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signed by Mr Jordi AYET PUIGARNAU, Director

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to: Mr Uwe CORSEPIUS, Secretary-General of the Council of the European  
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Subject: Commission Staff Working Paper  
Impact Assessment *accompanying the documents*  
Proposal for a Regulation of the European Parliament and of the Council  
amending Regulation (EC) No 443/2009 to define the modalities for reaching  
the 2020 target to reduce CO<sub>2</sub> emissions from new passenger cars  
*and*  
Proposal for a Regulation of the European Parliament and of the Council  
amending Regulation (EU) No 510/2011 to define the modalities for reaching  
the 2020 target to reduce CO<sub>2</sub> emissions from new light commercial vehicles

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Delegations will find attached Commission document SWD(2012) 213 final (part II).

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Encl.: SWD(2012) 213 final (part II).



EUROPEAN COMMISSION

Brussels, 11.7.2012  
SWD(2012) 213 final

Part II

**COMMISSION STAFF WORKING DOCUMENT**

**IMPACT ASSESSMENT**

*Accompanying the documents*

**Proposal for a regulation of the European Parliament and of the Council amending Regulation (EC) No 443/2009 to define the modalities for reaching the 2020 target to reduce CO<sub>2</sub> emissions from new passenger cars**

**and**

**Proposal for a regulation of the European Parliament and of the Council amending Regulation (EU) No 510/2011 to define the modalities for reaching the 2020 target to reduce CO<sub>2</sub> emissions from new light commercial vehicles**

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# COMMISSION STAFF WORKING DOCUMENT

## IMPACT ASSESSMENT

### *Accompanying the documents*

**Proposal for a regulation of the European Parliament and of the Council amending Regulation (EC) No 443/2009 to define the modalities for reaching the 2020 target to reduce CO<sub>2</sub> emissions from new passenger cars**

and

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## 7. ANNEXES

### 7.1. Glossary

**Autonomous mass increase (AMI)** – is an indicator of an average increase of mass of the fleet resulting from factors which are external to the Regulation, for example additional comfort and safety measures.

**Banking and borrowing** – is a scheme whereby the manufacturers are allowed to bank over-compliance in some years and borrow by under-complying in others, while still achieving the end goal. This means that a desired outcome should be achieved by a certain time but the optimal route to that point may differ between economic actors. To enable banking and borrowing it is necessary to define an expected trajectory of compliance and then assess borrowing or banking against that baseline.

**Car** – a motor vehicle which is of category M1 as defined in annex II to Directive 2007/46/EC and therefore is designed and constructed for the carriage of passengers and has no more than eight seats in addition to the driver's seat.

**Eco-innovations** – are innovative technologies which reduce real world CO<sub>2</sub> emissions from vehicles but whose effect is not measured in the type approval test. The current Regulations permit manufacturers to be granted a maximum of 7 gCO<sub>2</sub>/km emission credits for their fleet on average if they equip vehicles with innovative technologies, based on independently verified data.

**Footprint (as utility parameter)** – is a measure of a vehicle's size obtained by multiplying its track width by its wheelbase.

**Light Commercial Vehicle (LCV)** – An alternative term for vehicles referred to in this Impact Assessment as vans.

**Light-duty vehicles (LDVs)** – are vehicles consisting of passenger cars and light commercial vehicles (vans). Legally they are vehicles in M and N classes with reference mass below 2,610 kg.

**Limit value curve** – the utility based approach adopted in the legislation results in the CO<sub>2</sub> reduction obligation being defined as a function of a "utility" parameter (e.g. mass or footprint) reflecting the utility of vehicles. The CO<sub>2</sub> targets are set according to this limit value function expressed as a formula (annex I to the Regulations). The function can take different shapes although in the current Regulations it is linear. The limit value curve approach ensures that vehicles with a larger utility parameter (currently mass) are allowed higher emissions than lower utility vehicles while ensuring that the overall fleet average meets the target. To comply with the Regulation, a manufacturer has to ensure that the overall sales-weighted average emissions of all its new cars or vans is not above the point on the limit value curve for its average utility parameter.

**Mass (as utility parameter)** – means mass of the vehicle in running order which is the reference mass of the vehicle less the uniform mass of the driver of 75 kg and increased by a uniform mass of 100 kg.

**Mileage weighting** – takes account of differences in distance driven annually and over their lifetime by different classes of vehicles. The ultimate goal of lowering total vehicle CO<sub>2</sub> emissions might be more cost effectively achieved from a larger reduction in vehicles that travel further and a corresponding reduction in effort for vehicles that travel less. Mileage weighting would in practice mean introducing a mileage weighting factor to the CO<sub>2</sub> emission values based on an estimate of the relative distances travelled by different vehicle classes and fuels.

**Modalities** – are the parameters established in the legislation which impact on how the targets are achieved. The modalities currently employed in the Regulations include a limit value curve, excess emissions premium, derogations, manufacturer pooling, eco-innovations, phase-in of targets and super-credits. According to the Regulations the modalities may be considered for amendment in view of implementation of the 2020 targets.

**NEDC** – New European Drive Cycle. This is a driving cycle supposed to represent the typical usage of a car in Europe, and is used, among other things, to assess the CO<sub>2</sub> and pollutant emission levels of new LDVs.

**Phase-in** – means a gradual increase in the percentage of the fleet required to meet the target. The phase-in for passenger cars means that in 2012, 65% of each manufacturer's newly registered cars must comply on average with the limit value curve set by the legislation. This will rise to 75% in 2013, 80% in 2014, and 100% from 2015 onwards. If 100% compliance is set beyond the target date, e.g. 2020, in reality phase-in leads to delay in implementation of the target.

**Slope of the limit value curve** – when defining the formulae depicting the limit value curve it is necessary to decide on its slope. A 100% slope is based on the observed trend in a base year (2009 for cars and 2010 for vans), scaled down by an equal relative reduction to reach the desired target. Once the curve is scaled down to a desired level one can rotate it around the point of average utility and the targeted CO<sub>2</sub> level, which means that even though the slope changes the average target remains the same. The rotation can make the curve flatter (below 100%) in which case vehicles with higher utility would have to reduce more in order to meet

the target, or steeper (above 100%) for which smaller vehicles would be asked to make more effort.

**Super credits** – are a multiplier used in the Regulations for vehicles with extremely low tailpipe emissions (below 50 gCO<sub>2</sub>/km). In the current car Regulation each low-emitting car will be counted as 3.5 vehicles in 2012 and 2013, 2.5 in 2014 and 1.5 in 2016. Similarly, each low-emitting van will benefit from the following multiplier 3.5 in 2014 and 2015, 2.5 in 2016 and 1.5 vehicles in 2017.

**Utility parameter** – to establish CO<sub>2</sub> emissions targets for different vehicles an objective means is needed to distinguish between them. Without this, all vehicles would have the same target. Distinguishing between vehicles based upon their utility as perceived by buyers or users has been considered to be most appropriate. Different means can be used to assess utility and some examples include the vehicle's mass, area, volume or carrying capacity. Mass is the utility parameter used in the current car and van Regulations.

**Van** – a motor vehicle designed and constructed for the carriage of goods which is of category N1 as defined in Annex II to Directive 2007/46/EC and to vehicles of category N 1 to which type-approval is extended in accordance with Article 2(2) of Regulation (EC) No 715/2007. These vehicles have a maximum mass not exceeding 3.5 tonnes.

**WLTP** – World Light-duty Test Procedure. This is being developed by UNECE and aims to establish a globally accepted methodology to measure light duty vehicle emissions and energy consumption.

## **7.2. Summary of the public consultation**

### **1. EU policy on road-vehicle greenhouse emissions (evaluation of Part B)**

#### *Analysis of responses to Questions B.1-B.5*

**B.1** Setting greenhouse emission standards for road vehicles is an important aspect of EU action to reduce such emissions.

**B.2** These standards should be in line with the greenhouse targets in the EU's roadmap to a low carbon economy and Transport White Paper.

**B.3** Road vehicle greenhouse gas emissions standards should be set based on the average greenhouse gas emissions of new vehicles entering the vehicle fleet.

**B.4** Standards for road vehicles should apply equally to different technologies used for powering road vehicles.

**B.5** EU regulation of road-vehicle emissions stimulates innovation in the automotive sector and helps keep Europe's automotive industry competitive.

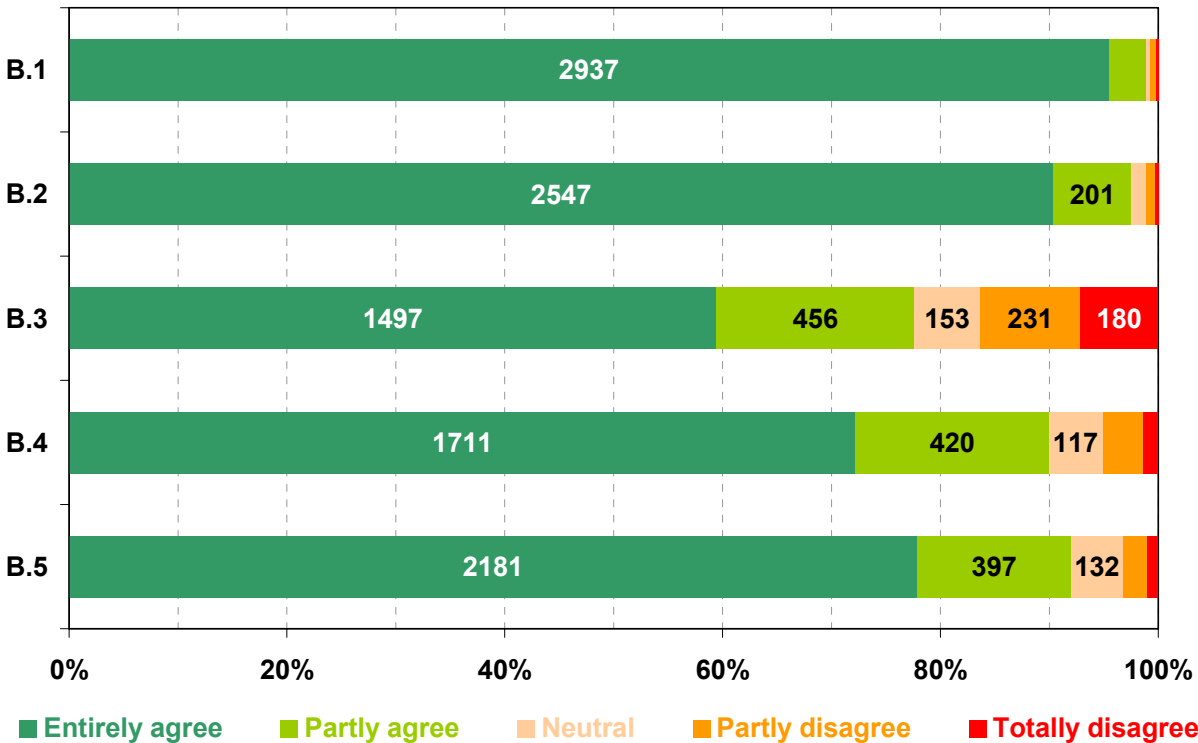
In general, the responses to section B of the consultation questionnaire were quite similar amongst stakeholders and individuals. For most questions, there was stronger support amongst individuals towards entirely agreeing with the policy statements, while with stakeholders there was more of a split between those who entirely agreed and those who partly agreed with the policy statements set out in section B.

Of individuals, 95% agreed that it was important to set greenhouse gas (GHG) emission standards as part of overall EU action to reduce such emissions while 55% of stakeholders entirely agreed and 31% partly agreed. A majority of respondents (89% of individuals entirely/partly and 77% of stakeholders entirely/partly) agreed that these standards should be in line with the GHG targets set out in the EU's roadmap to a low carbon economy and Transport White Paper. The choice of the appropriate measurement approach for setting GHG emission standards provoked a broader range of responses. While 64% and 59% of individuals and stakeholders respectively were in favour (entirely/partly agreed) of using the (current) fleet average approach, 33% of all respondents were either neutral or disagreed to some extent with setting targets based on the average GHG emissions of new vehicles entering the entire fleet.

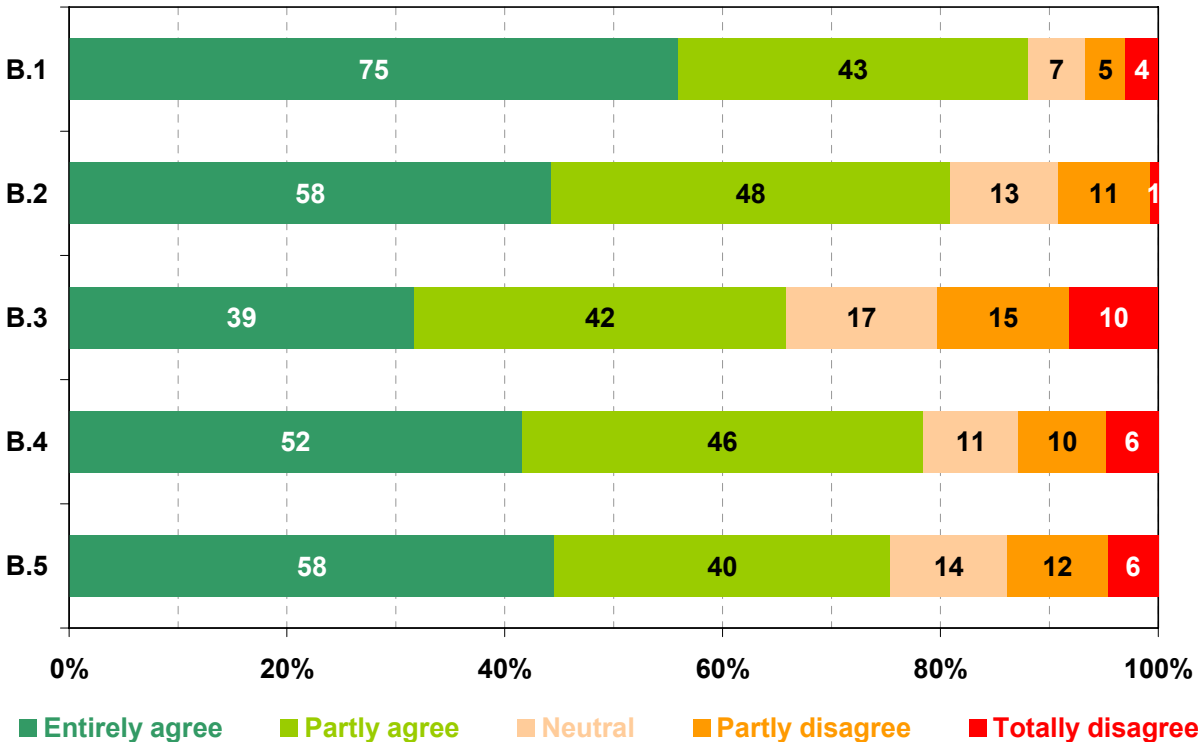
Stakeholders (72% entirely/partly agreed) and individuals (69% entirely/partly agreed) were mainly supportive of applying standards equally to different technologies used for powering road vehicles, while 72% of stakeholders and 83% of individuals agreed or partly agreed that EU regulation of road-vehicle emissions stimulates innovation in the automotive sector and helps keep Europe's automotive industry competitive. The number of stakeholders who disagreed or partly disagreed that standards should be applied equally to different technologies or that EU regulation had had a positive impact in terms of innovation and competitiveness (12% and 13% respectively) was proportionately higher than that of individuals.

These results are shown graphically in charts 1 and 2.

**Chart 1:** Answers from all citizens to questions in Part B



**Chart 2:** Answers from organized stakeholders to questions in Part B





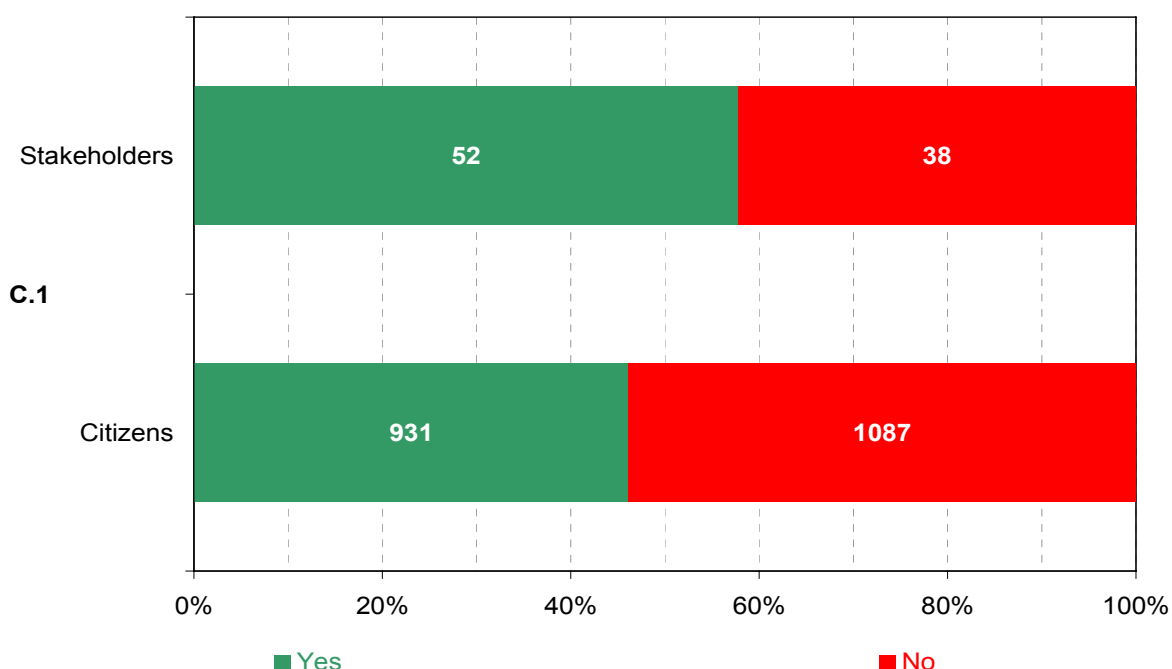
## 2. Light-duty vehicles (cars and vans) (evaluation of Part C)

### Analysis of responses to **Question C.1**

#### C.1 Do you think the current legislation is working and delivering tangible benefits?

There was a mixed assessment of the impact of the current legislation on light duty vehicles (cars and vans) by both stakeholders and individuals. While 38% of stakeholders agreed that the legislation was working, 28% felt that the legislation was not working or delivering tangible benefits. With regard to individuals more people felt that the legislation was not working (35 %) as opposed to those who agreed that it was delivering benefits (30%). Quite a significant proportion of stakeholders (34%) and individuals (35%) had no opinion in relation to question C1. This may partly be due to the fact that the legislation has only been in force for a short period of time (particularly the legislation on vans), and thus it is difficult to conclusively assess the impact it has had to date.

**Chart 3:** Answers to question C.1 in Part C



*Summary of responses to **Question C.2** (only answered by respondents answering no to question C1)*

#### C.2 Please specify why the current legislation is not working and delivering tangible benefits.

The respondents who felt that the legislation was not working or delivering tangible benefits mostly argued that the targets within the current legislation were not ambitious enough (almost 500 responses raised this point, including six from organisations). The majority of these respondents felt that the targets should be more stringent in order to have a greater impact on the reduction of CO<sub>2</sub> emissions and to encourage and stimulate the development of new technologies. Indeed over 80 respondents specifically argued that the legislation does not force technology change, while over 50 respondents felt that non-technical policies, including the promotion of alternative forms of transport, education and taxation, were required to

complement technical policies in reducing CO<sub>2</sub> emissions and affecting a culture change in the use of transport. A significant number of these respondents also argued that progress was being made too slowly and that greater enforcement of the current legislation and future legislation was required (over 50 individuals). Around 40 respondents felt that the legislation should do more to promote the use of alternative fuels.

A large number of respondents (almost 200 individuals) felt that the resistance of manufacturers to fully embrace greener technology and produce and promote cleaner and more efficient cars was a major factor in the legislation not being effective. Indeed many of these respondents felt that manufacturers are too powerful, have too much influence over politicians and policymakers and are profit-driven. On the other hand, a small number of manufacturers and individuals felt that the markets were driven by customer needs and consumer demand and thus influencing this would be the driver for change rather than regulation. Over 30 respondents highlighted the need for creating incentives to purchase more efficient, greener vehicles. For some respondents (over 60 individuals), a perceived increase in the number of new cars in general and, in particular, high performance and 4x4 cars being sold, indicated that the legislation was having no effect.

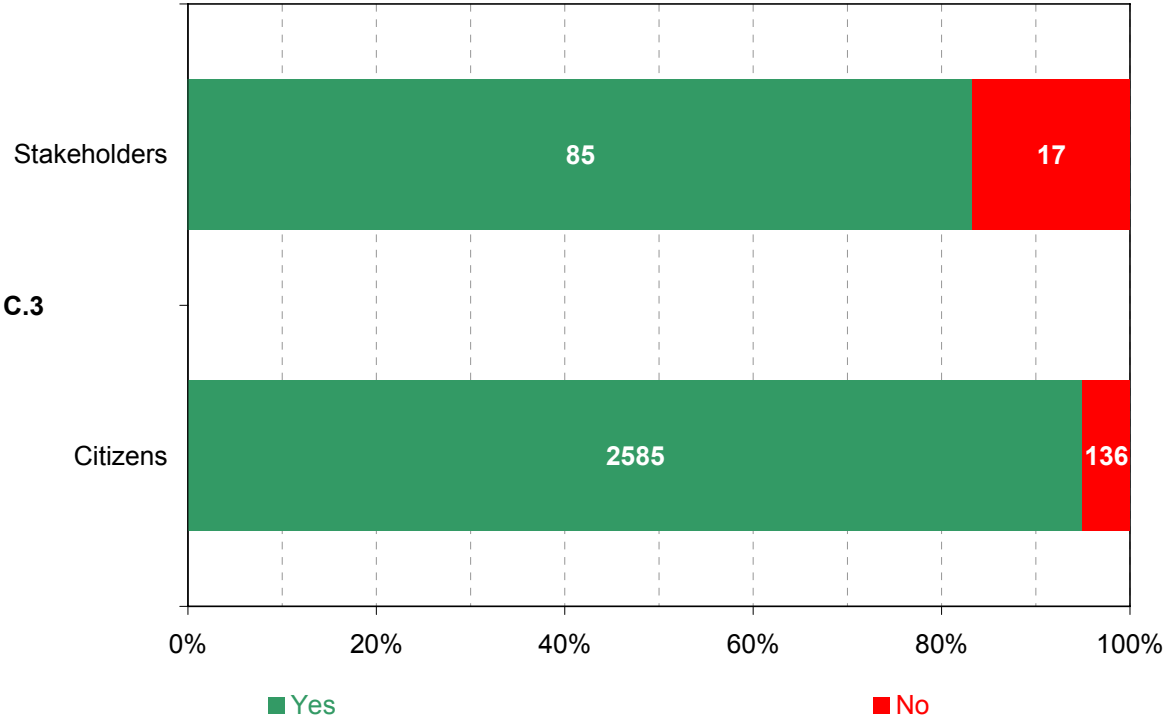
A number of organisations (including World Autosteel) questioned the use of tailpipe measurements, arguing that the legislation should focus on well-to-wheel emissions to enable a better assessment of overall vehicle emissions. Around 60 individuals also argued that more benefits could be obtained through focussing on other initiatives, including imposing more stringent standards on other industries and regulating emissions of other pollutants. Over 20 respondents highlighted that the current legislation was undermined by the fact that it does not regulate older cars, of which there are still a large amount in use. Other comments raised by a small number of respondents (individuals) included the need for alternatives to fleet average measurements, weight of vehicles relative to emissions, distortion between implementation of the legislation in member states, black carbon and the lack of a global market for low CO<sub>2</sub> vehicles.

