025, the share of ultra-low carbon vehicles in 2025 will amount to approximately 10%. For those 10% vehicles on the market the payback analysis of the higher costs is much more difficult to perform as there is a considerable number of variables involved in these calculations. Even though the key determinants are the purchase price and fuel costs, other costs for maintenance, motor vehicle taxes, insurance costs, and others need to be considered.

As many of these parameters are still relatively uncertain, it is difficult to provide an accurate prediction of development. There are a couple of research studies who have taken on this exercise, which will be shortly discussed below.

Due to the higher initial purchase price and the significant lower running cost of vehicles of electric vehicle, any comparison with a conventional car requires a total cost of ownership (TCO) perspective. All studies we looked at expect capital cost differentials to substantially narrow by 2025, with the new technology becoming cost-competitive if fuel savings are included. The reason for this is that ultra-low carbon vehicles are expected to have much lower refuelling costs and a clear benefit of savings in yearly running costs.

A recent report by Pike Research (2012)[44] compared the TCO of different powertrains of small and mid-sized passenger cars and found that by 2025 compact BEV models could have lower TCOs for fleet operators than the small gasoline models. In addition, the PHEV could have lower TCO than the mid-sized gasoline sedan. Another study by Cambridge Econometrics and Ricardo-AEA (2013)[45] showed that the TCO is expected to converge within the next decade for the different powertrain technologies. By 2025, for instance, BEV and PHEVs could become more cost-effective on a TCO basis than the average ICE or HEV. This is also confirmed by a study by McKinsey (2010)[46] which shows that the TCO of the different powertrains (ICE, PHEV, EV, FCEV) is expected to converge after 2025 (or even earlier in case tax exemptions are in place of government incentives are offered). Finally, a study by Oliver Wyman (2010)[47] also expects that the TCO of a battery electric vehicle will be lower by 2025 than a car powered by an ICE. The reasons for a convergence of TCO of the different powertrains include an improvement in battery technology, learning curves, increased economies of scale and increase in fuel prices.

- Several selected studies show that a sustainable TCO benefit for ultra-low carbon vehicles can be achieved in 2025.
- There will be several “early adopter segments” for ultra-low carbon vehicles in the short run, including fleets, car-sharing schemes and technological interested individuals, to help to drive initial ramp-up scaling to make EVs more cost-efficient.
- With the accumulated market which will develop over the next 12 years, the capacity is provided to drive initial ramp-up scaling so that ultra-low carbon vehicles become more cost efficient also for the general consumer group.

To sum up, the selected studies suggest that a sustainable TCO benefit for ultra-low carbon vehicles can be achieved in 2025. If the benefits of using cheaper electricity as the automotive fuel are combined with lower anticipated maintenance costs, the TCO equation could be favourable to ultra-low carbon vehicles over conventional cars, particularly when taking into account that the cost of petrol and diesel fuels will increase as expected, but many uncertainties remain.

There are likely to be several “early adopter segments” for ultra-low carbon vehicles in the short run to help to drive initial ramp-up scaling to make EVs more cost-efficient. Generally speaking, those segments who are most sensitive to total cost of ownership considerations will be most likely to opt for the new technologies, particularly when the economic rationale for those cars is solid. For instance, governmental fleets[48] and company fleets[49] represent an attractive means of

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44 Pike Research (2012): Total cost of ownership of alternative fuel vehicles for fleet operators – TCO comparison of alternative fuel light-duty and medium-duty vehicles in fleet operations: http://www.pikeresearch.com/research/total-cost-of-ownership-of-alternative-fuel-vehicles-for-fleet-operators.

45 CE Cambridge Econometrics and Ricardo-AEA (2013): An economic assessment of low carbon vehicles.

46 McKinsey (2010): A portfolio of power-trains for Europe: a fact-based analysis – the role of battery electric vehicles, plug-in hybrids and fuel cell electric vehicles. http://ec.europa.eu/research/fch/pdf/a_portfolio_of_power_trains_for_europe_a_fact_based__analysis.pdf.