### *Analysis of responses to **Question C.3***

**C.3** If the Commission's analysis demonstrates that the 2020 target of 147 gCO<sub>2</sub>/km for light-commercial vehicles is technically achievable, at reasonable cost, should the target be confirmed?

In response to this question, 83 % of individuals and 62% of stakeholders felt that the 2020 target of 147 gCO<sub>2</sub>/km for light commercial vehicles should be confirmed. A relatively small proportion of stakeholders (26%) and individuals (12%) had no opinion in relation to question C3.

**Chart 4** Answers to question C.3 in Part C



*Summary of responses to **Question C.4** (only answered by respondents answering no to question C3)*

**C.4** Please specify why the 2020 target of 147 gCO<sub>2</sub>/km for light-commercial vehicles, if technically achievable, should not be confirmed.

The respondents who did not agree that the 2020 target of 147 gCO<sub>2</sub>/km for light commercial vehicles should be confirmed mostly argued for a more ambitious level of reductions. A large number of individuals (over 80) claimed that, if the target can be achieved and it is not set at the limit of feasible reductions, it may not be ambitious enough and thus hinder innovation and delay the necessary CO<sub>2</sub> reductions. Furthermore a small number of individuals (around 10) felt that greater support and investment should be given to developing other technological solutions and cleaner technology. Some individuals (around 20) indicated that the target should be lowered to between 100-130gCO<sub>2</sub>/km or suggested (around 10) that the target date should be shifted to an earlier date than 2020 (e.g. 2015). On the other hand, International Road Transport Union (IRU) and some other organisations linked to IRU (e.g. German Bus and Coach Association) questioned the practicality of CO<sub>2</sub> efficiency standards claiming a fuel efficiency standard would be more appropriate and would give greater incentives for transport operators to invest in more efficient vehicles. Some respondents also pointed out the fact that well-to-wheel emissions should be part of the 2020 target (City of Stockholm and 5 individuals) or that the CO<sub>2</sub> standard should rather become an energy efficiency standard accompanied by standards on carbon content of fuels (2 individuals). Other comments raised by a small number of individuals (less than 5) included the need to focus on other areas in reducing CO<sub>2</sub>, the benefits of reducing the number of vehicles on the road and the importance of not allowing 'reasonable cost' to be a barrier to setting ambitious targets.

### 3. Future developments – beyond 2020

#### Analysis of responses to Questions E.1 and E.3

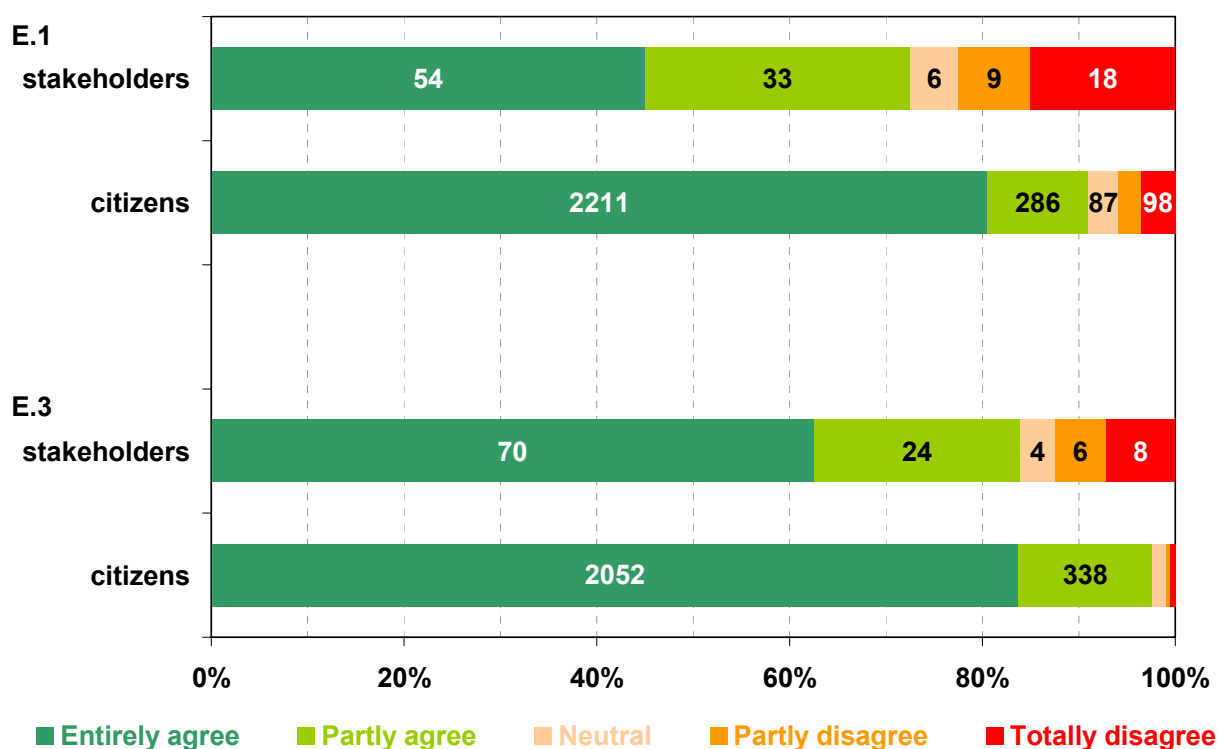
**E.1** Road-vehicle emissions may be reduced by changes in other policies, such as taxation. Should targets for road vehicles continue to be set, regardless?

**E.3** Should the approach to regulating road-vehicle emissions consider emissions from the whole energy lifecycle?

With regard to developments beyond 2020, there was a slight variation in the views expressed overall between stakeholders and individuals. A majority of individuals (81% entirely/partly agreed) and stakeholders (64% entirely/partly agreed) felt that targets for road vehicles should be set, regardless of the potential impact of other measures on road-vehicle emissions. Quite a significant number of stakeholders (20%) partly or totally disagreed that targets should continue to be set for road vehicles while less than 5% of individuals made similar responses.

There was general support for a life cycle energy approach to regulating road-vehicle emissions from individuals, with 66% entirely agreeing that this approach should be taken and 11% partly agreeing. Proportionally a smaller number of stakeholders were in favour of such an approach (69% entirely/partly in favour), with 13% either being neutral on the issue or disagreeing that a life-cycle energy approach should be adopted.

**Chart 5:** Answers to questions E.1 & E.3 in Part E



## *Summary of responses to Question E.2*

**E.2** In your opinion, which are the policies in which changes might affect the setting of greenhouse gas targets for road vehicles?

Respondents to this question highlighted a range of general policy areas in which changes might affect the setting of GHG targets for road vehicles. A common theme in a large number of responses (over 300 individual responses and over 30 responses from organisations) was a belief that taxation or fiscal policies could have a significant effect on the setting and achievement of targets. Many organisations listed taxation as a key policy area without providing further detail while some individuals highlighted specific tax policies including general taxes on fuel/cars/manufacturers, tax reductions/exemptions for company cars, lower taxes for low emitting vehicles, taxation on alternative fuels and carbon taxes. A large number of respondents (over 200 individuals) argued that policies promoting the use of alternative transport for freight, such as rail and river, and for people, such as walking, cycling, electric and hybrid vehicles, would have a significant effect on the setting of GHG targets. Furthermore over 100 respondents (inc. 5 from stakeholders) felt that policies promoting, developing and improving public transport would be important. In addition over 60 respondents argued that congestion policies, including environmental zoning and road charging, would reduce overall road usage and influence the setting of GHG targets. Further policy areas aimed at reducing road usage and long distance travel, such as general foreign & trade policies and the promotion of local production and consumption (over 75 individuals) were highlighted as being influential on the setting and achievement of targets. Improved industrial and employment policies and practices were also considered to be potential mechanisms through which road usage could be reduced.

A large number of respondents (over 120, including Transport & Logistiek Vlaanderen (Road Haulage Association) and European Road Haulers Association (UETR)) identified policies concerning the design, manufacturing and sale of vehicles as being areas in which further changes and improvements could impact on the setting of GHG targets. Policies in respect of research, development and promotion of alternative fuels (over 90 respondents) and energy/renewable energy (over 70 individuals) were also highlighted by respondents as important. A number of individual respondents (over 40) and organisations (including International Council on Clean Transportation, European Tyre & Rubber Manufacturers Association (ETRMA), Fédération nationale des transports routiers (FNTR), Federeation Internationale de l'Automobile (FIA)) felt that policies concerned with improving public education/awareness of emissions/green technology and behavioural campaigns could have an impact on the setting of GHG targets. A large number of respondents also felt that R&D and innovation (over 75, including 18 organisations) and investment in infrastructure and improved urban planning (over 60) could affect the setting of GHG targets.

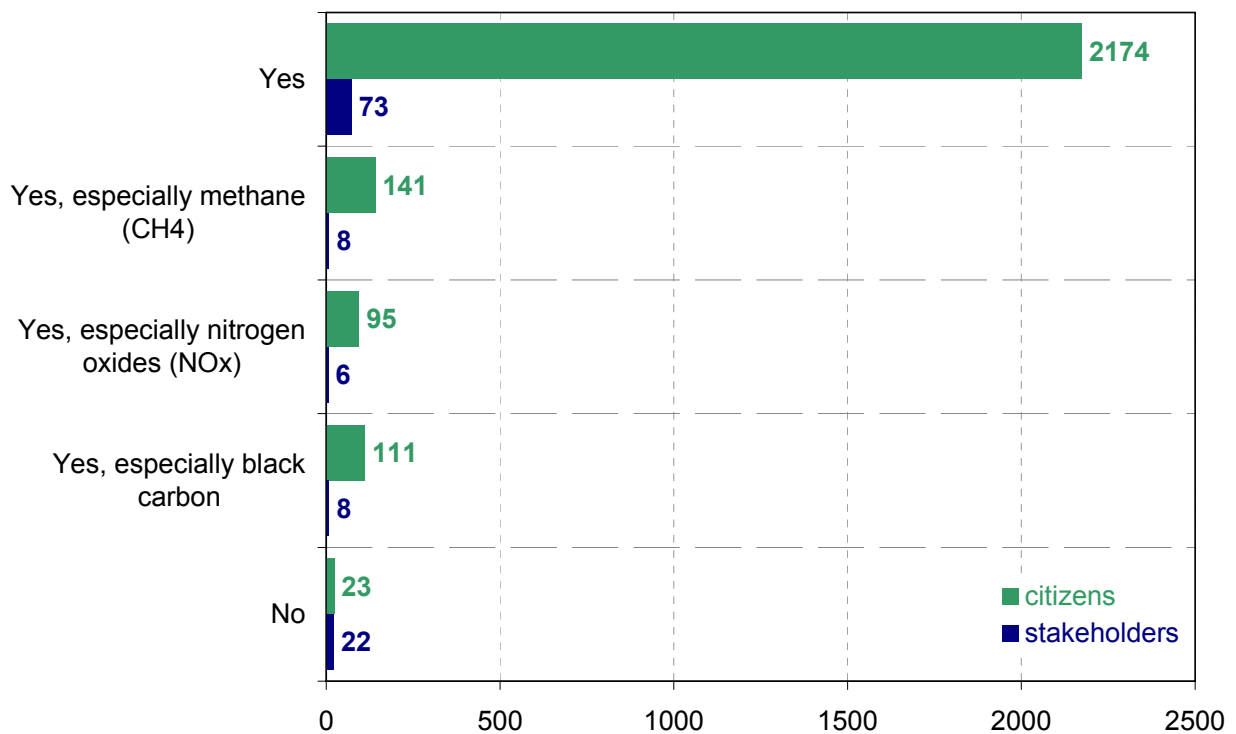
Organisations such as Transport for London, Jumbocruiser Limited, International Association of Public Transport (UITP) and Verband Deutscher Verkehrsunternehmen (VDV) highlighted emission policies such as the EURO classes legislation as an area which could affect the setting of targets while a significant number of individuals (over 90) provided general comments on the actual setting of emission limits and targets. Respondents also highlighted other general policy areas as being significant. These included general transport policy (150+), environment policy (70+), climate change policy (20+), air quality policy (8+), agricultural policy (10+), economic policy (75+), social policy (30+) and health policy (10+).

*Analysis of responses to Question E.4*

**E.4** Should other road-vehicle greenhouse emissions also be measured, alongside carbon dioxide (CO<sub>2</sub>)?

Individuals tended to be more demanding with regard to the issue of other road-vehicle greenhouse emissions being measured alongside CO<sub>2</sub>. 70% of individuals agreed that other greenhouse emissions should be measured with 5%, 3% and 4% specifically agreeing that methane, nitrogen oxides and black carbon respectively should be measured. Less than 1% of individuals felt that other greenhouse emissions should not be measured. 53% of stakeholders agreed that other greenhouse emissions should be measured with 6%, 4% and 6% specifically agreeing that methane, nitrogen oxides and black carbon respectively should be measured. 16% of stakeholders specified that other road-vehicle greenhouse emissions should not be measured.

**Chart 6:** Answers to question E.4 in Part E



*Analysis of responses to Questions E.5 & E.6*

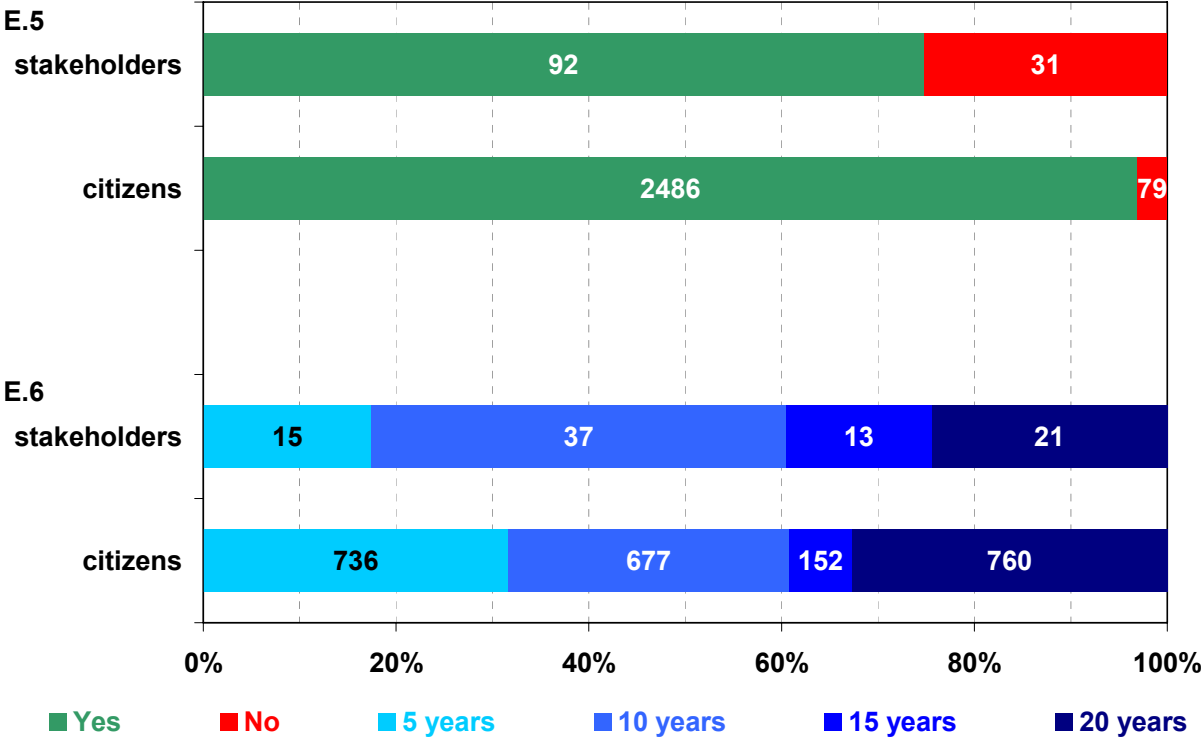
**E.5** Should longer-term indicative targets (for after 2020) be set?

**E.6** Please specify for what time period (following adoption of the related legislation)?

While the majority of both stakeholders (67%) and individuals (80%) agreed that longer term indicative targets should be set for after 2020, there was more opposition to this amongst stakeholders with 23% disagreeing with the setting of longer term indicative targets as opposed to only 3% of individuals disagreeing with the setting of longer term targets. 17% of individuals and 10% of stakeholders provided no opinion on question E5.

Responses in relation to the time frame for such legislation were quite mixed amongst both stakeholders and individuals. A quarter of all individuals chose not to answer question E6 or expressed no opinion, but of those that did 32% felt that the time frame for targets (following adoption of the related legislation) should be within 5 years, 29% specified 10 years, 15% specified 15 years and 33% specified that 20 year targets should be set. With regard to the stakeholder responses, 63% provided an answer to E6. Of these respondents, 17% felt that the time frame for targets (following adoption of the related legislation) should be within 5 years, 43% specified 10 years, 15% specified 15 years and 24% specified that 20 year targets should be set.

**Chart 7:** Answers to questions E.5 & E.6 in Part E



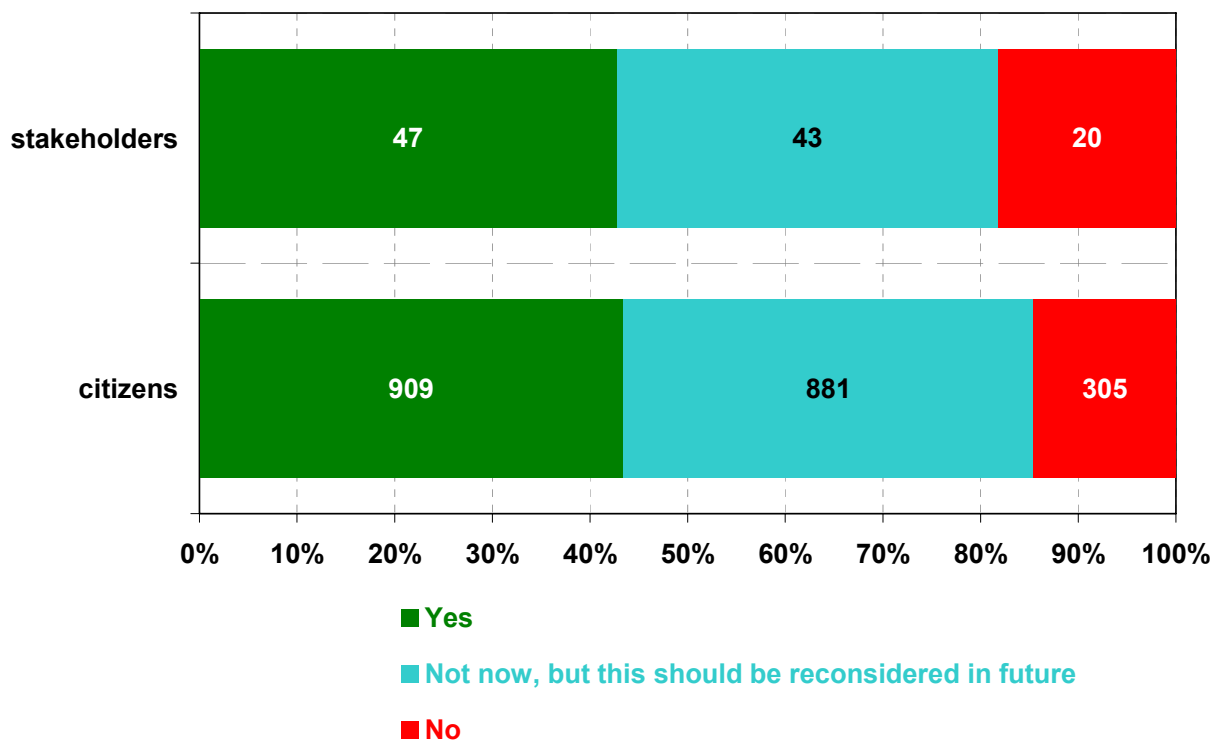
*Summary of responses to **Question E.7** (only answered if respondents answered No to Question E5)*

**E.7** Please specify why long term indicative targets for after 2020 should no be set

The respondents who did not agree that long term indicative targets (for after 2020) should be set mostly argued that it was more appropriate to focus on implementing action in the short term to reduce CO<sub>2</sub> and achieve the targets already set for 2020. Around 10 organisations (including representatives of the car industry) and 20 individuals questioned the practicality of setting indicative targets for beyond 2020 without having knowledge of the developments in technology which may or may not materialise between now and then. In addition, 10 respondents claimed that short term targets are more achievable than unrealistic long term targets. The International Road Transport Union further stated that, in the absence of new procedures for the declaration of fuel consumption and CO<sub>2</sub> generation of complete transport units being designed, voluntary targets set by the transport industry should be encouraged.

Other comments raised by a small number of respondents (<3) included the setting of conditioned fleet targets, the limited positive impact of legislation on small business, the restriction of private vehicle use and the inconvenience for hauliers of too many policy changes.

**Chart 8:** Answers to questions E.8 in Part E



*Analysis of responses to Question E.8*

**E.8** The current legislation contains vehicle-based targets until 2020. For post-2020, should we consider alternatives to vehicle-based greenhouse gas regulation?

In relation to question E.8 and the possible consideration of alternatives to vehicle-based targets post 2020, responses were generally quite similar amongst stakeholders and individuals. 34% of stakeholders and 29% of individuals agreed that alternatives to vehicle based regulation post 2020 should be considered. 31% of stakeholders and 28% of individuals felt that alternatives to vehicle based regulation should not be considered now but be reconsidered in the future, while 15% of stakeholders and 10% of individuals felt that alternatives to vehicle based regulation should not be considered. A significant number of stakeholders(20%) and individuals(32%) had no opinion or chose not to answer the question.

*Summary of responses to Question E.9*

**E.9** Please specify which alternatives

The respondents who provided comments on alternatives to vehicle based greenhouse gas regulation (post 2020) highlighted a number of other policy areas and initiatives in which further measures could be implemented to reduce the emission of greenhouse gases. A common theme in a number of responses from individuals (around 65) was a desire for the promotion and development of improved rail and river networks for the transportation of both



people and goods. These individuals argued that a reduction of road usage is key to reducing pollution and a proportion of these respondents also recommended that more widespread, targeted congestion measures and road-charging policies should be implemented in towns and cities. In tandem with these comments, a significant number of other respondents (around 40) highlighted the importance of developing, promoting and incentivising the use of public transport, walking and cycling as viable, affordable and safe alternatives to the use of private vehicles. Further promotion and development of electrically powered vehicles was supported by organisations including Shecco and Going Electric as well as individuals, as was the research, development and promotion of alternative fuels and more sustainable/renewable energy sources (individuals). The promotion of local production and consumption was also considered to be economically and environmentally advantageous by individuals.