47 Oliver Wyman (2010): http://www.oliverwyman.com/media/OliverWyman_automotivemanager1_2010_E-Mobility.pdf

48 Governments can make use of their purchasing power to buy electric vehicles. For instance, “La Poste”, the French postal service, currently owns the largest electric vehicle fleet in France. In addition, the Greater London Authority aims to introduce 1,000 EVs to its fleet by 2015.

49 Leading firms with a large number of company cars have already started to include low-emission vehicles in their fleet. Fleet customers represent a crucial opportunity to let the electric vehicle market

increasing EV adoption. In addition, car sharing schemes, taxis[50], car rental companies[51], wealthy and technologically interested individuals[52] and households who aim to purchase a second vehicle[53] will be additional attractive markets for ultra-low carbon vehicles. The growth of the market share of ultra-low carbon vehicles in such kind of markets will provide the scale economies to make the new technologies more cost-effective. In addition, public charging infrastructure will be developed, which also will help to reduce the potential EV customers' range anxiety over time. With the accumulated market which will develop over the next 12 years, the capacity is provided to drive initial ramp-up scaling so that ultra-low carbon vehicles become more cost efficient also for the general consumer group.

6. The need to move towards a "footprint"-based standard

By making use of mass as the parameter for determining the limit values, less incentive is provided to manufacturers to invest in light-weighting which is seen as a very efficient technical option for reducing CO_2 emissions from passenger cars. Research has also shown that reduced mass has the biggest potential for fuel consumption reductions.[54] There are many technologies nowadays available[55] that can reduce vehicle mass without any compromise in vehicle size or function[56].

- We support implementing a footprint-based system which encourages manufacturers to invest in mass reductions.

The recent report by the ICCT showed that by making use of footprint as the parameter for determining the limit values, the necessary CO_2 reductions can be achieved in a more economical way. Therefore, costs passed on to car buyers are lower than if mass is used as the parameter for determining the limit values. We therefore suggest implementing a footprint-based system which encourages manufacturers to invest in mass reductions.

grow. One reason for that is that business drivers tend to drive significantly more kilometres per year so that vehicles with low running costs will help to limit the operating costs and reduce the payback period. In addition, business tend to apply more rational decision making criteria by making use of total lifecycle cost thinking when making purchasing decisions.

50 Europe-wide there are approximately 600.000 taxis in use. The average taxi vehicle drives many more kilometres per year than the average private driver. This distance is often travelled in cities where fuel efficiency of conventionally driven car is low due to the stop-and-go nature of city driving.

51 There are several companies, including Hertz Corp., which have publically stated that they intend to include electric vehicles into its European fleet.

52 The consultancy BCG for instance sees a relatively strong uptake for electric vehicles from specific consumer segments. Their study showed that there is evidence of a "green" consumer group (approximately 9% in Europe) that shows a willingness to pay for an electric vehicle even if the total cost of ownership is higher than for a conventionally driven car. CE Delft (2011) also expects that there will be a small segment in the market of so-called "innovators" which will be interested in switching to EVs even if the TCO will be not competitive with conventionally driven cars. The study expects that this group will represent 5% of the car buyers in Europe.

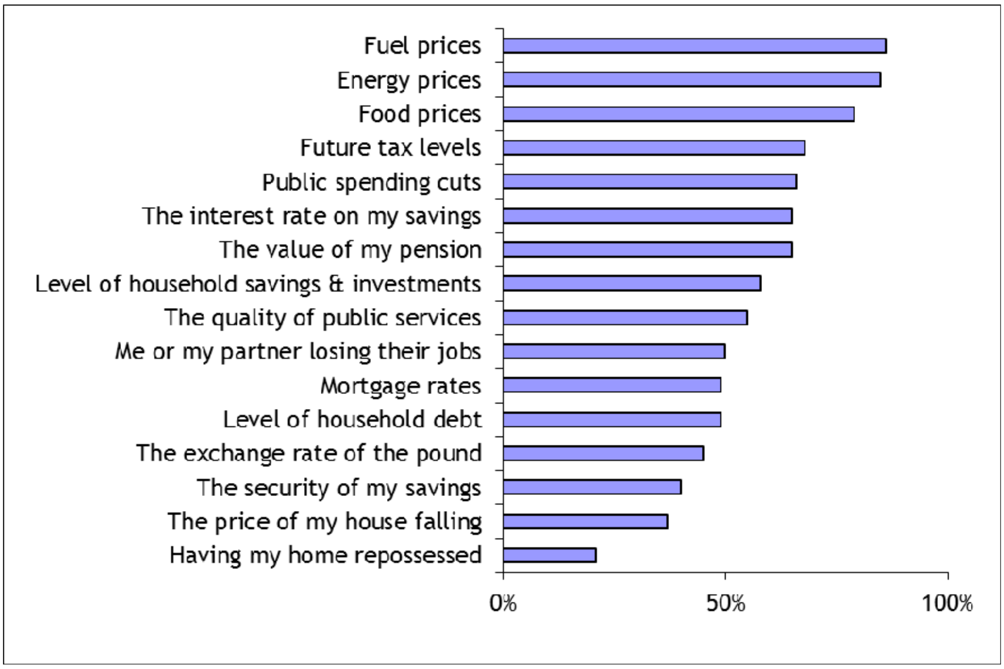
53 Another market for electric vehicles would be consumers who purchase their electric vehicle as their second car, in addition to purchasing a regular conventionally driven car. Many households in the European Union own two cars or even more. In Germany for instance, more than 82.2% of all households own at least one car. Of those households, who own a car, almost a third of all households own two cars and almost 6% own three cars or more (see ADAC: http://www.adac.de/_mmm/pdf/statistik_mobilitaet_in_deutschland_0111_46603.pdf.)

54 Assessment of technologies for improving light-duty vehicle fuel economy (2011, p. 116): http://www.nap.edu/openbook.php?record_id=12924&page=116

55 Including component-level lightweight material substitution (high-strength steel, aluminium, and composites) and using more comprehensive mass-optimized vehicle structural designs that integrate parts and employ more advanced lightweight bonding and forming techniques.

56 German, J. and N. Lutsey (2010). "Size or Mass?: The Technical Rationale for Selecting Size as an Attribute for Vehicle Efficiency Standards." International Council on Clean Transportation.

Annex 1: Major consumer worries in the UK[57]



Annex 2: Imperfections in the market for fuel economy

Imperfect information	A first market failure occurs through a lack of information on the fuel consumption of a car, which makes it difficult for drivers to choose the most fuel efficient vehicle. In the European Union, buyers of new cars must be provided with information about the fuel consumption and CO_2 emissions of cars at the point of sales and through marketing materials. This is regulated through Directive 1999/94/EC. However, the current implementation of the scheme has not guaranteed that all European consumers are given clear, comparable and credible information on the fuel consumption and CO_2 emissions of cars sold on the EU market at the point of purchase.[58] In addition, the Directive does also not guarantee that information is provided to consumers in a visible way via all kind of media.[59] Some means of communication, including television, the Internet[60], radio and cinema, are not required by the Directive to include specific information on the fuel consumption of the car. Not providing consumers with relevant information before they enter the showroom is however a risk in case consumers take their purchase decision before encountering any labelling information. In addition, even though the Directive requires that information needs to be easy to understand even on a superficial contact, the wording is particularly weak regarding the specific requirement of the font size and the space which needs to be dedicated to such kind of information.

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57 Which? (2012): Quarterly consumer report: http://www.which.co.uk/documents/pdf/quarterly-consumer-report-october-2012-299958.pdf.

58 In several countries, including the Czech Republic and Poland, for instance, no standardised label format exists since it is not set by legislation. This leads to a situation where every car dealer can use a different format. Other member states (e.g. Sweden, Hungary and Italy) also only meet the minimum requirements of the Directive by using a simple format listing the required information in a list or table format. Furthermore, some member states make use of a labelling system which is even considered as complicated to understand (e.g. Germany with the relative rating scheme based on weight). Finally, at present there are no modifications planned for the label in some Member States as developments at EU level are being awaited.

59 For instance, only printed promotional literature, which includes advertising in newspapers, magazines and posters, must display the fuel consumption and CO_2 emissions of the cars to which it refers.