A large number of respondents (greater than 60) argued that a holistic approach was required with regard to the regulation of all industries/sources of pollution in society, with particular reference being made by some to the airline and energy production industries. A number of transport and motoring organisations, including Transfrigoroute International and IRU, highlighted the importance of implementing a wide range of initiatives in the field of transport, energy and fiscal policy as well as industry led initiatives to reduce fuel consumption. Taxation policy was also viewed as a key tool by individual respondents (around 40), who argued that further initiatives, ranging from the introduction of a carbon tax to having higher taxes on companies/consumers producing/purchasing high emitting vehicles and vice versa, could have a significant effect on the manufacturing, promotion and sale of goods (in particular vehicles) with a subsequent effect on the environment. Some respondents (around 30) also pointed out the fact that well-to-wheel emissions should be part of all future targets (City of Stockholm), while other respondents (around 15) supported the introduction of a personal carbon allowance (or cap and trade) scheme.

Both individual (around 15) and organisational (including ETRMA) respondents supported the undertaking of further research and stakeholder engagement on possible alternative policy options and the development of new technology for reducing pollution. A number of individuals (around 15) supported measures to regulate and improve the design and production of vehicles, with particular focus on the energy costs and emissions from vehicle production, the weight of vehicles and the type and recyclability of materials used in vehicle production.

#### **4. Additional comments (evaluation of part F)**

The comments provided as additional input covered a wide range of issues concerning light-duty and heavy-duty vehicles.

##### **Light-Duty Vehicles**

A substantial number of individuals (almost 300) felt that it was essential for Europe to continue to lead by example in making efforts to reduce GHG emissions from transport. The majority of these respondents felt that binding legislation, which forces manufacturers to develop, produce and promote more efficient vehicles, is key to reducing overall transport emissions. Furthermore, a large number of individuals (around 100) specifically called for the setting of more ambitious targets and the taking of more urgent action to reduce the impact of transport emissions, raising concerns about the environmental consequences of delayed action on emissions or a lack of action. Some respondents (around 20), including the consumer organisation, highlighted the benefits to consumers of greater fuel efficiency of light-duty

vehicles and thus affordable mobility in the context of increasing fuel prices, and called for greater use of vehicle regulation rather than, for example, targets on share of biofuels. A similar number of respondents (individuals) noted other co-benefits of increased fuel efficiency such as greater energy security, better air quality, and savings on fuel spending. Greenpeace and a significant number of individuals (around 50) called for targets for both cars and commercial vehicles to be set for 2025 which should be in line with the effort needed to decarbonise transport by 2050. Public authorities generally stated that the indicative targets for 2025 and 2030 should be set prior to 2015 to give sufficient planning certainty to the industry. A large number of individuals (over 80) felt that the car industry had too much influence and lobbying power and that it was essential that vehicle manufacturers were led by policymakers rather than the reverse.

On the other hand, representatives of vehicle manufacturers raised concerns over setting long-term targets and called for the focus on implementation of the existing legislative framework. Representatives of the automotive industry highlighted that the targets in place are already challenging. According to these contributions, the targets should not be dismissed as unambitious because the good progress the industry has made is due to the substantial investments of car manufacturers in the recent past. They called for taking account of duration of the life cycle of products and the necessity to set the targets which are known to be achievable already today. A delivery company raised concerns of a possible extra burden on the vehicle users in case the legislation is unbalanced and discriminatory across transport users.

Some respondents (around 10) highlighted the need to change the current scheme and base the legislation on the size-based utility parameter rather than mass. The problem of unrepresentative results of the official measurement of fuel consumption and the need to bring it closer to reality was brought up on several occasions (including by 5 individuals). One automotive manufacturer claimed the need to shift to a well-to-tank approach in evaluating the emissions from different sectors and sources, e.g. electricity generation for upstream emissions and automotive producers for tailpipe emissions. A number of individuals (around 20) and organised stakeholders were in favour of regulating life-cycle emissions i.e. taking into account pollution resulting from the vehicle production phase, and involving a range of stakeholders- auto manufacturers, fuel suppliers and users- into action to reduce CO<sub>2</sub>. Other individuals (around 35) felt that it was important for manufacturers to continue to invest in research and development and to improve the design and use of technology in vehicles.

A lot of respondents (individuals) referred to the need for a wider integrated legislative approach leading to behavioural change (over 50) and greater transport efficiency e.g. incentives to shift from personal to public transport (around 75), a reduction in road usage and congestion (around 70), appropriate fiscal incentives (around 80), alternative modes of freight transport such as rail and river (around 80), incentives for and promotion of alternative fuels and energy sources (around 80) including those in the early phase of development, a sustainable mobility policy (around 30), and the promotion of local production and consumption (around 40). Respondents representing transport operators claimed the incentives to upgrade their fleets to increase efficiency should be allowed to ease the burden of upfront investments, e.g. financial incentives etc. The same respondents were against speed limiters for light commercial vehicles claiming these could lead to reverse modal shift to other less efficient modes of transport. Transport associations were also concerned by the impact of legislation on SME's and lack of coherent approach of EU transport policies.

Other comments raised by a small number of individuals (less than 10) included the need to review the current scheme by including upstream emissions from production of fuels, extension of the scope of CO<sub>2</sub> standards to other categories of vehicles (e.g. non-road mobile machinery), labelling of vehicles, personal carbon quotas, the need for a worldwide international approach to fighting climate change, the need to reduce emissions of all pollutants and a reduction in speed limits.

### 7.3. List of participants in the stakeholder meeting 6 December 2011

European Aluminium Association  
European Hydrogen Association  
Industry Grouping for a Fuel Cells and Hydrogen Joint Undertaking  
European Association for Battery, Hybrid and Fuel Cell Electric Vehicles  
Association for Emissions Control by Catalyst  
European Car Manufacturers Association  
Conservation of Clean Air and Water in Europe  
Japan Automobile Manufacturers Association  
HONDA (JAMA Europe)  
SUZUKI (JAMA Europe)  
European Renewable Ethanol Association  
Association of European Small Volume Manufacturers  
McLaren (ESCA)  
LOTUS Cars (ESCA)  
ASTON MARTIN (ESCA)  
Burson-Marsteller (consultant to ESCA)  
PEUGEOT CITROEN  
TOYOTA  
VOLKSWAGEN  
FIAT  
DENSO  
BOSCH  
European Association of Automotive Suppliers  
Johnson Controls International  
HYUNDAI Motor Company  
Transport and Environment  
European Climate Foundation  
Greenpeace EU  
Greenpeace UK  
DAIMLER  
VOLKSWAGEN  
Organisme Technique Central  
RENAULT  
BETTER PLACE  
Ministry of Interior, HUNGARY  
Ministry for Ministry of Infrastructure and Transport, ITALY  
Environment and Nature Policy Section of the Permanent Representation of the NETHERLANDS to the EU  
Ministry of Infrastructure and the Environment, Directorate General of the Environment, section Climate and Air Quality, NETHERLANDS  
Leaseurope  
Ministry of Economy, Trade and Business Environment; ROMANIA  
Ministry of Science, Industry And Technology, Automotive Industry Department; TURKEY  
Office for Low Emission Vehicles, UK LEV  
Department for Business, Innovation and Skills, UK  
Department for Transport, UK

The Society of Motor Manufacturers and Traders Limited  
Low Carbon Vehicle Partnership  
The International Council on Clean Transportation  
Verband der Automobilindustrie  
Ministry of Transport, BELGIUM  
Ministry of Environment, BELGIUM

## 7.4. Summary of the stakeholder meeting of 6 December 2011

Chairman: Philip Owen, DG Climate Action

The aim of this meeting was to present to stakeholders the work carried out so far by contractors (TNO consortium)<sup>1</sup> which will underpin the reviews of the modalities of achieving the 2020 targets set in Regulation 443/2009/EC (CO<sub>2</sub>/cars) and Regulation (EU) 510/2011 (CO<sub>2</sub>/vans). In addition, the Commission also presented its intentions for considering these emissions beyond 2020.

### 1. Introduction

The European Commission, DG Climate Action opened the meeting and outlined the context of the discussion highlighting the EU's objective of 80-95% GHG reduction by 2050 and the ongoing Commission initiatives such as *'Roadmap for the competitive low carbon economy in 2050'* and the *'Transport White Paper'*. The role of transport decarbonisation in meeting the EU 2050 targets, as well as co-benefits of increased energy security and competitiveness of the EU automotive industry were highlighted.

### 2. Presentation of car analysis

The contractor presented the main findings of the study 'Support for the revision of Regulation 443/2009 on CO<sub>2</sub> from cars'. Data on vehicle fleets, technologies, costs and projections of the likely cost and technological means of achieving the 2020 targets had been gathered. The study analysed the cost impacts and distribution of effort between manufacturers depending on the choice of modalities i.e. the utility parameter (mostly mass and footprint), different shapes and slopes of the limit value curve, and some other flexibilities (e.g. super credits, banking and borrowing).

Stakeholders were invited to ask questions and make comments.

#### Summary of discussion

- Costs

Stakeholders asked for clarification regarding the differences between the alternative cost curves included in the report, notably the differences between the curves based on input from ACEA and those based on US EPA analysis. The environmental groups (T&E, Greenpeace, ECF) praised an approach of looking at alternative cost curves in particular using data from other parts of the world, and also taking account of additional progress in average CO<sub>2</sub> emissions in 2002-09 not explained by the technological improvements.

The issue of unexplained progress was discussed. The contractor explained that the progress not due to technologies on the cost curve was believed to have arisen using other technologies, powertrain optimisation and utilisation of flexibilities in the test procedure. A significant part of the reductions were not from the technology cost curve and it was likely that each scenario had elements of truth. While US data was key, EU industry data could not

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<sup>1</sup> Consortium composed of TNO, Ricardo, IHS Global Insight, CE Delft, Okopol, AEA Technology, Transport and Mobility Leuven; analysis carried out under Framework Contract on Vehicle Emissions - No ENV.C.3./FRA/2009/0043

be ignored. ECF argued that the scenarios including this unexplained progress had to be the central assumptions for the Commission's further analysis.

ESCA stated that in the period before the CO<sub>2</sub>/cars legislation, manufacturers did not have so much incentive to reduce CO<sub>2</sub> emissions and this sudden improvement of average emissions is probably linked to careful engine tuning, cheap technological improvements and exploiting test-cycle flexibilities, and these would have been essentially cost free.

An extensive discussion took place regarding the extent to which the costs of meeting emissions targets are passed through to consumers via vehicle prices. The contractor explained that the relationship between these factors is not straightforward, especially since the prices of vehicles have not increased despite substantial improvement in car fuel efficiency seen in the last decade. Even though these reductions required investment by manufacturers, the efficiency gains in other aspects of vehicle production could have outweighed these costs. A further Commission study<sup>2</sup> on this subject was mentioned.

- Utility parameter

Several participants (SMMT, LowCVP, ESCA) enquired about the impacts of changing the utility parameter from reference mass to footprint and the additional cost of this shift. The consultant explained the methodology underlying the analysis and highlighted the conclusion that the additional average cost of changing the parameter to footprint would be only €10 higher than maintaining mass, and that this effect is due to the usage of the same cost curve for both parameters. If a separate cost curve was constructed for footprint it would result in lower cost of light weighting which is more effective for footprint. The result would therefore be a somewhat lower average cost for footprint (estimated at around €60 less than for mass).

LowCVP expressed regret that a similar analysis based on alternative cost curves from the US EPA analysis was not carried out in view of their much lower weight reduction costs. The consultant explained that further work was needed to ensure the appropriateness of the US analysis for the characteristics of the EU fleet. A discussion regarding differences in expected costs of light weight technologies in the EU and US followed, with an indication of a wide range of different approaches underlying the EU and US cost assumptions.

- Limit value curve

The representative from ESCA questioned whether the linear curve was a proper function, especially for vehicles at the extremes which are usually produced in low volumes and have a negligible impact on total CO<sub>2</sub>. The contractor explained that overall for the purpose of defining limit functions there is no convincing alternative, for example non-linear curve or other function, and that for this reason small-volume manufacturers have a separate provision under the current scheme.

- Co-benefits

T&E and Greenpeace asked the Commission to take a proper account in the impact assessment of the benefits resulting from greater fuel efficiency of vehicles such as fuel savings to consumers, impact of lower demand for oil imports on prices of oil, shift of oil

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<sup>2</sup> *"Effect of regulations and standards on vehicle prices"* available for download at: [http://ec.europa.eu/clima/policies/transport/vehicles/cars/docs/report\\_effect\\_2011\\_en.pdf](http://ec.europa.eu/clima/policies/transport/vehicles/cars/docs/report_effect_2011_en.pdf)

expenditure to other sectors of the EU economy and increases in employment in R&D and manufacturing.

- Other interventions

The ICCT explained that the US legislation sets a target of 50% reduction by 2025 which is supported by 13 manufacturers. This target when translated to the EU fleet characteristics means an equivalent of 70-80 gCO<sub>2</sub>/km. ICCT also explained that in January it will have new information on technology cost, which seems likely to show lower costs than the TNO analysis.

Better Place stated that in their view battery cost assumptions used were too high making electrified powertrains appear less attractive than they already are.

ACEA noted that the study covers the issues well. It highlighted that this microeconomic analysis should be put in the macroeconomic context of the EU economic situation and uncertainties as to how the market will look in 2020. ACEA expressed preference for a stable regulatory scheme and expressed concerns if a shift from mass to footprint was favoured arguing that the correlation between CO<sub>2</sub> and mass is better than with footprint. Footprint may be similar for vehicles with different design thus it does not necessarily reflect the utility of the vehicle as claimed. ACEA stated that the majority of countries in the world (including China, Japan, South Korea) base their CO<sub>2</sub> or fuel economy standards on mass. It also outlined its main concerns regarding CO<sub>2</sub> monitoring. Finally, ACEA argued that manufacturers should have flexibility as to how they reach the long-term target and therefore intermediate targets are not desirable.

### **3. Presentation of van analysis**

The contractor presented the interim results of the equivalent analysis carried out for light commercial vehicles (vans). The feasibility of the 2020 target for vans needs to be confirmed and according to the updated analysis the target can be met at an additional average cost of €550. This is lower than assumed in the 2008 report, partly due to a shorter distance to the target (the fleet average emissions of 203g CO<sub>2</sub>/km in 2007 dropped to 181g CO<sub>2</sub>/km in 2010). In addition, the consultants have analysed the possibility of using the alternative utility parameters of footprint and payload.

Stakeholders were invited to ask questions and make comments.

#### Summary of discussion

- The 2020 target

In view of the 22 gCO<sub>2</sub>/km drop in average emissions from 2007 to 2010, T&E expressed concern as to the discrepancy between the reduction effort expected from cars and vans and lack of sufficient incentives to use reduction technologies that will be used in cars. The contractor explained that the answer lies partly in the lower quality of 2007 data and partly in a possible overestimation of the baseline.

The environmental groups claimed that a more stringent 2020 target may be necessary.

- Utility parameter



The European Aluminium Association highlighted that the utility parameter should primarily be correlated with utility rather than CO<sub>2</sub> and called for technological neutrality in regulatory design. They argued that using mass as the parameter disadvantages lightweighting. T&E argued that it was important to move away from mass since this could reduce compliance costs and it was difficult to see why manufacturers oppose it.

The ICCT confirmed that the 2010 average in LCV market was 180 gCO<sub>2</sub>/km according to their database, and suggested that in order to overcome the difficulties of using footprint as a utility parameter for vans the fleet could be split into 3 sub-segments. The consultant highlighted possible perverse incentives for gaming due to separate limits per category within the same legislation.

Daimler highlighted that payload is one of the most important purchasing criteria thus there is still a benefit of making the vehicles lighter in case of a mass-based parameter. In addition, it stated that manufacturers have been improving fuel efficiency for years leading to the drop in average emissions. VDA also stated that the argument against mass giving a lower incentive for lightweighting is theoretical. The contractor disagreed with this statement claiming that some manufacturers have stopped development in this area while in the longer term lightweighting will be an increasingly important reduction technology. If mass is retained as a utility parameter some of this potential will be lost.

- Other issues

The representative from the Department for Transport (UK) asked to what extent the cross-over between cars and vans was taken into account in the cost curves. The consultant explained the cross-over cars/vans exists and the resulting cost reductions of wide-scale application of certain technologies in both categories. The cost curves include these learning effects where possible but whenever reduction technologies have a different potential in vans it is taken into account.

ACEA stated that they do not see any major change in cost estimates from the previous analysis. They also mentioned the problems with CO<sub>2</sub> data for vans, especially for multi-stage vehicles.

#### **4. Post-2020 issues**

The Commission presented its intentions for work on the post-2020 perspective for light duty vehicles. The presentation listed the concerns associated with this timeframe, i.e. the uncertainty as to the costs of technologies and the optimal reduction potential, as well as the conflict between these and industry's need for planning certainty. The presentation outlined the main points for upcoming analysis that will look at possible alternative regulatory metrics to the current approach of tailpipe emissions, and their impact on the attractiveness of different technologies. Finally, the Commission explained that a certain indication of a possible post-2020 reduction level is necessary in order to provide the industry with planning certainty as had been the case with the 2020 target. Such indication of a potential future level of ambition could be included in a Commission communication accompanying the proposals.

#### Summary of discussion

LowCVP highlighted that a technology neutral approach would mean that the entire life cycle analysis would be needed and mentioned a study on this topic available on their website.

Metrics alternative to the tailpipe approach would give a lot more opportunities for manufacturers to decide how to reduce their emissions.

T&E supported discussion on this topic and added that in addition to a change of metric two other issues needed to be taken into account: change of test-cycle and revision of the Labelling Directive. The appropriate order for these actions should be established. It also questioned why trading schemes were included as no stakeholder was requesting these. Greenpeace support setting intermediate targets in line with a 95% decarbonisation objective. They stated that the car sector is able to achieve zero emissions and that it may be necessary to accelerate reductions beyond 2020.

ACEA said that agreement was needed on where to go, but there was no industry position on this topic yet. ACEA called for a new integrated approach post-2020 whereby all actors involved would contribute towards the emission reductions. Finally, ACEA expressed preference for setting a long-term perspective first and allowing for the flexibility as to the ways of achieving these targets.

ECF highlighted the role the transport sector has to play in decarbonisation, and highlighted that road transport can deliver a big share of these reductions. ECF urged the Commission to set an ambitious pathway, especially in view of expected wider penetration of electric vehicles.

VDA raised the issue of uncertainty in the long-term perspective and questioned the possibility of defining an optimal reduction target without knowing what is possible. The Commission explained that the thought had been for a Communication accompanying the proposals to contain indicative targets or ranges with a further step of detailed analysis a few years later. It was highlighted that US legislation defines a target for 2025 already now.

UK argued that a vision for emission reductions is needed and pointed out that some of the embedded and lifecycle emissions are regulated even if not within the vehicle Regulations.

ESCA supported the view that further work on well-to-wheel reductions is needed and would also like to see a technology-neutral scheme, also from the point of view of emissions covering other GHGs not just CO<sub>2</sub>. ESCA stated that trading would introduce uncertainty.

## **5. Other issues**

Mileage weighting – in view of the potential improvement in cost effectiveness, is it worth considering taking account of vehicle lifetime mileage in the regulatory scheme?

The participants were unenthusiastic about this option and referred to difficulties of obtaining mileage profiles for different categories of vehicles and EU Member States, and the need for a robust monitoring of mileage. T&E highlighted a trade-off between complexity and effectiveness, the danger of loopholes and the need to ensure the environmental integrity of such a scheme. LowCVP raised concern over potential market distortion and a lower reduction pressure on larger vehicles. VDA mentioned the complexity, lack of data and potential disadvantages to certain manufacturers based on their portfolio. Better Place had concerns over data, future changes in mileage and its belief that a shift from oil was the key objective.

Eco-innovations – is there a need to continue this flexibility?

VDA and CLEPA stated that there will always be off-cycle technologies and that it is important to provide incentives for such innovative technologies. T&E argued that a new test-cycle that requires all devices to be operated would remove the need for such flexibility. Greenpeace were critical and stated that the best incentive for innovative technologies are tough targets. UK supports the principle of eco-innovations but thought the process could be improved and costs reduced. SMMT said that eco-innovations help to keep the cost of compliance with the legislation down.

Super-credits – in view of the fact that they lead to an increase in overall CO<sub>2</sub> emissions, are these a desirable feature?

Better Place was in favour of keeping the super-credit scheme to advance market penetration of alternative powertrains and phase-out oil use in transport. T&E argued the main objective of the legislation is to save CO<sub>2</sub> emissions with oil reduction as a co-benefit. Greenpeace opposed super-credits and stated that EVs would already be cost effective according to the study and so tough targets would be enough to see more low emitting cars on the road.

Other comments

VDA asked the Commission to reopen the discussion on how to incentivise consumers to make use of the technologies appropriately (e.g. ecodriving).

T&E asked for the issue of speed limits to be considered in view of the evidence from Spain showing a 9% reduction in fuel use following slightly lower speed limits.

ICCT asked for consideration to be given to how consumers can be encouraged to buy efficient cars and the use of intelligent feebates and labelling.

## **6. Closing comments**

The Chairman summarised the discussion, outlined the next steps and closed the meeting.

## 7.5. General policy context

- **EU commitment to reduce GHG emissions**

To avoid the most dangerous impacts, the EU has a stated objective of limiting global climate change to a temperature increase of 2°C above pre-industrial levels. The Copenhagen Accord<sup>3</sup> included reference to this objective. In order to have a likely chance to limit long term global average temperature increase to 2°C or less compared to pre-industrial levels, global emissions need to peak by 2020 and be reduced by at least 50% globally by 2050 compared to 1990. The EU has endorsed this GHG emission reduction objective.

The European Council reconfirmed the EU target of 80-95% by 2050 compared to 1990 in the context of necessary reductions according to IPCC by developed countries as a group, with the aim of keeping average global temperature rise below 2 degree Celsius as compared to pre-industrial levels. However, current EU policies would only lead to ca. 40% reduction in GHG emissions by 2050. Therefore, the European Commission proposed the '*Roadmap for moving to a competitive low carbon economy in 2050*'<sup>4</sup> (hereinafter 'the Roadmap') looking beyond the 2020 objectives and setting out a plan to meet the long-term target of reducing domestic emissions by 80% by mid-century. The Roadmap provides guidance on how this transition can be achieved in the most cost-effective way. According to the Roadmap and the underlying analysis every sector of the economy must contribute and, depending on the scenario compared to 1990, transport emissions need to be between +20 and -9% by 2030 and decrease by 54-67% by 2050<sup>5</sup>.

In March 2011 the Commission also adopted the '*Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*' (hereinafter the White Paper on Transport) which outlines the main challenges facing transport, including scarcity of oil in future decades, extreme volatility of oil prices and the need to drastically reduce world GHG emissions. It sets out future transport strategy within a frame of achieving a 60% reduction in transport GHG emissions by 2050. Improving energy efficiency of transport is one of the major contributors to the decarbonisation goal. The White Paper on Transport complements and is fully consistent with the Roadmap.