60 When the original car labelling Directive was adopted in 1999, online advertisement was only in its initial stage. The Internet has now become a major – if not the primary – source of consumer information and advertisement on cars. A study by Capgemini (2010) shows that almost 90% of consumers make use of the Internet when researching vehicles.

Distrust in fuel consumption data	Despite the requirement of providing fuel consumption and CO_2 emission information to consumers, we consider the information provided still to be imperfect as the fuel consumption declared on the labels very likely deviates from the value achieved in real world driving. As shown by several studies, there is a growing gap between the measurement of emissions during type approval and the level of real world emissions.[61] Therefore, the fuel consumption reductions achieved in laboratory conditions are not translated into monetary benefits for consumers. Consumers therefore often do not trust the data they are provided with and are potentially also not willing to pay much more for a fuel efficient vehicle.
Bounded rationality	Even when the information is available, it is often not the case that consumers completely understand or make use of the information they are provided with. Reasons for that are that consumers lack the time, resources or also the ability to always make optimal decisions. Choosing among a large number of brands and models and specific equipment versions is a complex task. Cars usually are a bundle of different characteristics, including the price, size, style, equipment version, comfort, safety, fuel consumption, etc. For an average consumer, it is a challenging task to simultaneously compare and trade-off all the attributes considered. In addition, in case the label only provides the minimum information regarding the fuel consumption and CO_2 emissions of a car, the calculation of fuel savings from a more efficient model often requires mathematical skills that some consumers do not possess[62]. Therefore, if the fuel consumption is presented in the form of litres/100 km or miles per gallon, consumers will have difficulty discerning the financial benefits of buying a more fuel efficient car.[63]
Principal-Agent problem related to company cars	A big share of new passenger cars is not purchased by private motorists but by firms. More specifically, more than 50% of all new passenger cars sold in the European Union are purchased by companies.[64] Instead of an increase in salary a company often offers private use of company cars to their employees.[65] As also the petrol is often paid by the company, employees are not given a direct financial incentive to choose a more fuel efficient vehicle. This kind of "market failure" has been intensified by a policy failure in the form of favourable tax treatment of company cars which has encouraged the purchase of larger and less-efficient vehicles to an even higher extent.[66] The impact of the prevalence of heavier and more powerful cars is directly felt in the second hand car market. Company cars are typically owned or leased for 3-5 years before being sold as private vehicles. Therefore, the second-hand car market is "oversupplied" by more expensive, subsidy driven cars and second-hand car buyers find a lack of fuel-efficient and yet affordable vehicles.

[61] The International Council on Clean Transportation (ICCT) compared the CO_2 emissions measured by the New European Driving Cycle (NEDC) at type approval with real world values. Based upon analysis of a large number of user entries of the German fuel consumption database spritmonitor.de, the ICCT found that the gap between type approval and real world CO_2 values increased from about 8% in 2001 to 23% today, with a particularly strong increase since 2007. According to a study by TNO (2012), this trend can be attributed to an increased use of flexibilities.

[62] In order to make a fully rational choice, the consumer would need to take into account fuel savings over the full holding period of the car. This requires the consumer to know how long the vehicle will remain in operation, how high the resale value would be, the average distance to be travelled in each future year and the future price of fuel. In addition, the consumer would also need to base the calculation of the fuel savings based on the values that are achieved in real world driving and not based on the official estimates.

[63] See for a similar argument Heinzle (2012): Disclosure of energy operating cost information: A silver bullet for overcoming the energy-efficiency gap? Journal of Consumer Policy 35, 43-64.