CO<sub>2</sub> emissions from transport have been growing over the last 20 years with an exception of 2008 and 2009 where a drop in CO<sub>2</sub> was combined with lower transport activity due to the economic slowdown. In 2008 around 70% of transport CO<sub>2</sub> emissions came from road transport<sup>6</sup>. As a result, it is the second biggest source of greenhouse gas emissions in the EU, after power generation and contributes about one-fifth of the EU's total emissions of CO<sub>2</sub>. Producing the fuel consumed by road transport adds about a further 15% to these emissions.

While emissions from other sectors are generally falling road transport is one of the few sectors where emissions have risen rapidly. Between 1990 and 2008 emissions from road transport increased by 26%. This increase acted as a brake on the EU's progress in cutting overall emissions of greenhouse gases, which fell by 16%. The share of LDV emissions as a proportion of road transport emissions is not known exactly, but is believed to lie between

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<sup>3</sup> UNFCCC, 2010, Decision 2/CP.15, Copenhagen Accord

<sup>4</sup> COM/2011/0112 final

<sup>5</sup> Excluding international maritime emissions

<sup>6</sup> *EU transport in figures 2011*, European Commission

66% and 75% of the total. Because the share is not known exactly it is not possible to be certain whether overall car emissions are increasing or decreasing.

In order to tackle road transport emissions, the European Commission implemented a comprehensive strategy designed to reach an objective of limiting average CO<sub>2</sub> emissions from new cars to 120 grams per km by 2012. In a progress report<sup>7</sup>, adopted in November 2010, the European Commission concluded that most of the measures contained in the 2007 strategy have already been implemented or are in the process of being implemented. The goal of reducing new car emissions to 120 gCO<sub>2</sub>/km by 2012, as defined in the strategy, is however not likely to be achieved because of changes to the timeline of some measures. In addition to the measures mentioned above, a number of complementary policies exist at EU and Member State level that assist in achieving the Regulations' goals. These include at EU level Directive 2009/33 on public procurement of vehicles, and at Member State level sales taxation, circulation taxes, other incentives (e.g. separate lanes or free parking spaces) and subsidies to procure low CO<sub>2</sub> emitting vehicles.

- **Innovation and competitiveness**

The EU is committed to innovation and boosting industrial competitiveness. Research and innovation drive productivity growth and industrial competitiveness. A transition towards a sustainable, resource efficient and low carbon economy is paramount for maintaining the long-term competitiveness of European industries. Competitiveness would be strengthened by favouring energy and raw material efficiency and promoting innovation and deployment of cleaner technologies along value chains with the use of long term incentives that encourage market creation and facilitate the participation of SMEs in these processes.

The automotive industry is faced with a number of challenges. Constraints on energy supply may exacerbate price volatility and lead over time to higher prices which can impact on demand for vehicles. Globally the market for LDVs is growing, however the geographical location of demand is changing with traditional markets such as the EU and USA stabilising but other parts of the world, Asia in particular, experiencing significant growth in demand for LDVs. This growth is accompanied by expanding LDV production in those areas of the world. New local manufacturers compete primarily for market share in those new markets at present but can be expected to compete more in the future in more traditional markets such as the EU.

The benefits of ensuring alignment between fighting climate change and encouraging innovation thus boosting competitiveness is summed up in the Roadmap for a competitive low carbon economy which states that *"...action, sometimes more ambitious than what countries would be ready to commit to internationally, is driven to a significant extent also by other domestic agendas: to accelerate innovation, increase energy security and competitiveness in key growth sectors and reduce air pollution. A number of Europe's key partners from around the world, such as China, Brazil and Korea, are addressing these issues, first through stimulus programmes, and now more and more through concrete action plans to promote the "low carbon economy". Standstill would mean losing ground in major manufacturing sectors for Europe."*

Increasing production and sales of LDVs in parts of the world other than the EU, North America and Japan are likely to result in increased competition in the automotive market.

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<sup>7</sup> Progress report on implementation of the Community's integrated approach to reduce CO<sub>2</sub> emissions from light-duty vehicles COM/2010/0656 final

Evidence from US suggests that failure to innovate weakens manufacturers' competitiveness. Increased global competition for energy resources is likely to lead to higher and more volatile prices. Parts suppliers compete globally. EU suppliers who have developed technology for application in the EU market will be better placed to sell this technology to manufacturers in other regions, especially if there is a short time lag between the requirement from EU regulations and those brought in other areas.

- **Energy use**

Oil, the main source of energy for road transport, is a limited resource and so will become increasingly scarce in future decades. Despite becoming more energy efficient, transport still depends on oil for 96% of its energy needs. Gasoline and diesel supply 95% of energy use in road transport. Road transport uses about 26% of all energy in the EU. For every unit of energy used in road transport, the process of extracting and refining the oil consumes a further 15%. While measures to improve performance in that sector are outside the scope of the current policy, that energy use and associated emissions will decrease as the energy used in vehicles reduces. This means that cars and vans combined (hereinafter light-duty vehicles) consume about 35% of EU oil consumption (including the energy used in refining the fuel) and about 18% of total EU final energy consumption. Their use results in the emission of approximately 13.5% of total EU CO<sub>2</sub> emissions including refinery emissions.

The sourcing of oil and the market structure may lead to increasing price volatility. While there are substantial sources of alternative fossil fuels, these mostly result in higher greenhouse gas emissions than oil making their use unviable in a climate constrained world. In 2005 oil prices were around \$59/barrel, since then they have been consistently higher and are projected to more than double from 2005 levels by 2050. Globally, the number of cars is projected to increase from around 750 million today to more than 2.2 billion by 2050<sup>8</sup>. Over that time transport is projected to account for almost 90% of increased oil use.

Energy security is an ongoing concern. The share of oil expenditure as a proportion of EU GDP has reduced dramatically since the 1970s. This has helped to improve the EU's resilience to oil price shocks. Measures that further reduce energy consumption in transport and thus reduce the energy needed per unit of activity in the economy, such as increased energy efficiency of vehicles, will further strengthen the EU's energy security.

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<sup>8</sup> IEA, Transport White Paper

## 7.6. Summary of car and van CO<sub>2</sub> Regulations

As part of the EU's overall strategy to reduce GHG emissions from cars and vans, two Regulations were adopted specifically aimed at setting CO<sub>2</sub> emission targets for new vehicles. Regulation (EC) No 443/2009, setting emission performance standards for new passenger cars was adopted by the European Parliament and the Council in 2009. The overall aim of the legislation is to ensure that average emissions from new passenger cars in the EU do not exceed 130 gCO<sub>2</sub>/km by 2015 and should decrease to 95 gCO<sub>2</sub>/km by 2020.

Similarly, in May 2011, the EU adopted legislation (Regulation (EU) No 510/2011) to reduce emissions from vans ('light commercial vehicles'). The vans Regulation will cut emissions from vans to an average of 175 gCO<sub>2</sub>/km by 2017 – with the reduction phased in from 2014 - and to 147 gCO<sub>2</sub>/km by 2020 although the latter target is subject to confirmation of feasibility.

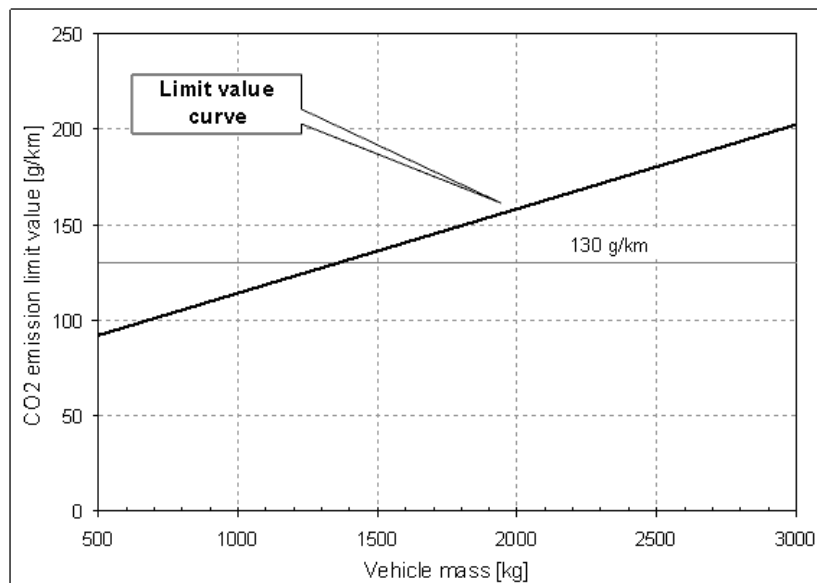
Key elements of the adopted legislation are as follows:

### Limit value curve

The targets in the Regulations are set according to the limit value curves expressed as formulae (in annexes I to the Regulations). The limit value curves differ for cars and vans and are designed in such a way that that heavier cars/vans are allowed higher emissions than lighter cars/vans while preserving the overall fleet average. This means that only the fleet average is regulated, so manufacturers are still able to make vehicles with emissions above their indicative targets if these are offset by other vehicles which are below their indicative targets. In order to comply with the regulation, a manufacturer will have to ensure that the overall sales-weighted average of all its new cars or vans does not exceed the relevant limit value curve.

The limit value curve has a certain slope (parameter 'a' in the formulae). The slope of the curve does not change the overall outcome in terms of average gCO<sub>2</sub>/km, it only defines the distribution of reduction effort between vehicles with different values of utility parameter, in this case mass. The curve is rotated around the point set by the average vehicle parameter (1372 kg in case of cars and 1706kg for vans) and the average CO<sub>2</sub> target to be achieved by the overall fleet (130 gCO<sub>2</sub>/km for cars and 175 gCO<sub>2</sub>/km for vans). This ensures that the same overall target is achieved. If the curve has a lower slope, the degree of effort required is proportionately greater from vehicles with a larger parameter (mass or footprint). If the curve is steeper then the effort required is proportionately greater from vehicles that have a smaller parameter.

The curve for passenger cars is set in such a way that, compared to today, emissions from heavier cars will have to be reduced by more than those from lighter cars (lower slope). The limit value curve for cars is illustrated in the graph below.



The limit value curve for vans is different in its value and its slope because cars are lighter and emit less CO<sub>2</sub> than vans. As compared to the cars limit value curve, the one for vans is steeper. As a result a similar level of reductions is required of vans of different sizes.

The precise formula for the limit value curve for cars is:

$$\text{Permitted specific emissions of CO}_2 = 130 + a \times (M - M_0)$$

Where:

- M = mass in kg
- M<sub>0</sub> = 1372.0
- a = 0.0457

The precise formula for the limit value curve for vans is:

$$\text{Permitted specific emissions of CO}_2 = 175 + a \times (M - M_0)$$

Where:

- M = mass in kg
- M<sub>0</sub> = 1706.0
- a = 0.093

### Phasing-in of requirements

In terms of passenger cars, in 2012, 65% of each manufacturer's newly registered cars must comply on average with the limit value curve set by the legislation. This will rise to 75% in 2013, 80% in 2014, and 100% from 2015 onwards.



With regard to vans, as of 2014, manufacturers must ensure that 70% of the new vans registered in the EU each year have average emissions that are below their respective targets. In 2015, the percentage rises to 75% and in 2016 to 80%, reaching 100% in 2017.

### **Lower penalty payments for excess emissions until 2018**

In case of cars and vans, if the average CO<sub>2</sub> emissions of a manufacturer's fleet exceed its limit value in any year from 2012 or 2014 respectively, the manufacturer has to pay an excess emissions premium for each car or van registered. For both cars and vans, this premium amounts to €5 for the first gCO<sub>2</sub>/km of exceedance, €15 for the second gCO<sub>2</sub>/km, €25 for the third gCO<sub>2</sub>/km, and €95 for each subsequent gCO<sub>2</sub>/km. From 2019, already the first gCO<sub>2</sub>/km of exceedance will cost €95.

### **Long-term target**

Targets of 95 gCO<sub>2</sub>/km for new passenger cars and 147 gCO<sub>2</sub>/km for vans are specified for 2020. Details of how these targets are to be reached, including the excess emissions premium, are presented in a proposal accompanied by this Impact Assessment. In addition, the 2020 target for vans is subject to confirmation of feasibility.

### **Eco-innovations**

Because the test procedure used for vehicle type approval is outdated, certain innovative technologies cannot demonstrate their CO<sub>2</sub>-reducing effects under the type approval test. The manufacturers can be granted a maximum of 7 gCO<sub>2</sub>/km of emission credits on average for their fleet if they equip vehicles with innovative technologies, based on independently verified data.

### **Super credits**

Both Regulations give manufacturers additional incentives to produce vehicles with extremely low emissions (below 50 gCO<sub>2</sub>/km). Each low-emitting car van will be counted as 3.5 vehicles in 2012 and 2013, 2.5 in 2014 and 1.5 in 2016. Similarly, each low-emitting van will benefit from the following multiplier 3.5 in 2014 and 2015, 2.5 in 2016 and 1.5 vehicles in 2017. This approach will help manufacturers further reduce the average emissions of their new car and van fleets. In case of vans, the manufacturers will be able to claim this 'super credit' for a maximum of 25 000 vans over the 2014-17 period.

### **Pools acting jointly to meet emission targets**

Manufacturers can group together to form a pool which can act jointly in meeting the specific emissions targets. In forming a pool, manufacturers must respect the rules of competition law and the information that they exchange should be limited to average specific emissions of CO<sub>2</sub>, their specific emissions targets, and their total number of vehicles registered.

### **Derogations**

Independent manufacturers of passenger cars who sell fewer than 10,000 vehicles per year, and who cannot or do not wish to join a pool, can instead apply to the Commission for an individual target consistent with their reduction potential. Manufacturers selling between 10,000 and 300,000 cars per year can apply for a fixed target of a 25% reduction from their 2007 average emissions.

Independent manufacturers of vans which sell fewer than 22,000 vehicles per year can also apply to the Commission for an individual target consistent with their reduction potential instead of joining a pool.

The tables below show derogations granted in 2011 for 2012 onwards.

**Table 1** List of manufacturers granted a niche derogation in 2011; \*Pooling 2012-2016

No	Niche OEM derogations granted in 2011	Registrations in 2010
1	Fuji Heavy Industries Ltd	30 655
2	Tata Motors* Jaguar Cars* Land Rover*	3582 23740 65534

**Table 2** List of manufacturers granted a small-volume derogation in 2011

No	Small volume OEM derogations granted in 2011	Registrations in 2010
1	Aston Martin Lagonda Ltd	1415
2	Caterham Cars Ltd	135
3	Ferrari S.p.A.	2361
4	Great Wall Motor Company Ltd	344
5	Koenigsegg Automotive AB	-
6	Lotus Cars Ltd	825
7	MG Motor UK Ltd	264
8	Morgan Motor Company Ltd	415
9	Proton	792
10	Ssangyong Motor Company	4785
11	Wiesmann GmbH	8
12	KTM-Sportmotorcycle AG	57
13	Litex Motors AD	-
14	Marussia Motors LLC	-
15	McLaren Automotive Ltd	-
16	Noble Automotive Ltd	-
17	Spyker Automobielen B.V	-
18	Mahindra Europe SRL	48

### Monitoring CO<sub>2</sub> emissions from new passenger cars and vans

Under the cars legislation, the Commission sets down rules on the data required to monitor the CO<sub>2</sub> emissions of new cars. The relevant national authorities in each Member State report annual registration figures for new cars to the European Commission, which collates the data. Manufacturers are invited to check that the data is correct. On that basis the Commission publishes, by 31 October each year, a list showing the performance of each manufacturer in terms of its average emissions and compliance with the annual emissions target. This allows for the manufacturers' progress to be tracked. With regard to vans, the Commission laid down

similar rules on the data required to monitor the CO<sub>2</sub> emissions of new vans. The Member States are required to monitor and deliver this data as of 2012.

For information the table below based on monitoring data provides reported registrations by manufacturing entity for 2010 where the number of vehicles registered is below the 300,000 registrations upper threshold for the niche derogation. The average vehicle mass and CO<sub>2</sub> emissions are also provided.

**Table 3** List of manufacturers below 300 000 annual registrations (data for 2010) excluding manufacturers pooling with OEMs larger than 300 000 registrations

Manufacturer Name	Pools (P) and Derogations (D- small volume; ND- niche)	Number of registrations	Average mass	Average CO <sub>2</sub> (100%)
SEAT		288629	1278.38	131.162
Kia Motors Europe GmbH		253706	1399.30	143.272
Automobile Dacia SA		251938	1237.01	144.989
Volvo Car Corporation		204926	1662.43	156.948
Mazda Motor Corporation		170007	1339.67	149.458
GM Daewoo Auto u. Tech. Comp.		146117	1253.96	143.544
Honda Motor CO	P1	102890	1343.77	143.823
<b>Honda Pool</b>		174637	1345,28	146,902
Magyar Suzuki Corporation Ltd.		87204	1177.91	136.665
Suzuki Motor Corporation		85177	1176.15	144.109
BMW M GmbH		77120	1652.88	156.242
Mitsubishi Motors Corporation (MMC)	P2	72594	1560.20	165.144
<b>Mitsubishi Pool</b>		89124	1463,58	158,122
Land Rover	D	65534	2351.43	231.494
Honda of the UK Manufacturing	P1	47840	1446.21	162.280
GM Italia S.r.l.		37670	1272.82	124.405
Dr.Ing.h.c.F. Porsche AG		34512	1855.34	238.859
Chrysler Group LLC		31121	1973.32	215.200
Fuji Heavy Industries Ltd.	ND	30655	1608.03	179.332
Chevrolet Italia		25442	1073.45	117.607
Jaguar Cars Ltd	D	23740	1900.33	199.016
Honda Automobile China CO	P1	20876	1133.46	126.094
Saab Automobile AB		19979	1676.64	175.341
Maruti Suzuki India Ltd.		19577	932.36	104.287
Daihatsu Motor Co. Ltd.		18972	1108.86	145.374
Mitsubishi Motor R&D Europe GmbH	P2	16530	1039.25	127.284
Dr Motor Company S. r. l.		4943	1167.22	138.566
Ssangyong Motor Company	D	4785	2023.10	215.728

Autovaz		3911	1293.44	219.516
Tata Motors Limited	D	3582	1293.00	151.987
Quattro GmbH		2596	1899.39	299.034
Ferrari	D	2361	1751.12	322.468
The London Taxi Company		1662	1902.13	227.739
Maserati S.p.A.		1626	2009.18	362.557
Honda Turkiye AS	P1	1587	1274.84	156.624
General Motors Company		1490	1847.93	296.400
Honda Automobile Thailand CO	P1	1444	1171.03	142.615
Aston Martin Lagonda Ltd	D	1415	1860.72	348.372
Bentley Motors Ltd		1187	2495.92	395.925
Geely Europe Ltd		918	1592.50	131.466
Lotus Cars Limited	D	825	1159.21	196.596
Proton Cars United Kingdom Ltd.	D	792	1394.89	153.557
Perodua Manufacturing Sdn Bhd		690	1013.88	140.230
Morgan Motor Co. Ltd.	D	415	1113.67	189.278
Rolls-Royce Motors Cars LTD		413	2494.48	332.063
Santana Motor S.A.		382	1498.15	204.921
Great Wall Motor Company Limited	D	344	1919.52	224.314
Automobili Lamborghini S.p.A		265	1619.11	357.362
MG Motor UK Limited	D	264	1180.16	184.717
ALPINA Burkard Bovensiepen GmbH + Co. KG		173	1753.38	210.341
Think		144	1158.61	0.000
Caterham Cars Limited	D	135	712.15	179.826
Sovab		94	2162.34	230.138
OSV - Opel Special Vehicles GmbH		67	1595.36	136.836
KTM-Sportmotorcycle AG	D	57	882.89	179.000
Iveco S.p.A		49	2471.90	216.694
Mahindra Europe S.r.l.		48	2029.38	251.500
O.M.C.I. S.r.l.		46	1169.78	167.848
Shijiazhuang Shuanghuan Automobile Company		44	1874.20	267.682
Tesla Motors Ltd		40	1335.00	0.000
Potenza Sports Cars		31	715.00	178.000
Pgo Ingenierie		29	1058.14	189.828
Secma		26	658.00	155.000
Bugatti Automobiles S.A.S		8	2011.50	589.250
Wiesmann GmbH	D	8	1409.88	257.250
Micro-Vett SpA		4	1448.75	0.000
Westfield Sports Cars		3	715.00	178.000
Artega Automobil GmbH & Co. KG		2	1420.00	220.000
Gumpert Sportwagenmanufaktur GmbH		2	1435.00	310.000

## The review clause

The co-legislators asked the Commission to review the Regulations and, if appropriate, amend the existing legal acts. Article 13(5) of the cars Regulation states:

*"By 1 January 2013, the Commission shall complete a review of the specific emissions targets in Annex I and of the derogations in Article 11, with the aim of defining:*

*—the modalities for reaching, by the year 2020, a long-term target of 95 gCO<sub>2</sub>/km in a cost-effective manner; and*

*—the aspects of the implementation of that target, including the excess emissions premium.*

*On the basis of such a review and its impact assessment, which includes an overall assessment of the impact on the car industry and its dependent industries, the Commission shall, if appropriate, make a proposal to amend this Regulation in a way which is as neutral as possible from the point of view of competition, and which is socially equitable and sustainable.."*

Article 13(1) of the vans Regulation states:

*"By 1 January 2013, the Commission shall complete a review of the specific emissions targets in Annex I and of the derogations in Article 11, with the aim of defining:*

*— subject to confirmation of its feasibility on the basis of updated impact assessment results, the modalities for reaching, by the year 2020, a long-term target of 147 gCO<sub>2</sub>/km in a cost-effective manner, and*

*— the aspects of the implementation of that target, including the excess emissions premium.*

*On the basis of such a review and its impact assessment, which includes an overall assessment of the impact on the car industry and its dependent industries, the Commission shall, if appropriate, make a proposal to amend this Regulation, in accordance with the ordinary legislative procedure, in a way which is as neutral as possible from the point of view of competition, and which is socially equitable and sustainable."*

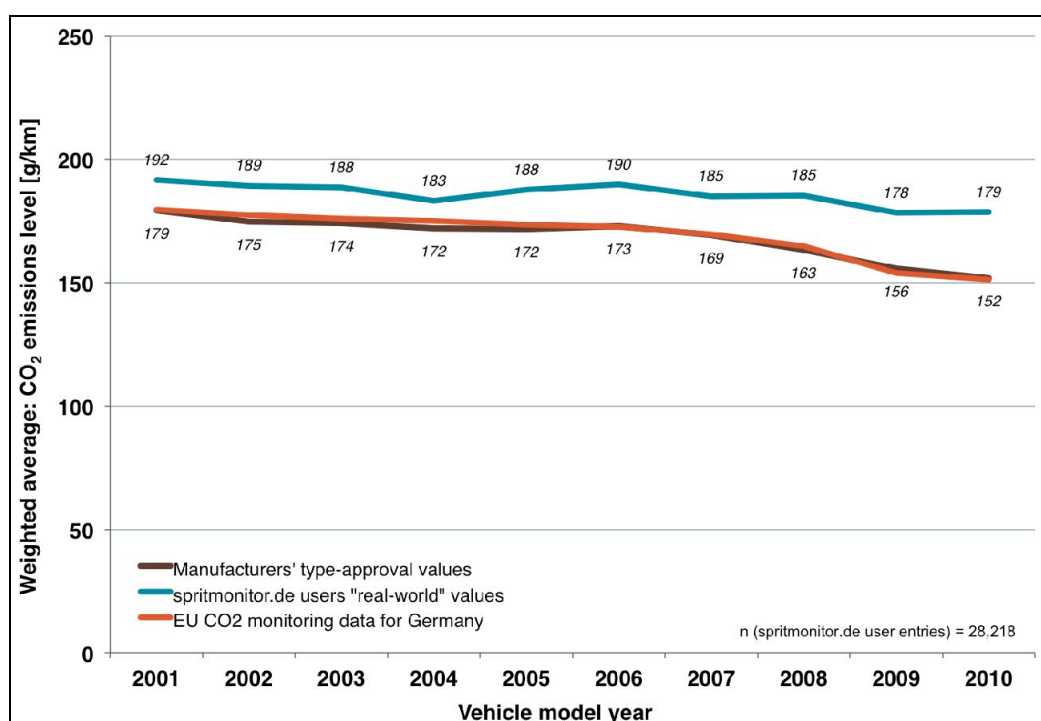
## 7.7. Test cycle CO<sub>2</sub> emissions

Vehicle type approval procedures include testing on a chassis dynamometer, to assess compliance with standards for exhaust emissions, and measure CO<sub>2</sub> emissions. The reported emissions provide the data to assess manufacturer compliance with the CO<sub>2</sub> Regulations

### Diverging real world and test cycle emissions

It has for some time been reported that fuel consumption experienced in real world conditions is substantially higher than measured in the test cycle with comparable effects on CO<sub>2</sub> emissions. A comparison of type approval values for cars in Germany with user reported consumption is shown in the figure below. Over the decade the divergence is seen to have increased from 7 to 17% of type approval values.

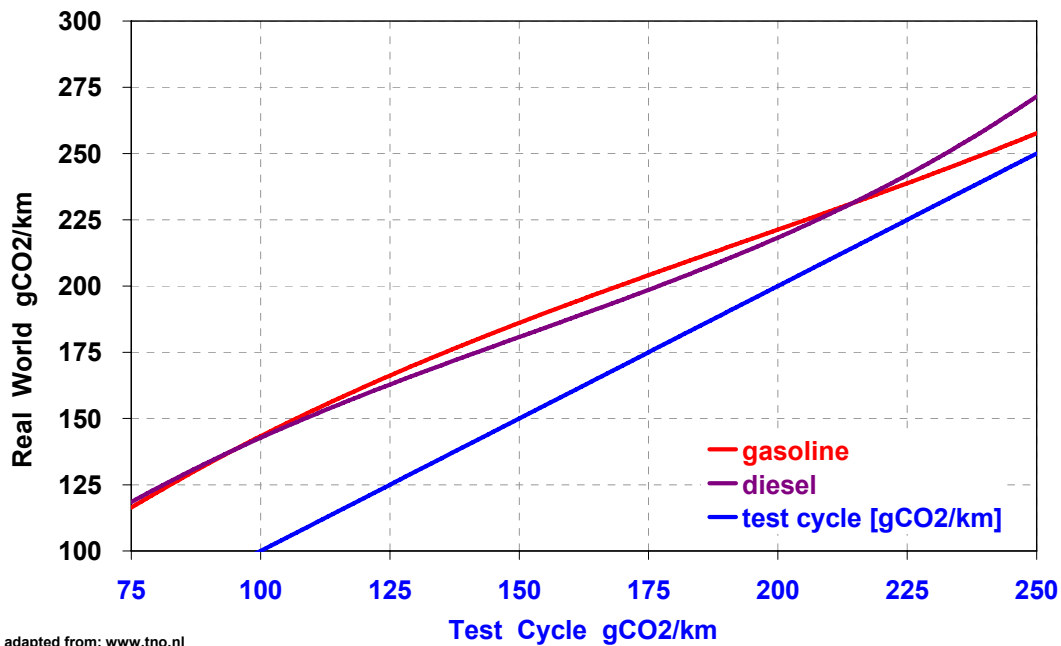
**Figure 1** Illustration of discrepancy between the test-cycle and real-world emissions; Source ICCT<sup>9</sup>



An analysis in the Netherlands using fuel-card data illustrates a larger absolute divergence for lower than higher CO<sub>2</sub> emitting cars. The graph below illustrates this increasing divergence at lower test cycle emissions.

<sup>9</sup> [http://www.theicct.org/sites/default/files/publications/ICCT\\_EU\\_fuelconsumption2\\_workingpaper\\_2012.pdf](http://www.theicct.org/sites/default/files/publications/ICCT_EU_fuelconsumption2_workingpaper_2012.pdf)

**Figure 2** Illustration of discrepancy between the test-cycle and real-world emissions; data sourced from TNO<sup>10</sup>



### Underlying reasons for divergence

Type approval tests do not require that all energy consuming devices in the vehicle are operating. Therefore the battery does not need to end up at the same state of charge at the end as the beginning, air conditioning does not need to be operated and other energy consuming options turned off. In aggregate these elements can result in a substantial reduction in fuel consumption and CO<sub>2</sub> emissions compared to real driving. As more energy consuming devices are incorporated in vehicle this will lead to a greater absolute divergence. However, the TNO data shows that the absolute divergence is greater for lower emitting cars (it is only around 20g for higher emitting vehicles) so this cannot be explained by only the unmeasured energy using equipment.

As average emissions reduce, any existing absolute divergence will become a higher percentage of the test cycle emissions. In the case of the German data, a 7% divergence in 2001 would be an 8.5% divergence in 2010 for this reason alone.

The vehicle type approval procedure is intended to represent a typical vehicle and driving conditions. Because this part of the procedure is performed on a single vehicle, manufacturers are allowed some flexibility in preparing vehicles and carrying out the tests. These flexibilities can also contribute to the divergence.

### Flexibilities

Some examples of the potential flexibilities available cover issues such as:

- Preconditioning;
- Running-in period;

<sup>10</sup> [http://www.tno.nl/downloads/co2\\_uitstoot\\_personenwagens\\_norm\\_praktijk\\_mon\\_rpt\\_2010\\_00114.pdf](http://www.tno.nl/downloads/co2_uitstoot_personenwagens_norm_praktijk_mon_rpt_2010_00114.pdf)

- Test track design;
- Reference mass;
- Brakes;
- Wheel and tyre specification, and rolling resistance;
- Tyre pressure;
- Ambient conditions;
- Laboratory altitude (air density);
- Temperature effects;
- Coast down curve or use of default load values;
- Battery state of charge;
- Gear change schedule and definition;
- Driving technique;
- DPF regeneration rates;
- Declared CO<sub>2</sub> value.

The aggregate effect of all these flexibilities if they were all employed to reduce measured CO<sub>2</sub> emissions might be substantial<sup>11</sup>.

### **Illustration of the impact of one flexibility**

Type approval tests are based on inertia class rather than actual measured mass. It is estimated to provide a few percent benefit to a manufacturer if the vehicle has a mass just below the inertia class threshold rather than being evenly distributed. Actual reported new car mass in 2010 illustrates clear bunching just below the inertia class thresholds as shown in the figure below and analysis shows the likelihood of mass being slightly below the thresholds is five times greater than being just above<sup>12</sup>.

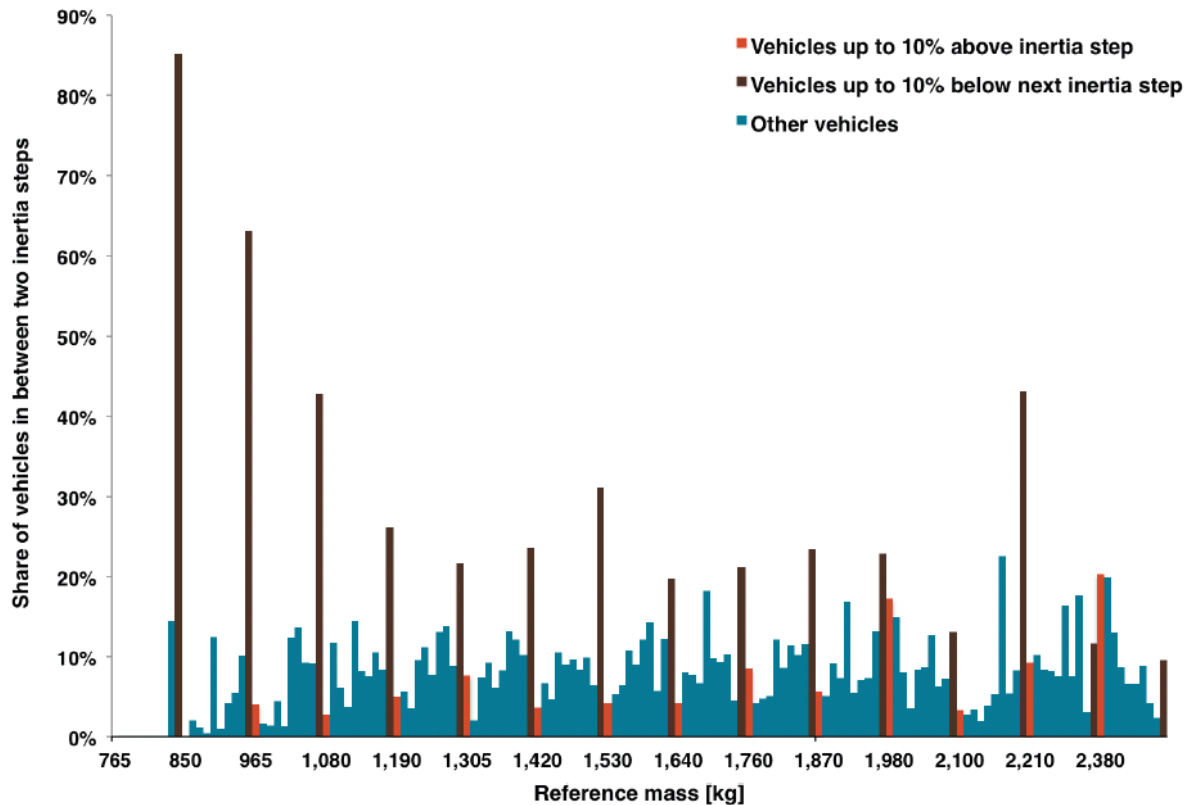
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<sup>11</sup> See for instance: '*Parameterisation of fuel consumption and CO<sub>2</sub> emissions of passenger cars and light commercial vehicles for modelling purposes*'; JRC; 2011

<sup>12</sup> [http://www.theicct.org/sites/default/files/publications/WLTP3\\_2011.pdf](http://www.theicct.org/sites/default/files/publications/WLTP3_2011.pdf)



**Figure 3** Distribution of vehicles in between inertia steps



### Implications for the review

As shown, there has always been a deviation between test cycle and real world CO<sub>2</sub> emissions. However, the fact that test procedure and real world emissions remain correlated means that using test procedure emissions as a basis for the Regulations is sound. Assumptions about the divergence are incorporated in the modelling carried out by the Commission.

Nevertheless, the increasing divergence between real world and test cycle emissions has implications for the analysis performed. The German data shows that the real world – test procedure divergence has grown from 13g to 27g over the time period against which the car study is carried out (since that is based on a 2002 baseline).

It is not known what proportions of this divergence are due to greater deployment of energy using equipment in cars or to exploitation of flexibility in the test procedures. However, on the assumption that some part of the divergence is due to greater exploitation of flexibilities, it means that part of the progress seen since 2002 has not been delivered through the deployment of technology on vehicles. This with other factors leads to the "*unexplained progress*" when comparing vehicle CO<sub>2</sub> performance with the technologies deployed on them.

The original cost curve produced for the analysis did not take this factor into account. However alternative cost curves (shown in the study as (a) and (c) and referred to in this Impact Assessment as cost scenario 2 and 4) have been prepared that do take account of this. These show lower costs to achieve the targets because less technology is needed. These are described in Annex 7.13.

## 7.8. Description of the baseline modelling scenario

### (1) Business as usual developments up to 2050

#### Modelling framework

The Commission has carried out an analysis of possible future developments in a scenario at unchanged policies, the so-called “Reference scenario”. The “Reference scenario” was used in the impact assessment accompanying *A Roadmap for moving to a competitive low carbon economy in 2050*<sup>13</sup>, the impact assessment accompanying the *White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*<sup>14</sup> and the impact assessment accompanying the *Energy Roadmap 2050*<sup>15</sup>. The Reference scenario is a projection of developments in the absence of new policies beyond those adopted by March 2010. In order to take into account the most recent developments (higher energy prices) and the latest policies on energy taxation and infrastructure adopted by November 2011, an additional scenario (named Scenario 0 here) was modelled to serve as a business as usual scenario for the present impact assessment.

The business as usual scenario (Scenario 0) is a projection, not a forecast, of developments in the absence of new policies beyond those adopted by November 2011. It therefore reflects both achievements and limitations of the policies already in place. This projection provides a benchmark for evaluating new policy measures against developments under current trends and policies.

Scenario 0 builds on a modelling framework including PRIMES energy model and its transport model (the PRIMES-TREMOVE model), PROMETHEUS and GEM-E3 models. All these models as well as other models used by the Commission in the context of energy-transport-climate modelling are described together with additional information on the website: <http://www.euclimit.eu/Default.aspx?Id=2>. The starting point for developing Scenario 0 is the “Reference scenario”. This “Reference scenario” has already been extensively described in:

- The documentation on the website of DG Energy, Market observatory: *Energy Trends to 2030*<sup>16</sup>.
- The impact assessment accompanying *A Roadmap for moving to a competitive low carbon economy in 2050*, which also provides in its Annexes additional information on PRIMES modelling undertaken in the decarbonisation framework.
- The impact assessment accompanying the *White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*, Appendix 3 (pages 130-152). The list of policy measures included in the “Reference scenario” is provided in Appendix 4: *Inventory of policy measures relevant for the transport sector included in the 2050 Reference scenario* (pages 153-155).

<sup>13</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2011:0288:FIN:EN:PDF>

<sup>14</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2011:0358:FIN:EN:PDF>

<sup>15</sup> [http://ec.europa.eu/energy/energy2020/roadmap/doc/sec\\_2011\\_1565\\_part1.pdf](http://ec.europa.eu/energy/energy2020/roadmap/doc/sec_2011_1565_part1.pdf)

<sup>16</sup> [http://ec.europa.eu/energy/observatory/trends\\_2030/index\\_en.htm](http://ec.europa.eu/energy/observatory/trends_2030/index_en.htm)

- The impact assessment accompanying the *Energy Roadmap 2050*, Part A of Annex 1, which describes assumptions, results and sensitivities in many details with respect to the *Reference scenario* (pages 49-97)<sup>17</sup>.

It is thus deemed not necessary to reproduce all information contained in the above listed references, but rather to discuss the common and different assumptions included in Scenario 0 relative to the “Reference scenario” and to provide the most relevant information with respect to the subject of this Impact Assessment.

Due to the detailed structure of the data by transport mode in the PRIMES-TREMOVE model and the lack of statistics, detailed data are not available for periods before 2005 and thus not shown in this section, even if data on aggregated level are shown prior to 2005 elsewhere.

## (2) Key assumptions of Scenario 0

The **population** projections draw on the EUROPOP2008 convergence scenario (EUROpean POPulation Projections, base year 2008) from Eurostat, which is also the basis for the 2009 Ageing Report (European Economy, April 2009)<sup>18</sup>. The key drivers for demographic change are: higher life expectancy, low fertility and inward migration.

The **macro-economic** projections reflect the recent economic downturn followed by sustained economic growth. Scenario 0 assumes that the recent economic crisis has long lasting effects, leading to a permanent loss in GDP. The recovery from the crisis is not expected to be so vigorous that the GDP losses during the crisis are fully compensated. In this scenario, growth prospects for 2011 and 2012 are subdued. However, economic recovery enables higher productivity gains, leading to somewhat faster growth from 2013 to 2015. After 2015, GDP growth rates mirror those of the 2009 Ageing Report. Hence the pattern of Scenario 0 is consistent with the intermediate scenario 2 “sluggish recovery” presented in the Europe 2020 strategy<sup>19</sup>. The medium and long term growth projections follow the “baseline” scenario of the 2009 Ageing Report (European Economy, April 2009)<sup>18</sup>, which derives GDP growth per country on the basis of variables such as population, participation rates in the labour market and labour productivity.

The population and macroeconomic assumptions used in Scenario 0 are common with those of the “Reference scenario”.

**Table 4: EU27 growth rates for key Scenario 0 assumption**

<b>annual growth rates [%]</b>	2010 > 2020	2020 > 2030	2030 > 2040	2040 > 2050
Population	+0.29	+0.12	+0.00	-0.09

<sup>17</sup> Short-term projections for oil, gas and coal prices were slightly revised according to the latest developments in the Reference scenario as compared to the version used in *A Roadmap for moving to a competitive low carbon economy in 2050*.

<sup>18</sup> European Commission, DG Economic and Financial Affairs: 2009 Ageing Report: Economic and budgetary projections for the EU-27 Member States (2008-2060). EUROPEAN ECONOMY 2|2009, [http://ec.europa.eu/economy\\_finance/publications/publication14992\\_en.pdf](http://ec.europa.eu/economy_finance/publications/publication14992_en.pdf). The “baseline” scenario of this report has been established by the DG Economic and Financial Affairs, the Economic Policy Committee, with the support of Member States experts, and has been endorsed by the ECOFIN Council.

<sup>19</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF>

Number of households	+0.65	+0.40	+0.31	+0.23
GDP	+2.21	+1.74	+1.50	+1.45
Household income	+1.91	+1.43	+1.58	+1.55

The **energy import prices** projections in Scenario 0 are based on a relatively high oil price environment and are similar to reference projections from other sources<sup>20,21</sup>. The Scenario 0 price assumptions for the EU27 are the result of world energy modelling (using the PROMETHEUS stochastic world energy model<sup>22</sup>) that derives price trajectories for oil, gas and coal under a conventional wisdom view of the development of the world energy system. The price development to 2050 is expected to take place in a context of economic recovery and resuming GDP growth without decisive climate action in any world region. Prices were derived with world energy modelling that shows largely parallel developments of oil and gas prices<sup>23</sup>. The actual assumed prices for fuel import prices are shown in **Table 5** and resulting end-user prices are shown in **Figure 4**.

**Table 5:** Energy import prices

\$'10 per boe(*)	2010	2020	2030	2040	2050
Oil	85.2	89.0	106.6	116.9	127.6
Gas (NCV)	53.8	62.5	77.1	87.4	99.0
Coal	22.8	28.9	32.8	32.8	33.7

(\*) \$'10 = U.S. Dollar of year 2010; boe = barrel oil equivalent

Similarly to the “Reference scenario”, the **price of the CO<sub>2</sub> emissions allowances** in the EU Emissions Trading Scheme reaches 15 €/tCO<sub>2</sub> by 2020 and is further projected to reach and stay around 50 €/tCO<sub>2</sub> in period 2040-2050 in Scenario 0. This price evolution is fully consistent with price evolution in Reference scenario used in the impact assessments referenced beforehand.

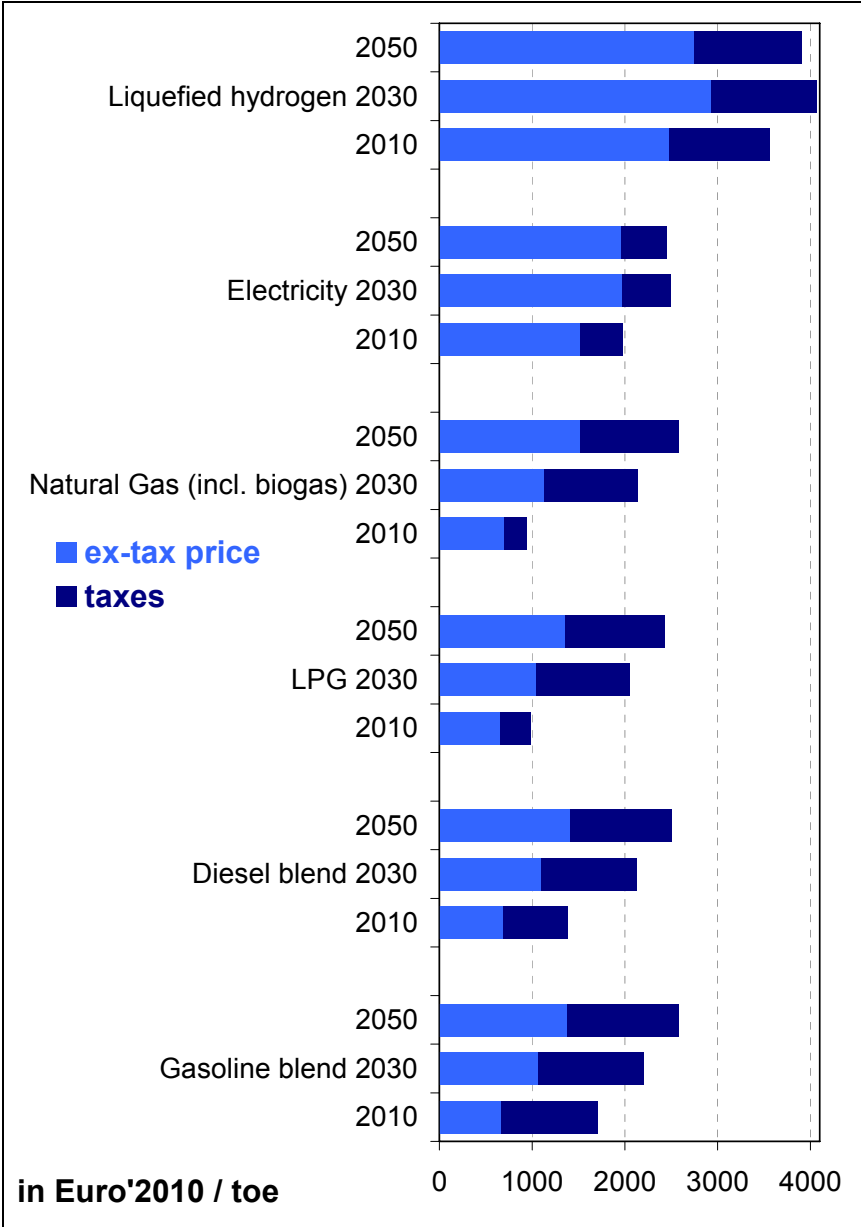
<sup>20</sup> The US Energy Information Administration and the International Energy Agency.

<sup>21</sup> Projections for oil, gas and coal prices as used in the “Reference scenario” in the *Energy Roadmap 2050*.

<sup>22</sup> [http://www.e3mlab.ntua.gr/e3mlab/PROMETHEUS%20Manual/prometheus\\_documentation.pdf](http://www.e3mlab.ntua.gr/e3mlab/PROMETHEUS%20Manual/prometheus_documentation.pdf)

<sup>23</sup> In PRIMES and PRIMES-TREMOVE models all monetary values are expressed in constant terms (without inflation). The economic modelling is based on Euro (€), for which the exchange rate is assumed to depreciate from the higher levels of around 1.4 \$/€. Thus there will be a somewhat faster increase in energy prices expressed in Euro if compared to prices expressed in U.S. Dollar.