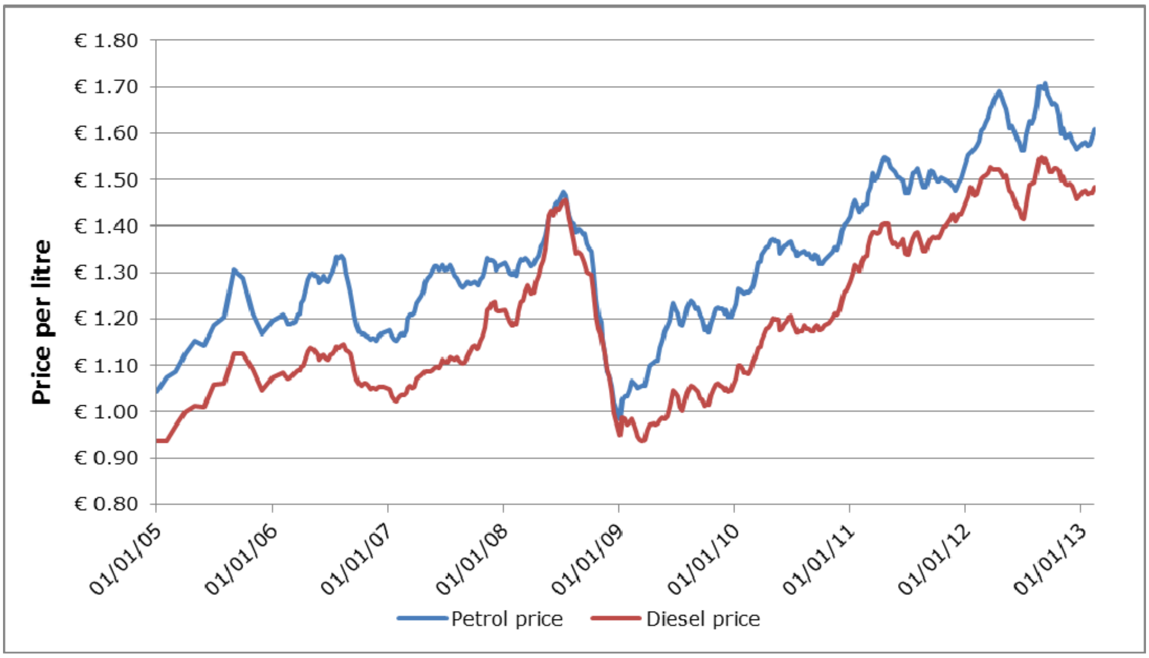
[64] Taxation papers Company Car Taxation (2010): http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/economic_analysis/tax_papers/taxation_paper_22_en.pdf.

[65] Evidence from Belgium and the Netherlands suggests that company cars are to a very large extent used for private purposes such as home-office commutes and other purely private purposes. Pure business-related use constitutes only about 20-30% of company car use (see http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/economic_analysis/tax_papers/taxation_paper_22_en.pdf.)

[66] Research has shown that company cars often belong to the higher segment in the market than cars which are registered privately. A study of car registrations in 18 European Member States revealed a significant tendency for larger and more expensive vehicles to be bought by firms rather than by private drivers. See Naess-Schmidt and Winiarczyk (2010).

Lack of sufficient and attractive offer	Whereas manufacturers need to bear to higher costs of developing new fuel efficiency technologies, drivers will be the ones reaping the benefits by gaining fuel savings. Although manufacturers should be able to pass on the additional costs to the consumers, through the fierce competition in the marketplace, they will not always be able to do so in order to stay competitively priced. Awareness of this potential outcome might be that manufacturers are more reluctant to invest into fuel efficient vehicles. The consequence is that the cars that are sold in the marketplace do not always represent consumers' demands. Even when consumers care about fuel consumption of a vehicle, they might not find the more efficient vehicle model available. This is of particular importance as consumers are considered to be extremely brand loyal. A study in Germany showed for instance that more than half of the new car buyers stick with the same brand when buying a new car.[67] In addition, the impact that design has on new vehicle shoppers is also substantial. A study by J.D. Powers (2013) showed that even though fuel economy is the number one car criteria among U.S. car buyers, a bad styling keeps customers from buying fuel efficient vehicles.[68] At the moment, we consider that the marketplace still offers an inadequate range of options which is appealing to consumers.

Annex 3: Development of fuel prices between 2005 and 2013



[67] Dataforce (2012): http://auto-clever.de/46895-54-prozent-der-neuwagenkaufer-bleiben-ihrer-marke-treu.

[68] 36% of the respondents of the survey argued that they did not consider buying a hybrid or an electric vehicle because of the higher initial purchase price, 25% did so because of the unpleasant exterior styling, see J.D. Powers (2013).