**Figure 4:** Fuel prices and taxes in Scenario 0



**Table 6** lists the policy assumptions which are included in Scenario 0 in addition to the policy assumptions of the "Reference scenario".

**Table 6:** Additional policy assumptions

Area	Measure	How it is reflected in the model
<b>Efficiency standards</b>	Update of the CO <sub>2</sub> standards for vans according to the adopted regulation <sup>24</sup>	Implementation of CO <sub>2</sub> standards for vans (175 gCO <sub>2</sub> /km by 2017, phasing in the reduction from 2014, and to reach 147 gCO <sub>2</sub> /km by 2020).
<b>Taxation</b>	Energy Taxation Directive (proposed revision in 2011)	Changes to minimum tax rates to reflect the switch from volume-based to energy content-based taxation and the inclusion of a CO <sub>2</sub> tax component. Where Member States tax above the minimum level, the current rates are assumed to be kept unchanged. For motor fuels, the relationships between minimum rates are assumed to be mirrored at national level even if the existing rates are higher than the minimum rates. Tax rates are kept constant in real terms.
<b>Internalisation of local externalities</b>	Eurovignette Directive (Directive 2011/76/EU)	Introduction of infrastructure charges in Poland (starting with 2011) and the announced introduction of distance based infrastructure charges in Denmark and Belgium (from 2014).
<b>Infrastructure</b>	TEN-T guidelines (revision 2011) and Connecting Europe Facility	Reflected through the increase in the capacity and performance of the network resulting from the elimination of bottlenecks and addition of missing links, and increase in the train length (to 1.5 km) and maximum axle load (to 22.5 tonnes), reflected through decreases in operation costs and time costs and higher load factors for freight.
<b>Internal market</b>	Recast of the first railway package (2010)	Reflected through a reduction of average operating costs for railway undertakings.
<b>Energy import prices</b>		Short-term increase reflecting price evolution up to 2010 as in the Energy Roadmap 2050.
<b>Technology assumptions</b>	Higher penetration of EVs reflecting developments in 2009-2010 national support measures and the intensification of previous action programmes and incentives, such as funding R&D projects to promote alternative fuels.	Slightly higher penetration of EVs. Assumed specific battery costs per unit kWh in the long run: 390-420 €/kWh for plug-in hybrids and 315-370 €/kWh for electric vehicles, depending on range and size, and other assumptions on critical technological components <sup>25</sup> .

<sup>24</sup> Regulation (EU) No 510/2011 of the European Parliament and of the Council of 11 May 2011, setting emission performance standards for new light commercial vehicles as part of the Union's integrated approach to reduce CO<sub>2</sub> emissions from light-duty vehicles

<sup>25</sup> International Energy Agency (2009), Transport, Energy and CO<sub>2</sub>: Moving Towards Sustainability.



Figure 5: Real world emissions estimates implementations in Scenario 0

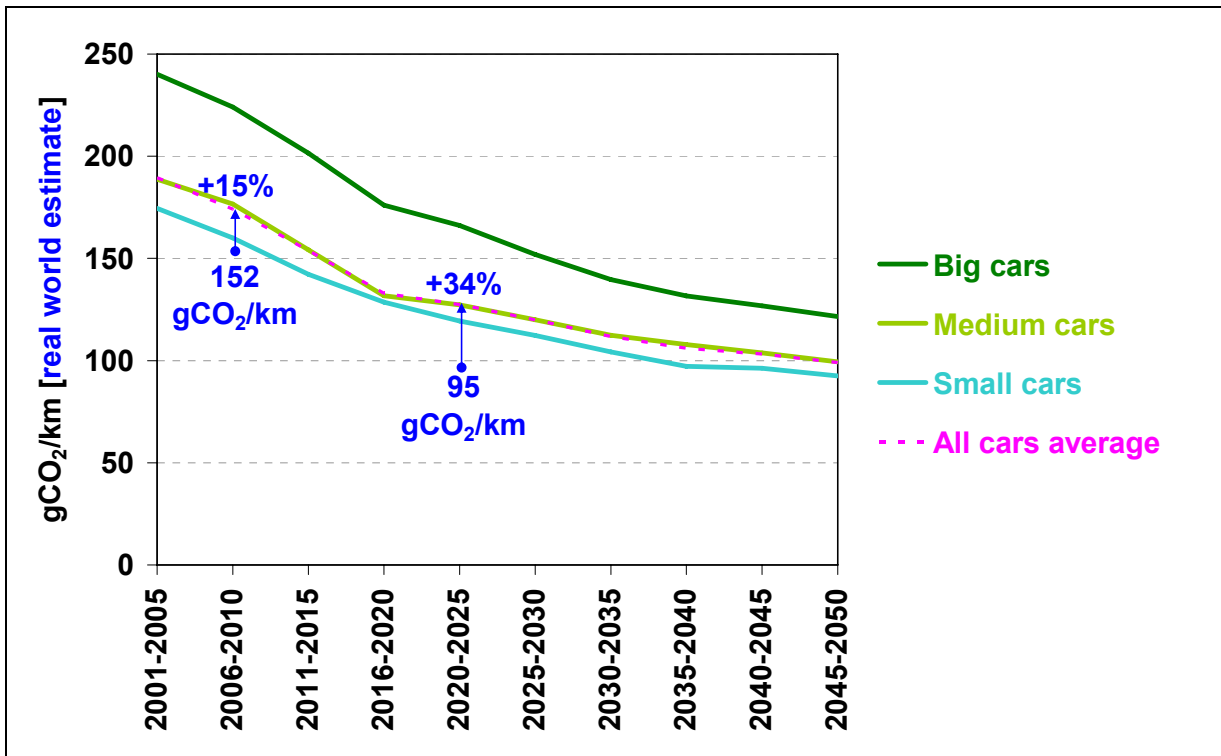
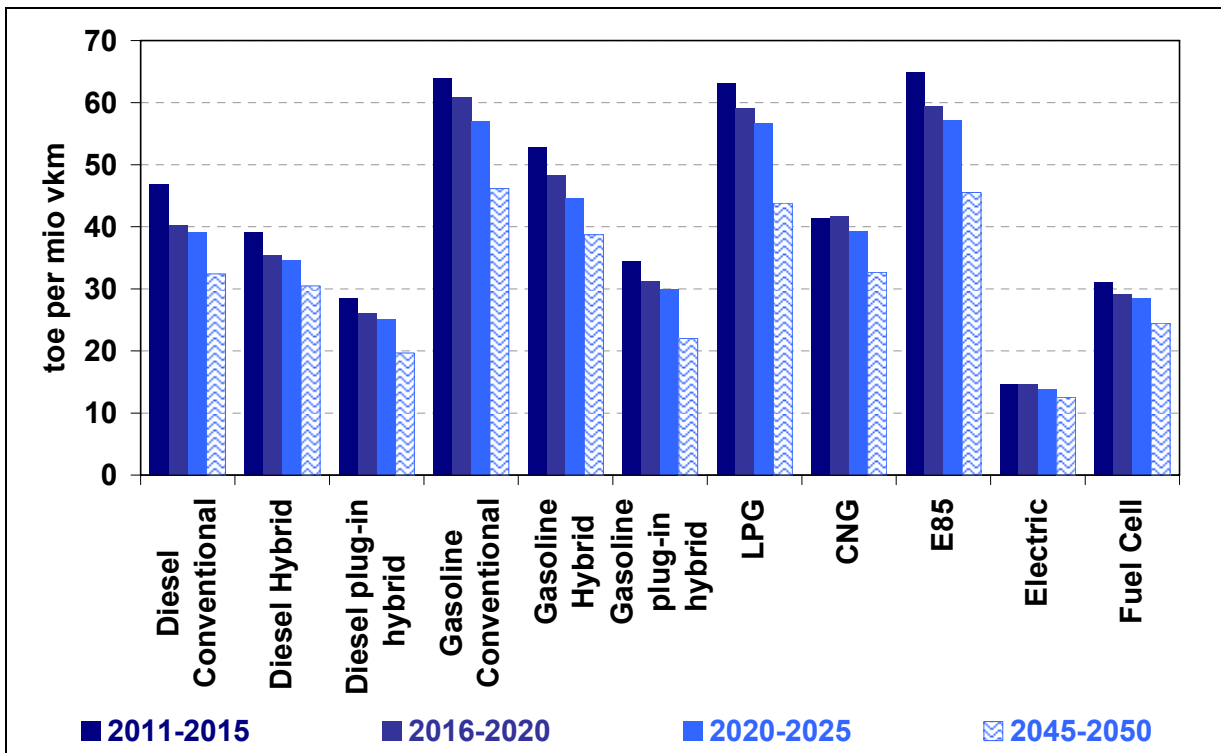


Figure 6: Real world efficiency of new medium sized passenger cars in Scenario 0





## (b) Implementation of Regulations (EC) 443/2009 and (EU) 510/2011

Regulation (EC) 443/2009 and Regulation (EU) 510/2011 were discussed and agreed in the co-decision process while the previous modelling framework was updated. Since there were some adjustments to the Regulations before they were agreed, these Regulations might be implemented with some minor deviation from the implementation presented here in the impact assessments which accompany *A Roadmap for moving to a competitive low carbon economy in 2050, White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system* and the *Energy Roadmap 2050*.

There is growing evidence of increased discrepancy between test cycle and real world emissions. These are for example described in a JRC study: *Parameterisation of fuel consumption and CO<sub>2</sub> emissions of passenger cars and light commercial vehicles for modelling purposes*<sup>26</sup>. Also real world evidence was documented and analyzed by TNO Industrie en Techniek: *CO<sub>2</sub> uitstoot van personenwagens in norm en praktijk – analyse van gegevens van zakelijke rijders*<sup>27</sup>.

**Figure 5** shows the discrepancy between estimated real world emissions and the test cycle emissions in Scenario 0 of the PRIMES-TREMOVE model.

**Figure 6** shows an example of assumed development in the Scenario 0 of energy efficiency for medium sized passenger cars over time for various technologies. It has to be noted that this is tank-to-wheel efficiency and thus efficiency of the fuel manufacturing is not included. As noted in the impact assessment accompanying the Low Carbon Economy Roadmap: *There is a strong correlation between what can or should be done in the transport sector, and what can or should be done in the power sector if the economy is to be decarbonised, i.e. reduce GHG emissions with around 80%. ... This is due to the impact of electrification itself on both the emissions in the transport sector (a lowering effect on emissions) as well as the power sector (an increasing effect on emissions due to the increased demand for electricity). The sum of emissions from both sectors follows a rather consistent path towards decarbonisation, independent of the scenario chosen. ... in the future all ETS sectors will be impacted by developments in the transport sector, such as electrification, even if the road transport sector is not part of the ETS.* Thus it has to be kept in mind that transport evolution analyzed in our scenario is following the *Ceteris paribus* principle and in our analysis we do not assume any further decarbonisation of other economy sectors than those indicated in Scenario 0.

## (c) Scenario 0 results (focusing on cars and vans)

Total **transport activity** is projected to grow in the next 40 years. Even though some decreases were observed recently as a consequence of the recent economic and financial crisis, the recovery foreseen is reflected by transport activity returning to its long-term trends. Road transport is expected to maintain its dominant role in both passenger and freight transport within the EU. Passenger transport by rail is projected to grow faster than passenger transport by road, while the growth rates in road and rail freight transport are expected to be in the long run more similar. Air transport and fast passenger trains are foreseen to grow significantly (and roughly at the same rate) and thus increase their shares in transport demand.

<sup>26</sup> [http://publications.jrc.ec.europa.eu/repository/bitstream/11111111/22474/1/co2\\_report\\_jrc\\_format\\_final2.pdf](http://publications.jrc.ec.europa.eu/repository/bitstream/11111111/22474/1/co2_report_jrc_format_final2.pdf)

<sup>27</sup> [http://www.tno.nl/downloads/co2\\_uitstoot\\_personenwagens\\_norm\\_praktijk\\_mon\\_rpt\\_2010\\_00114.pdf](http://www.tno.nl/downloads/co2_uitstoot_personenwagens_norm_praktijk_mon_rpt_2010_00114.pdf)

**Table 7: Transport activity growth rates in Scenario 0**

	2010 > 2020	2020 > 2030	2030 > 2040	2040 > 2050
<b>Activity changes measured in Gvkm</b>				
Road transport	1.35	0.68	0.60	0.38
Public road transport	0.87	0.44	0.41	0.24
Busses	1.76	1.18	0.43	0.22
Coaches	0.47	0.07	0.39	0.26
2Wheelers	1.39	1.02	0.60	0.41
Private cars (M1)	1.33	0.69	0.55	0.36
Small cars	1.22	1.10	0.67	0.40
Medium cars	1.93	0.27	0.27	0.22
Big cars	-2.02	1.76	1.80	0.95
Passenger LDV (N1)	1.58	0.78	0.62	0.38
Road Freight Transport	1.46	0.65	0.82	0.52
Trucks (HDV)	1.66	0.53	0.80	0.50
HDV 3.5 - 7.5 tons	1.52	-0.08	1.03	0.43
HDV 7.5 - 16 tons	2.10	0.67	0.63	0.52
HDV 16 - 32 tons	1.57	0.79	0.88	0.49
HDV >32 tons	1.56	0.55	0.62	0.54
Freight LDV (N1)	0.69	1.16	0.99	0.65
<b>Activity changes measured in Gpkm for passenger and Gtkm for freight</b>				
Passenger rail transport	1.87	1.95	1.05	0.72
Freight trains	2.34	1.35	0.78	0.58
Aviation	3.79	2.55	1.50	1.28
Passenger inland navigation	0.96	0.86	0.47	0.31
Freight inland navigation	1.45	1.43	0.56	0.27

As can be seen from **Figure 9**, the **energy use** of cars and vans is projected to continue to decrease between now and 2050, despite increased activity (**Figure 8**). This is due to the observed recent decrease in the efficiency of new cars and vans in the EU as well as the expected effects of the Regulation (EC) 433/2009 and Regulation (EU) 510/2011. The use of alternative fuels (LPG, CNG, electricity and hydrogen) is expected to remain limited in Scenario 0. Their share is foreseen to increase from 3.3% in 2005 to 8.0% in 2050. However this is not mostly due to increases in their energy quantities consumed, but rather due to decrease in gasoline and diesel use. The gasoline/diesel ratio for use in cars and vans (including respective biofuels blends) drops from 1.3 in 2005 to nearly 1 in 2020, but it is expected to rebound back to 1.2 by 2050.

Figure 7: Transport activity of light duty vehicles (cars & vans)

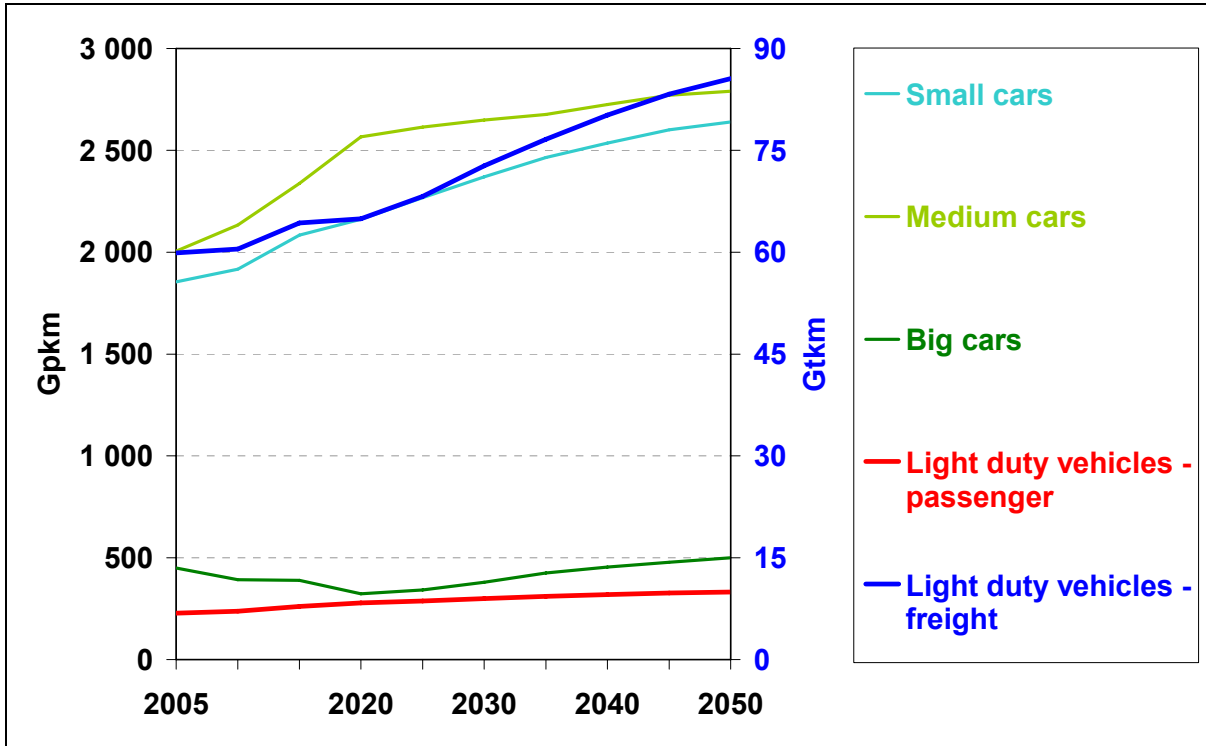


Figure 8: Energy use of light duty vehicles (cars & vans)

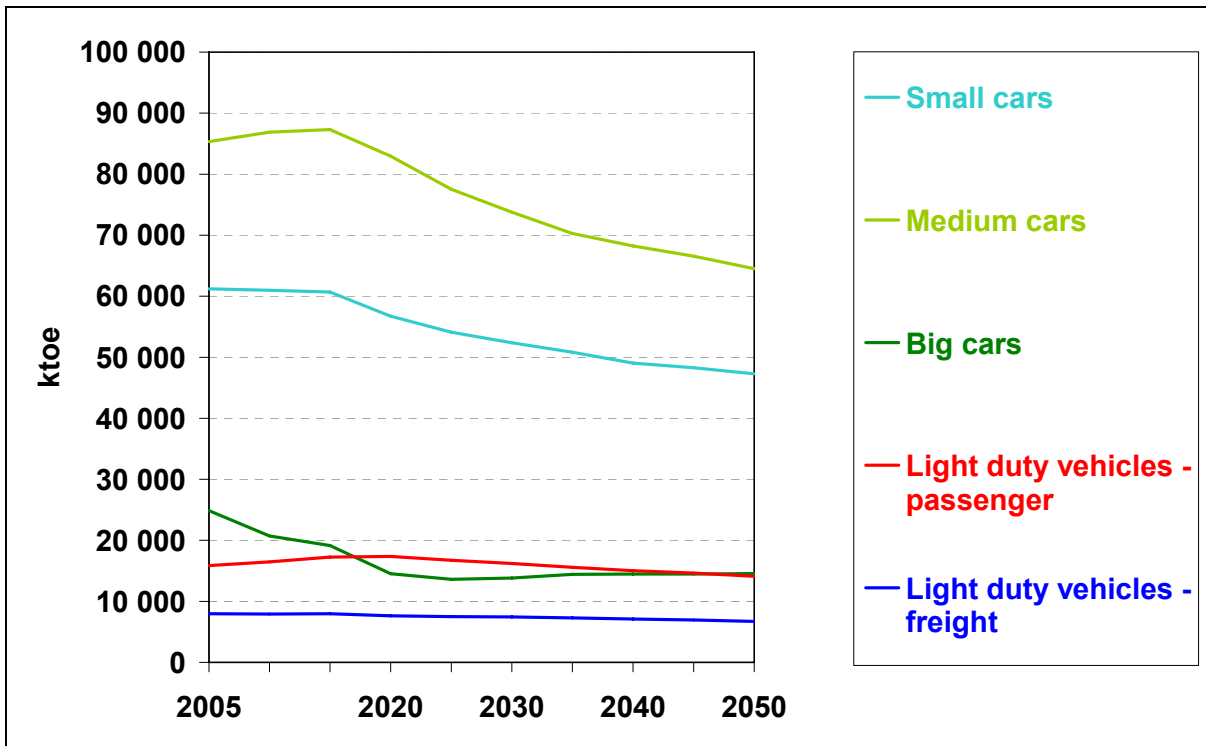


Figure 9: Energy use of light duty vehicles (cars & vans) by fuel

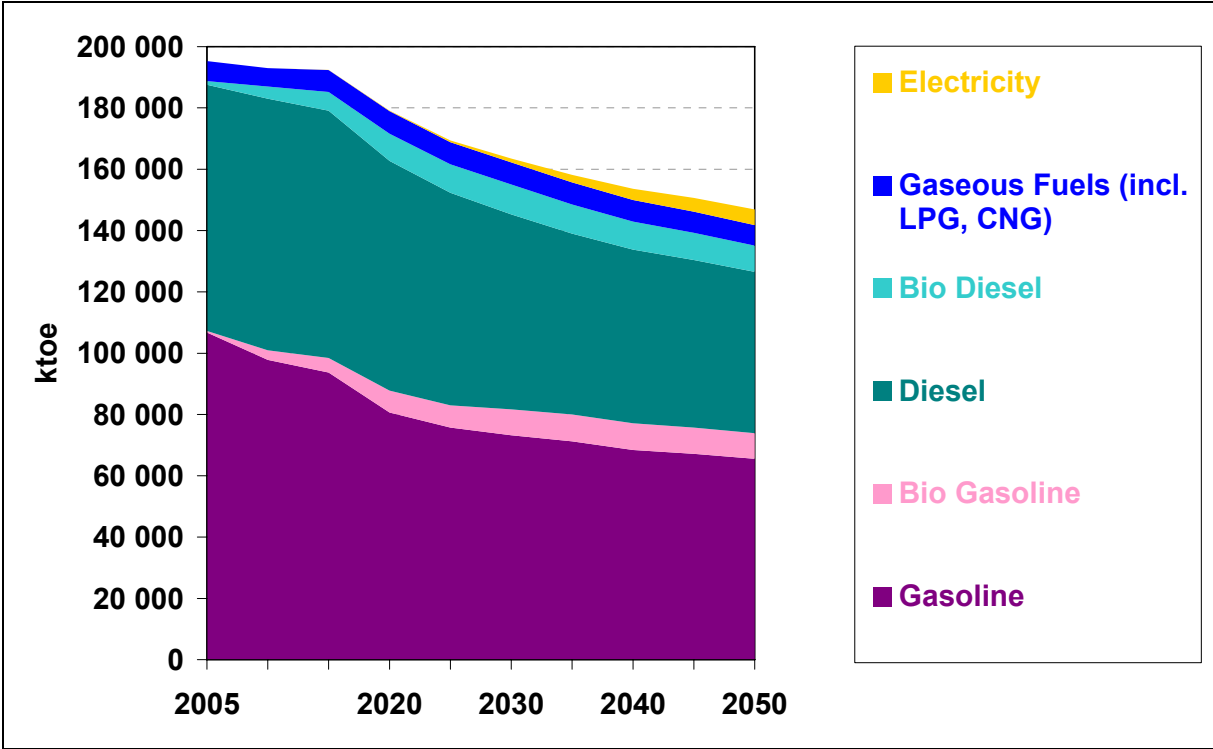
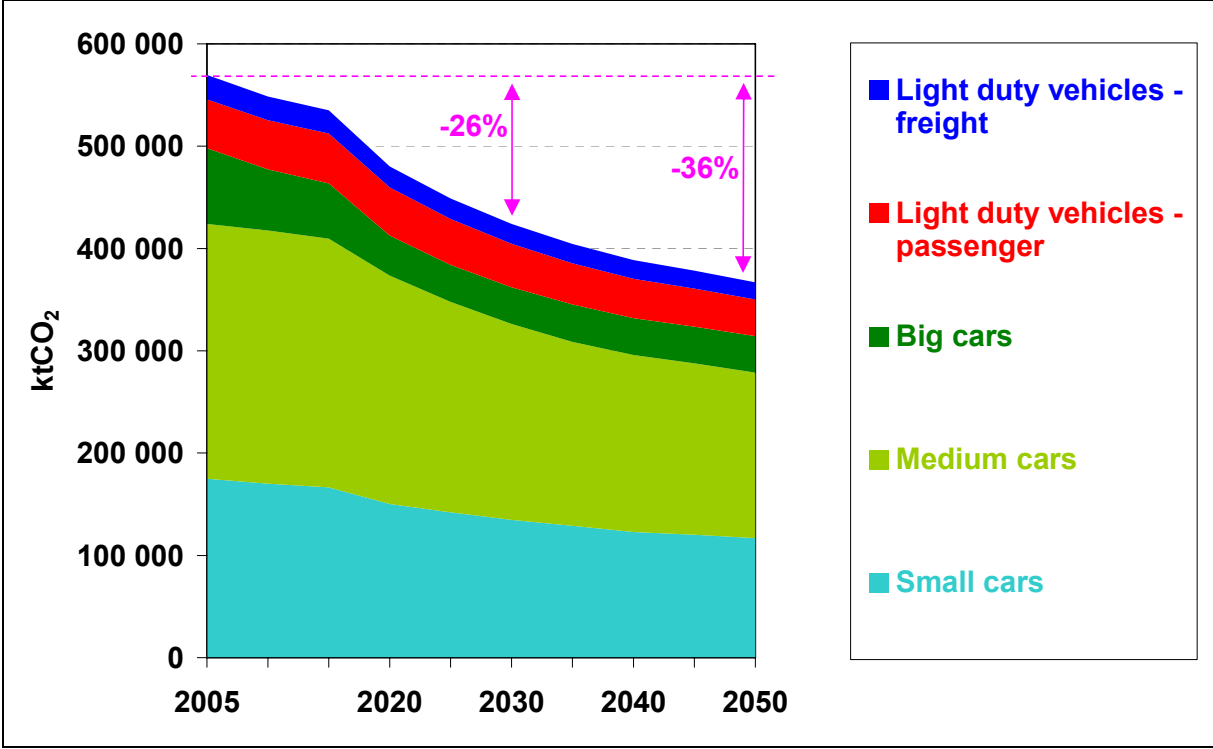
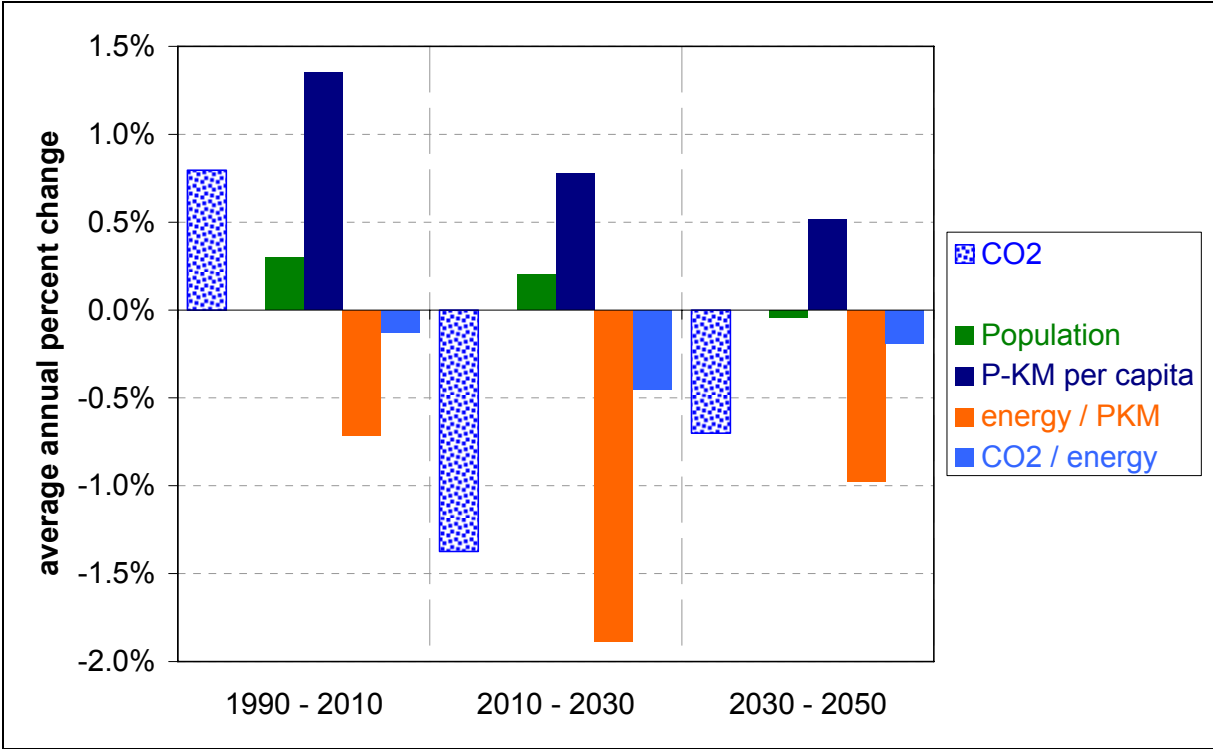


Figure 10: TTW CO2 emissions of light duty vehicles (cars & vans)



**Figure 11: Decomposition of TTW CO2 emissions of cars**



Reductions in CO<sub>2</sub> emissions (Figure 10) are somewhat bigger than reductions in energy use due to the anticipated small increase in the use of biofuels and expect future use of electricity in electric vehicles and plug-in hybrids (these fuels are counted as zero emissions fuels in transport sector as their emissions are accounted elsewhere). Compared to 2005, CO<sub>2</sub> emissions from cars and vans in Scenario 0 are 26% lower in 2030 and 36% lower in 2050. While detailed official historical statistics of CO<sub>2</sub> emissions from cars and vans within road transport sector are not available, estimates suggest that between 1990 and 2005 the CO<sub>2</sub> emissions of cars and vans increased by around 20%. With that in mind, one can roughly estimate CO<sub>2</sub> emissions changes with respect to 1990: in 2030 at around -10% and in 2050 at around -20%.

A **decomposition** of passenger cars CO<sub>2</sub> emissions into the product of population, average annual distance driven per capita, energy per kilometre (approximation for the energy efficiency) and carbon intensity of fuels is shown in Figure 11 (variant of the Kaya identity). While in the last 20 years (period 1990-2010) the improvements in energy efficiency and carbon intensity of fuels were not able to offset the increases in population and distances driven, as a consequence of the implemented regulations and directives (on vehicles as well as on fuels) some significant improvements can be seen in the period 2010-2030. While several policies have long lasting effects even after 2030, the rate of efficiency improvements and fuel carbon intensity are assumed to slow down significantly (period 2030-2050) in the absence of any additional policy measures.

**(3) Scenario 1 - sensitivity: lower efficiency improvements**

Scenario 1 is a counter-factual scenario whereby a hypothetical situation without 2020 CO<sub>2</sub> regulation target for cars and vans in place and considerably lower efficiency improvements in cars and vans to those assumed in Scenario 0 up to 2050. Such scenario quantifies how much the 2020 targets and further efficiency improvements bring in terms of energy and CO<sub>2</sub>

savings. In **Table 11** the exact rates of improvements in Scenario 0 and Scenario 1 are compared.

While in general the impact on total passenger transport activity is small, modelling results suggest that if there were no regulation standards in 2020 and beyond, there would be more transport activity of big passenger cars replacing some of the medium passenger cars' activity. Some shift to buses could also be observed but it would be very limited (slightly less than 1% additional activity by buses), as the transport by cars is more expensive. One has to keep in mind that Scenario 0 activity increase is slightly above 30% between 2010 and 2050 for passenger cars.

The increase in CO<sub>2</sub> emissions is roughly the same as the increase in energy use, however due to slightly different structure of fuel use there is a minor discrepancy between increased energy use and CO<sub>2</sub> emissions (the gasoline to diesel use ratio for cars and vans in Scenario 0 is 1.21 in 2050, however in scenario 1 this ration is 1.15).

**Table 8: Key differences for passenger cars in Scenario 1 compared to Scenario 0**

<b>cars</b>	2020	2030	2040	2050
vehicle-km	-0.6%	-0.8%	-0.9%	-1.0%
energy	+6.1%	+11.9%	+15.5%	+18.6%
TTW CO <sub>2</sub>	+6.0%	+12.1%	+15.9%	+19.1%

There is no significant direct impact on air pollutant. Air quality standards (EURO) are assumed to be independent of fuel consumptions and CO<sub>2</sub> emissions in the modelling and as total distance driven is not significantly changed and is partly compensated by modal shift to buses, effect on air pollutant emissions is very small.

It is important to note that increased energy costs (fuel spending) in Scenario 1 are directly proportional to energy use increases as the change in fuel use composition is only very minor.

A similar magnitude of changes for light duty vehicles (vans) can be observed as for cars (**Table 9**).

**Table 9: Key differences for light duty trucks (vans) in Scenario 1 compared to Scenario 0**

<b>vans: all</b>	2020	2030	2040	2050
vehicle-km	-0.7%	-1.4%	-1.6%	-1.6%
energy	+2.9%	+8.5%	+14.6%	+17.8%
TTW CO <sub>2</sub>	+2.9%	+8.4%	+14.6%	+17.8%
<b>vans: passenger</b>	2020	2030	2040	2050
vehicle-km	-0.8%	-1.3%	-1.3%	-1.2%
energy	+2.8%	+8.7%	+15.3%	+18.9%
TTW CO <sub>2</sub>	+2.8%	+8.7%	+15.3%	+18.8%
<b>vans: freight</b>	2020	2030	2040	2050
vehicle-km	-0.6%	-1.6%	-2.3%	-2.5%
energy	+3.0%	+8.0%	+13.1%	+15.7%
TTW CO <sub>2</sub>	+3.0%	+7.9%	+13.1%	+15.6%

Overall we can conclude that implementing 2020 targets for cars and vans saves 27 Mt CO<sub>2</sub> already in year 2020 due to the gradual adaptation of vehicles beforehand (difference in CO<sub>2</sub> emissions in Scenario 1 and Scenario 0). These savings increase to 39 Mt CO<sub>2</sub> in years 2025

and to 49 Mt CO<sub>2</sub> savings in 2030. The cumulative savings in period 2020-2030 can be estimated (based on the modelling results) at around 422 Mt CO<sub>2</sub>, which is equivalent to annual CO<sub>2</sub> emission of passenger cars and vans in 2030 in Scenario 0 (424 Mt CO<sub>2</sub>). Total cumulative savings in period 2020-2050 are at 1.6 Gt CO<sub>2</sub>.

Compared to Scenario 0, the CO<sub>2</sub> emissions of passenger cars in year 2020 are 24.9 Mt CO<sub>2</sub> higher in Scenario 1 (aka in case 2020 targets are not implemented). For vans this difference is 1.3 Mt CO<sub>2</sub> and 0.6 Mt CO<sub>2</sub> for passenger and freight respectively. In 2030 the CO<sub>2</sub> emissions in Scenario 1 are further increased compared to Scenario 0: 43.6 Mt CO<sub>2</sub> for passenger cars, 3.7 Mt CO<sub>2</sub> for passenger vans and 1.6 Mt CO<sub>2</sub> for freight vans.

**Table 10:** Additional CO<sub>2</sub> emissions in Scenario 1 compared to Scenario 0

<b>Mt CO<sub>2</sub></b>	in year 2020	in year 2030	in period 2020-2030	in period 2020-2050
passenger cars	24.9	43.6	383.6	1 437.2
vans: passenger	1.3	3.7	26.5	140.8
vans: freight	0.6	1.6	11.7	57.8
<b>Total</b>	<b>26.8</b>	<b>48.9</b>	<b>421.8</b>	<b>1 636.7</b>

**Table 11:** Improvements in modelled average efficiency of new vehicle registrations shown by category and decade for the period between 2010 and 2050 for scenario 0 and 1

% p.a.	Scenario 0				Scenario 1			
	10>20	20>30	30>40	40>50	10>20	20>30	30>40	40>50
<b>Small cars</b>								
Diesel Conventional	-1.01	-0.80	-0.52	-0.63	-0.38	-0.18	+0.01	-0.16
Diesel Hybrid	-0.92	-0.60	-0.40	-0.58	-0.35	+0.02	+0.13	-0.03
Gasoline Conventional	-1.80	-0.62	-0.64	-0.08	-0.86	-0.26	-0.20	+0.04
Gasoline Hybrid	-0.77	-0.88	-0.53	-0.07	-0.26	-0.27	-0.03	+0.16
<b>Medium cars</b>								
Diesel Conventional	-2.99	-0.81	-0.53	-0.84	-1.67	-0.49	-0.11	-0.25
Diesel Hybrid	-2.15	-0.60	-0.33	-0.58	-1.24	-0.15	+0.14	-0.06
Gasoline Conventional	-1.39	-1.11	-0.89	-0.76	-0.66	-0.60	-0.27	-0.25
Gasoline Hybrid	-2.07	-1.20	-0.55	-0.45	-1.35	-0.49	-0.03	-0.01
<b>Large cars</b>								
Diesel Conventional	-1.84	-1.27	-0.21	-0.62	-0.96	-0.62	+0.35	-0.24
Diesel Hybrid	-1.69	-0.54	-0.55	-0.58	-0.88	+0.07	-0.02	-0.20
Gasoline Conventional	-1.10	-0.98	-0.88	-0.87	-0.52	-0.65	-0.23	-0.25
Gasoline Hybrid	-2.35	-0.88	-0.46	-0.52	-1.32	-0.45	-0.02	-0.03
<b>Light duty vehicles-passenger</b>								
Diesel Conventional	-1.11	-1.22	-0.84	-0.54	-0.45	-0.31	-0.22	-0.11
Diesel Hybrid	-1.19	-1.03	-0.81	-0.50	-0.50	-0.03	-0.20	-0.14
Gasoline Conventional	-0.89	-0.55	-0.64	-0.69	-0.36	-0.21	-0.23	-0.18
Gasoline Hybrid	-1.46	-0.80	-0.58	-0.54	-0.92	-0.24	-0.14	-0.02
<b>Light duty vehicles-freight</b>								
Diesel Conventional	-1.12	-1.18	-0.87	-0.56	-0.47	-0.28	-0.25	-0.14
Diesel Hybrid	-1.14	-1.10	-0.84	-0.52	-0.49	-0.12	-0.22	-0.15
Gasoline Conventional	-0.88	-0.35	-0.60	-0.61	-0.31	+0.02	-0.18	-0.13
Gasoline Hybrid	-1.21	-0.52	-0.51	-0.55	-0.66	+0.00	-0.06	-0.07



## 7.9. Impacts on competitiveness

### **Introduction**

In analysing impacts on competitiveness a distinction should be made between different affected sectors and different markets. There may be an effect on the competitiveness of European businesses, relative to each other or to companies from outside the EU, on the European market and on other, global markets. Impacts on competitiveness may be viewed from the perspective of the European economy as a whole based on the competitiveness of European companies on global markets.

Overall economic impacts, as discussed in chapter 5, do not directly lead to impacts on competitiveness. To analyse these it needs to be assessed, for different categories of companies, whether various economic impacts are different for different companies operating on the same market.

All affected sectors will be discussed but the focus of this annex will be on competitiveness impacts in the automotive sector.

This annex first identifies the sectors which are possibly affected. Then an assessment is given of impacts with respect to general drivers that may affect competitiveness. In addition to that impacts on the capacity of affected companies to innovate are assessed. Based on these general evaluations and additional information from available studies the impacts on competitiveness of businesses in different affected sectors are analysed in more detail. After that specific attention is paid to impacts on SMEs.

### **Which are the affected sectors?**

The main sectors directly affected are light duty vehicle manufacturers and component suppliers. These sectors need to develop and apply new technologies in order to reduce the CO<sub>2</sub> emissions of new passenger cars and light commercial vehicles. Many of the technologies included in the cost curves for 2020 are already available today and are being applied or are starting to be applied in production vehicles. The main actions required by the vehicle manufacturers and component suppliers therefore are to further increase the technical and commercial maturity of new technologies required to meet the 2020 targets and to timely develop vehicles in which these technologies are applied to the required extent.

There may be an effect on the competitiveness of European businesses in the automotive manufacturing sector, relative to each other or to companies from outside the EU, on the European market and on other, global markets.

Indirect impacts on other sectors in the vehicle manufacturing supply chain might e.g. arise due to demand for different materials.

While there may be economic impacts on car dealers and distribution networks (e.g. through pressure on dealer margins) it is not expected that their mutual competitiveness will be directly affected. Indirect effects could result from the impacts of the implementation of the 2020 targets on the car manufacturers represented by these dealers, but such effects are not considered intrinsic to the nature of the regulation.

Indirect impacts on sectors outside the supply chain are likely to be mainly felt in the fuel supply sector and in sectors using light duty vehicles.

The competitiveness of companies in the fuel supply sector might be affected as a result of the reduction in fuel consumption.

Users of passenger cars and light commercial vehicles will generally benefit from the lower total cost of vehicle ownership. This is especially the case for light commercial vehicle users, where the payback period of the additional vehicle costs associated with applying CO<sub>2</sub>-reducing technologies is very short. These changes will lead to further indirect impacts as costs of using energy and of carrying out the transport elements of business will decrease. This is not expected to affect the competitiveness of companies competing on the European market, but may to some extent benefit the global competitiveness of internationally operating companies and of the European economy as a whole.

Overall changes in the price of passenger transport by car and goods transport by LCVs could affect the competitiveness of road transport relative to suppliers of alternative forms of passenger mobility or goods transport. This could result in modal shifts.

### **Overview of the affected sectors**

The automotive industry is one of Europe's key industrial sectors, and its importance largely derives from its linkages within the domestic and international economy and its complex value chain. In 2007, the automotive sector had a turnover of over €780 billion<sup>28</sup> and value added in the automotive sector amounted to around €140 billion, representing about 8% of European manufacturing value added. The sector directly employs more than 2.3 million people (or around 6% of manufacturing employment) and is responsible in total for more than 12 million jobs across Europe, about 5.5% of EU-27 employment. Most of the employees (ca. 60-70%) are engaged in skilled (or semi-skilled) manual work, while 30-40% are trained professionals or technicians (e.g. engineers, business and sales specialists, IT, quality control, marketing, management).

Automotive industry employment in manufacturing is particularly important in Germany (≈ 13% of manufacturing employment), Sweden (≈ 9%) and in France, Belgium, the Czech Republic and Spain (≈ 8% each). Before the financial crisis, there had been a trend of increasing employment in the automotive sector in the new Member States, where some manufacturers have been installing substantial additional production capacity, while declines have been observed in some EU-15 countries. New Member States offered location advantages based on their skilled labour, lower labour costs and tax policy, which, combined with the EU regulatory framework context and proximity to major markets, led to a high level of automotive-related investment into the region. In recent years most of investment in new EU production capacity was in the new Member States.

A decline in demand and production since mid-2008, due to the financial crisis, brought a significant number of job cuts. The industry has strived to preserve its core and most-skilled staff by reducing its temporary and agency workforce and short-term measures (temporary shut-downs, shorter working weeks, salary cuts, voluntary departures and early retirement). In the first quarter of 2009, a net loss of more than 21,000 jobs in the sector was reported following a net loss of almost 32,000 in the last quarter of 2008. It should be noted that although these figures are heavily impacted by the crisis they also reflect the restructuring effort undertaken by the industry. Recent statistics, such as those in the European

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<sup>28</sup> Unless otherwise highlighted, figures in the following sections are taken from the DG Enterprise and Industry 2009 study on competitiveness of main industrial sectors entitled: *European Industry in a Changing World Updated Sectoral Overview 2009*

Competitiveness Report 2011, have indicated that market conditions improved in 2010 with a subsequent increase in production following the decline in the previous two years.

### ***The number and distribution of firms in the automotive sector including the share of SMEs***

The automotive sector can be divided into suppliers (who, in turn are split into different “tiers” depending on the complexity of the contribution to the automotive product) and Original Equipment Manufacturers (OEMs, who are responsible for the final product itself). Supply chain management (process innovation) is one of the key strengths of the European automotive industry and major European suppliers are among the world leaders.

Typically, about 75% of a vehicle’s original equipment components and technology are sourced from the automotive suppliers. According to CLEPA (the European Association of Automotive Suppliers), the supplier sector includes some 3000 companies, of which 2500 are SMEs employing over 3 million people. European suppliers are recognised as world leaders in technology and innovation, particularly in electronics, powertrain and driveline components. The automotive value-chain provides an important outlet for sectors such as mechanical and electrical engineering, electronics, steel, metal-working, chemicals and rubber. It is estimated that for €1 of value added by the automotive industry itself, supporting industries generate approximately €2.7 of additional value added.

The automotive aftermarket consists of approximately 665,000 companies<sup>29</sup>, the vast majority of which are SMEs and employs approximately 3.5 million people and provides around €82 billion worth of components (spare parts, tyres, accessories, etc.). EU motorists are estimated to spend around €140 per year on components and services for passenger cars.

### ***Labour productivity or total factor productivity***

In 2010, the European automotive industry produced about 16.4 million cars and light commercial vehicles, equivalent to about 27% of total production worldwide (15 million of which were cars). The sector has on average produced 16.4 million passenger light duty vehicles over the period 2008-2010, which, considering that this covers the financial downturn, is an indication of overall strength and robustness.

For the recent past, it is difficult to disentangle the evolution of the industry from the effects of the economic downturn. In view of this the figures given below for the period 2005-10 should be treated with caution since they cover the period of extreme turbulence.

- Average annual growth rate of employees was -2.4%.
- Average annual growth rate of hours worked was -2.6%.
- Average annual growth rate of labour productivity per person employed, which measures output divided by the number of people employed was 1.4%.
- Labour productivity per hour worked average annual growth rate was 1.5%.
- Average annual growth rate of unit labour cost, which measures the average cost of labour per unit of output was 0.3%.

### ***Market share of the world market***

In 2007, the EU automotive industry held a global market share of about 27% and this remains relatively stable. Exports and imports vary but in 2010 it was estimated that EU-27

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<sup>29</sup> According to CECRA (customer services, repair and servicing, spare parts, accessories and tuning) statistics

car exports amounted to €83 billion and imports €26 billion, giving a trade surplus of €57 billion<sup>30</sup>. Germany is by far the biggest vehicle exporting EU Member States, and is responsible for around half of the EU total. In 2008, only Japan exported more cars than the EU.