Annex 4: Forecast of the future market penetration of ultra-low carbon vehicles

Author	Year	Annual sales projections ultra-low carbon vehicles
Roland Berger strategy consultants[69]	2011	Best case scenario by 2025: - BEV: 12% of new car sales in the EU by 2025 - REEX: 14% of new car sales in the EU by 2025 - Full hybrids/PHEV: 11% of new car sales in the EU by 2025
Joint Research Centre[70]	2010	Scenario 1 by 2020/2030: - BEV: 0.5%/1.9% - PHEV: 5%/13.5% Scenario 2 by 2020/2030: - BEV: 0.9%/9.0% - PHEV: 8.9%/32.5% Scenario 3 by 2020/2030: - BEV: 1.6%/4.7% - PHEV: 6.4%/15.4% Scenario 4 by 2020/2030: - BEV: 2.9%/29.0% - PHEV: 11.4%/32.6%
Oliver Wyman[71]	2011	Market projection by 2025: - BEV: 2.7% - PHEV: 5%
A.T. Kearney[72]	2012	Moderate scenario by 2025: - EV: 12% - PHEV: 24% - REEX: 4%
CE Delft[73]	2011	Scenario 1 by 2025: - 16% PHEV - 5% EREV - 5% BEV Scenario 2 by 2025: - 7% PHEV - 2% EREV - 2% BEV Scenario 3 by 2025 (EV breakthrough scenario): - 13% EREV - 10% BEV - 31% PHEV

[69] Roland Berger Strategy Consultants (2011): Automotive landscape 2025 – Opportunities and challenges ahead: http://www.rolandberger.com/media/pdf/Roland_Berger_Automotive_Landscape_2025_20110228.pdf

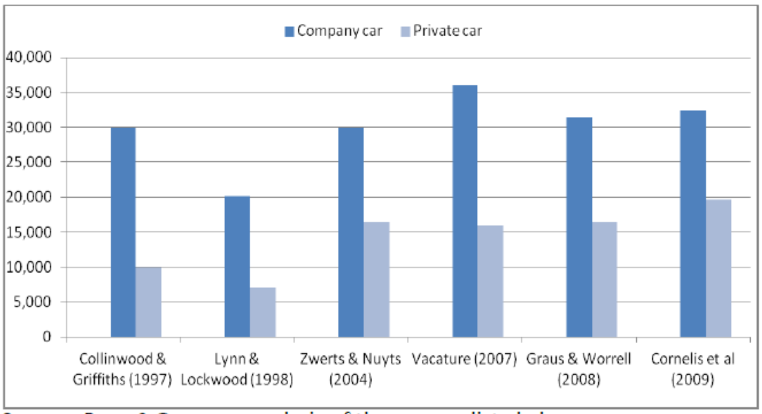
[70] Nemry, F. And Brons, M. (2010): Plug-in hybrid and battery electric vehicles – Market penetration scenarios of electric drive vehicles. JRC Technical Notes: http://ftp.jrc.es/EURdoc/JRC58748_TN.pdf.

[71] Oliver Wyman (2011): E-mobility 2025 – power play with electric cars. http://www.oliverwyman.com/media/ManSum_E-Mobility_2025_e.pdf.

[72] AT Kearney Powertrain 2025 study

[73] CE Delft 2011: http://www.cedelft.eu/publicatie/impact_of_electric_vehicles/1153.

Annex 5: Annual distance driven in company cars and private cars



Source: Booz & Company analysis of the sources listed above.

Annex 6: EU-average distance driven per year of different vehicle categories[74]

	Average km driven in the first year (all cars)	Average km driven in the first year (private cars)
Petrol small	14.438 km	10.829 km
Petrol medium	16.772 km	12.579 km
Petrol large	16.839 km	12.629 km
Diesel small	23.041 km	17.281 km
Diesel medium	24.574 km	18.431 km
Diesel large	26.318 km	19.739 km

[74] FLEETS study, published in the Impact assessment accompanying the Commission proposal SWD/2012/213: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52012SC0213:EN:NOT.