In terms of car trade the four main partners with which the EU has a surplus are NAFTA, EFTA, China and the Middle East. In 2009, more than 40% of EU car trade surplus came from EU exports to NAFTA, 21.4% to EFTA, 19.7% to China and 12.4% to the Middle East. Japan is the fifth largest destination of EU exports (5.6%) but is also the EU's biggest car trade deficit (€ -5.2 bn), as EU imports are about five times its exports. Other trading partners with which the EU car trade balance is in deficit are South Korea (€ -1.8 bn), India (€ -1.4 bn) and Turkey (€ -1.2 bn), as its imports are 3, 15 and 1.5 times higher than the value of its exports to those countries.

Within the EU significant net exporters are Germany, France and Spain, whereas net importers are UK and Italy. Germany produces about 50% more vehicles than it sells domestically, while Italy has been producing about half the number of units sold in the country. Central and Eastern Europe countries have been producing about 11 vehicles for every 10 consumed in their markets (Czech Republic, Slovakia and Poland produce each at least twice as many vehicles as consumed domestically). However, due to the important and intensified international division of labour along the value chain, especially within the European Single market, the story-line behind production and trade figures is much more complex. Indeed, it is estimated that for car manufacturers in bigger EU countries such as Germany, France or Italy about 40% (in value terms) of the components of a car assembled has been imported, 25% of which from other EU countries. For manufacturers in smaller countries, this share is estimated to be significantly higher.

The revealed comparative advantage index, which compares the share of a given industry's exports in the EU's total manufacturing exports with the share of the same industry's exports of a group of reference countries, was 1.22 in 2007 and 2008 and 1.3 in 2009. In comparison, the revealed comparative advantage index in the USA in 2009 was 0.96 and in Japan was 2.13. An RCA index greater than one indicates that the EU vehicle manufacturing industry continues to be very competitive at an international level. The implementation of the 2020 targets is unlikely to change this position.

In the long-term, European manufacturers are therefore well placed to take advantage of any market opportunities and Community trade policy plays a supportive role in terms of enabling fair market access. In terms of market share, production volumes, value added, employment levels and net trade position, the industry has maintained its global competitiveness in recent years. The EU has traditionally enjoyed a significant trade surplus in automotive industry products and it is not expected that the 2020 targets will impact on this.

### ***Foreign Direct Investment (ratio of inward/outward FDI stock to value added)***

In 2008, Eurostat estimated that the level of inward FDI (stocks), which measures the direct investment from outside the EU in the EU27 in respect of vehicles and other transport equipment to be €22.9 billion. The outward investment, which indicates the level of investment of EU companies in foreign markets, was estimated to be €60.4 billion.

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<sup>30</sup> EUROSTAT statistics.

## **Indirectly affected sectors**

Indirect impacts on sectors outside the supply chain are likely to be mainly felt in the fuel supply sector and also by vehicle users who will benefit from lower total cost of ownership. These changes will lead to further more indirect impacts as the cost of energy and the transport elements of business decrease.

### ***Fuel supply sector***<sup>31</sup>

In terms of the fuel supply sector, the two main types of enterprises which will be affected are filling stations and fuel refineries. In 2006 there were around 74,000 enterprises classified as retail sale of automotive fuel in the EU-27, less than 10% of all motor trade enterprises (which includes the wholesale, retail sale and repair of motor vehicles and motorcycles, as well as the retailing of automotive fuels and lubricants). These enterprises generated €178 billion of turnover, from which resulted €14 billion value added, 13.4 % and 8.6 % of the motor trades total respectively. The sector employed half a million people, 11.8 % of the motor trades workforce. Contributions from some Member States (e.g. France) may be low, due to a large proportion of fuel being sold through service stations that belong to retailers classified under retail trade rather than retailing automotive fuels.

The pattern of turnover for the retail sale of automotive fuels in the EU-27 was less steady than motor trade as a whole, particularly between 1998 and 2005. The retail sale of automotive fuels grew strongly to 1999 flattened out from 2000 to 2002, at a time of continued growth across motor trades as a whole. This was followed by much stronger growth through to 2005. However oil prices changes should be taken into account when analysing these findings, as the volume of automotive fuel may have fallen while sales in value terms rose (due to significant price increases).

In 2006 there were around 1100 enterprises classified as concerned with fuel processing and the refining of petroleum products in the EU 27, of these around 100 are refineries. Turnover was estimated to be around €476 billion with around €30 billion value added. Over 128,000 people were employed in the sector. Between 1997 until 2007 average growth for the refined petroleum products sector was 0.8% per year.

It is likely that implementing the 2020 targets will impact negatively on the fuel supply sector due to a lower demand for fuel. However, in the case of the filling stations, there is a trend of steadily reducing numbers of filling stations and increasing diversification with a major part of their revenues coming from activities other than selling fuel. Modelling indicates a reduction in demand for fuel resulting from the impact of the 2020 targets of up to 15% by 2030. However, there is no evidence to suggest that this will lead to a proportionate decline in turnover and employment in relation to filling stations and refineries.

## **What is the overall effect on cost and price competitiveness?**

The impacts on costs are extensively discussed in chapter 5 of the main text. The total impact on costs comprises changes in the costs of manufacturing vehicles, possible additional compliance costs for manufacturers and changes in the usage costs of vehicles, mainly associated with possibly increased purchase prices and reductions in fuel consumption.

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<sup>31</sup> Source of figures on the retail sale of fuel - EUROSTAT

***Does the assessed proposal cut or increase compliance costs of the affected sector(s)?***

There is not expected to be any additional costs of compliance with the legislation over and above those associated with the development and application of the technologies required to meet the CO<sub>2</sub> target.

Existing legislation already contains monitoring provision so there are not expected to be any additional costs associated with this. No new monitoring equipment is needed and no additional staff time or business services are needed. No enterprises or sectors are at a disadvantage under the existing monitoring provisions. Derogations do give slightly different monitoring and reporting requirements but are judged to not be distortive of competition.

***Does the proposal affect the prices and cost of intermediate consumption?***

Intermediate consumption is an accounting flow which consists of the total monetary value of goods and services consumed or used up as inputs in production by enterprises, including raw materials, services and various other operating expenses. A distinction needs to be made between impacts on the amount of intermediate consumption (amount of products or services used in production) and the costs or price of intermediate consumption (cost or price of a given product or service used in production).

For vehicle manufacturers the amount of intermediate consumption is expected to increase relative to a situation without the implementation of the 2020 targets. A significant part of the additional technologies to be applied to new vehicles is likely to be purchased from suppliers. Whether this leads to a net increase in the cost of intermediate consumption depends on the extent to which additional technology costs are compensated by reductions in the costs of other supplied products and services due to other drivers. As part of the applied technologies (e.g. advanced transmissions or hybrid propulsion systems) may also provide added value to the user the gross added value may increase. If manufacturers are able to increase the sales price accordingly an increase in the cost of intermediate consumption, therefore, does not necessarily lead to an increase in the share of intermediate consumption in the gross turnover.

For sectors that use vehicles the costs of intermediate consumption are expected to decrease as the net cost of using vehicles decreases. As indicated earlier, however, this impact is considered to be small or negligible.

***Does the proposal affect the cost of capital?***

As the implementation of the 2020 targets does not directly affect the financial sector, there are no direct effects to be expected on the cost of capital. Indirect impacts could occur if the proposed legislation would lead to drastic (i.e. sudden or very large) changes in the need for investment capital by automotive manufacturers, suppliers or other affected sectors or if the risks associated with providing such investment capital would increase.

As there will be an acceleration in innovation and the application of new technologies an increased demand for investment capital is to be expected. However, compliance only involves the introduction and gradual increase in the level of application of additional technical adaptations in vehicles. It does not require major restructuring of the automotive sector's operations or structure.

There are no negative impacts expected on the demand for passenger cars and vans. Also, meeting the 2020 targets does not yet require large investments in alternative technologies

such as electric, plug-in hybrid or fuel cell vehicles for which the market success is still uncertain. The additional investments therefore are not expected to increase the risk for financial institutions to provide investment capital.

As a consequence, and given the long lead time, there is no reason to believe that the implementation of the 2020 targets will lead to significant impacts on the cost of capital.

### ***Does the proposal affect the cost of labour?***

The only possible changes in the cost of labour would be those resulting from the additional or new labour demand (e.g. due to new skills requirements). In the automotive R&D departments there may be some shift in competences from mechanical to electrical engineering, but if shortages in new engineering disciplines would affect wages the impact on average labour costs for vehicle manufacturing of the manufacturing industry in general would be small. As far as requirements for labour skills in the actual manufacturing of components and vehicles are concerned, no significant deviations from the existing situation are expected.

As the implementation of the 2020 targets does not affect labour law or labour conditions, there would be no additional compliance costs related to employment.

### ***Does the proposal affect the cost of energy?***

The objective of the proposals is to reduce CO<sub>2</sub> emissions. The implementation of the 2020 targets does not directly affect the costs of producing energy carriers for the transport sectors or for other sectors. Achieving the CO<sub>2</sub> reduction goal, however, will indirectly reduce energy use. This will have a dampening or even lowering effect on energy prices, which will be beneficial to the transport sector as well as to other sectors.

### ***Does the policy proposal affect consumer's choice and prices?***

The proposals will not limit consumer choice directly. Cost assessments as presented in section 5 are carried out under the assumption that CO<sub>2</sub> emission reductions are achieved without affecting the performance of vehicles and the distribution of new vehicle sales over different marketing segments, and show that meeting the targets set in the proposals is technically and economically feasible without violating this assumption.

In their strive to meet the targets in a cost-optimal way manufacturers, however, may decide to adjust their product portfolio, and e.g. terminate production of specific types of vehicles or reduce the performance of specific models. But the implementation of the 2020 targets as such is technology neutral and does not prevent the placing on the market of any particular type of vehicle.

Companies using vehicles are likely to benefit indirectly since their costs of vehicle operation are expected to decrease.

In TNO et al. 2011<sup>32</sup> assessments have been made of the impact on vehicle prices relative to a reference situation without the 2020 targets. Compared to such a reference the implementation

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<sup>32</sup> Support for the revision of Regulation (EC) No 443/2009 on CO<sub>2</sub> emissions from cars, Service Request #1, carried out by TNO, AEA, CE Delft, IHS Global Insight, Ökopol, Ricardo and TML under Framework Contract No. ENV.C.3./FRA/2009/0043. Final Report, November 2011. See: [http://ec.europa.eu/clima/policies/transport/vehicles/cars/docs/study\\_car\\_2011\\_en.pdf](http://ec.europa.eu/clima/policies/transport/vehicles/cars/docs/study_car_2011_en.pdf)

of the 2020 targets will increase costs of manufacturing vehicles and is thus in the end expected to lead to increased vehicle prices, as increased costs can only temporarily be absorbed by manufacturers and at some point need to be passed on to consumers. Price impacts of the 2020 targets, however, are superimposed upon autonomous price trends. As discussed in chapter 14 of TNO et al. 2011, there are a multitude of drivers that tend to have a downward effect on the price of cars. The net impact of regulation on the price of vehicles depends on the ratio of the additional manufacturing costs and the cost reductions due to other drivers, whereby the cost of applying CO<sub>2</sub> reducing technologies might even enhance the strive for achieving cost reductions. Recent evidence shows that while CO<sub>2</sub> emissions have been consistently declining over the last decade, so have vehicle prices. Public information from vehicle manufacturers suggests that vehicle prices have may also not increase in real terms as a result of the implementation of the 2020 targets.

### ***Would the impacts above require a major restructuring of affected enterprises' operations?***

For some of the technologies that are expected to be applied in some innovations in production processes may be necessary. But there is no reason to believe that any major restructuring of the automotive industry's operations would be required.

### **Effect on enterprises' capacity to innovate?**

The automotive sector invests significantly in R&D. According to the 2011 EU Industrial R&D Investment Scoreboard the R&D expenses of European automotive manufacturers were just over €21 billion in 2010, 4.4% of their turnover. According to CLEPA, component suppliers invest about €15 billion in R&D, which is approximately 5% of turnover and receive the majority of the patents. This is complemented by investments in the production process and fixed assets amounting to over €40 billion per annum. European automotive firms are leaders in some transitional drive-train and fuel technologies and are investing in ground-breaking technologies, such as battery-powered hybrid vehicles, electric vehicles and hydrogen. As products are becoming increasingly complex from a technological point of view (e.g. the role of electronics), the industry is focusing increasingly on advanced, high technology products which necessarily rely on a highly skilled workforce.

Overall the implementation of the 2020 targets promotes innovation and may as such be expected to increase rather than decrease the automotive sector's capacity to innovate. The issues are what the size of the additional demand for innovative capacity is that the regulation requires, whether the sector will be able to mobilise this in time, or whether increased focus on innovation with respect to efficiency improvement and CO<sub>2</sub> emission reduction would go at the expense of innovation in other important areas.

A significant proportion of this R&D will already be related directly or indirectly to measures reducing CO<sub>2</sub> emissions. This proportion may increase in future. However, given the rates of CO<sub>2</sub> reduction in the passenger car sector over the last decade (approximately 2% per year) and the projected ongoing rate of reduction needed to meet the target (approximately 3% per year) it seems unlikely that the amount of R&D required will exceed the existing capacity of the industry. Without expansion in R&D capacity the increased need for R&D into CO<sub>2</sub> reducing technologies, could require some shift in priorities of R&D departments at the expense of other innovations.



There is no evidence of a shortage of skills needed either for the development of the technologies required or for their application in vehicle production. There does not appear to be any issue relating to IPR protection specific to the automotive sector.

The automotive sector is constantly innovating its products. Marketing new vehicle types and new technologies forms a key aspect of encouraging vehicle purchase. This will continue and as a part of this trend CO<sub>2</sub> reducing technologies will be incorporated in a somewhat higher pace than before.

Overall it is considered that the additional demand for innovation with respect to CO<sub>2</sub> reducing technologies can be catered for within the industry's R&D capacity or by a manageable increase in this capacity.

Distribution, marketing and after-sales services are also well developed in the automotive sector and the necessary management and organisational skills and talents are demonstrably available and are expected to be able to adequately deal with the new technologies applied to reduce CO<sub>2</sub> emissions of vehicles.

In the on-line consultation, 72% of stakeholders and 83% of individuals supported the view that EU regulation of road vehicle emissions stimulates innovation in the automotive sector and helps keep Europe's automotive industry competitive. It is likely that the sector will continue to invest in similar levels of R&D to remain competitive and to develop more efficient vehicles.

### **What is the effect on the competitiveness of car manufacturers?**

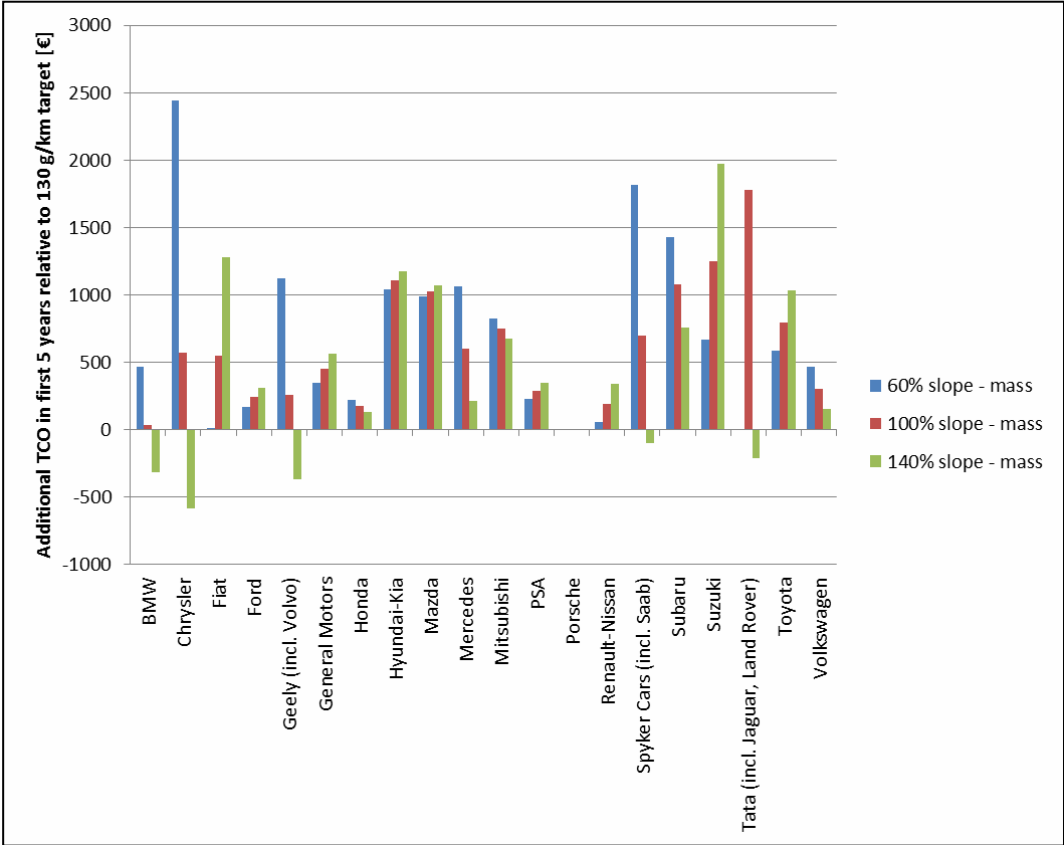
As discussed in section 5 there will be different impacts on different manufacturers. The additional manufacturer costs per vehicle for meeting the manufacturer specific target depend on a manufacturer's historical average CO<sub>2</sub> emissions (the 2002 resp. 2010 baseline) and on its product portfolio (division of sales over different segments).

Differences in the costs for meeting the 2015 / 2017 targets for cars and vans respectively are dominated by differences in the distance to target for different manufacturers, as their starting points were very different. In moving from the manufacturer average values in 2015 / 2017 for cars and vans to the manufacturer specific 2020 targets the differences in distance to target are greatly reduced. How much an individual manufacturer needs to reduce between 2015 / 2017 and 2020 depends on the choice of utility parameter and on the position (determined by target level and slope) of the utility based limit function for the 2020 target relative to the limit function for the 2015 / 2017 targets.

As a result of the non-linearity of the cost curves for CO<sub>2</sub> reduction, however, manufacturers which need to achieve similar relative reductions between 2015 / 2017 and 2020 may see markedly different costs depending on the amount of CO<sub>2</sub> reducing technologies they already had to apply in order to achieve their 2015 / 2017 targets. For manufacturers with a larger distance to their 2015 / 2017 target the additional vehicle costs for moving from the 2015 / 2017 target to the 2020 target will generally be higher. This results in a longer payback period (or higher increase / lower reduction of the total cost of ownership- TCO) for the users of their vehicles and thus a reduced attractiveness of these vehicles compared to products from other manufacturers. Changes in TCO can thus be a basis for assessing impacts of the implementation of the 2020 targets on mutual competitiveness of car manufacturers on the EU market.

In principle therefore the implementation of the 2020 targets may affect the mutual competitiveness of vehicle manufacturers on the European market. Such changes in mutual competitiveness may in turn affect the extent to which different companies are able to pass through the costs of additional technologies applied to meet the 2020 target. This impacts on the profitability of automotive manufacturers and may more indirectly also affect their competitiveness on global markets.

**Figure 12** Change in TCO for the passenger car end user in the first five years of vehicle use with reference mass as utility parameter<sup>33</sup>



**Figure 12** shows the change in TCO of passenger cars marketed by different manufacturers as a result of moving from their 2015 targets to the manufacturer specific targets for 2020 based on mass as utility parameter. Figures are based on the increased vehicle price minus the net present value of the fuel cost savings achieved in the first 5 years. Generally the payback time of the additional vehicle price is shorter than the vehicle lifetime (see **Figure 16**), leading to net lifetime cost savings. But for this example savings over a shorter period are included to reflect consumer myopia, which generally leads to an increased TCO.

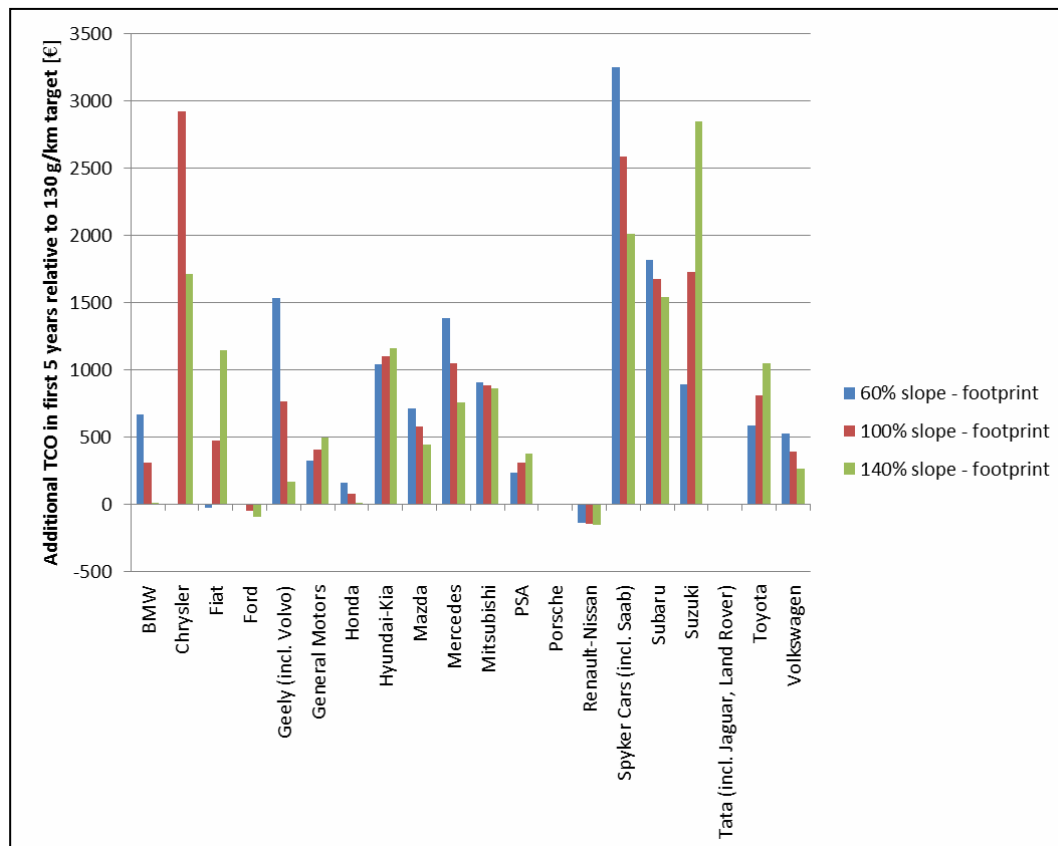
For mass as utility parameter changes in TCO are generally larger for Japanese and Korean manufacturers (with the exception of Honda) than for European manufacturers. TCO changes for manufacturers with a product portfolio focussing on smaller or larger cars are very sensitive to the slope of the limit function. TCO changes for BMW are markedly lower than

<sup>33</sup> The oil price assumed is \$ 120/barrel with an annual mileage for petrol vehicles of 14,000 km and 16,000 km for diesels. A factor of 1.195 is used to convert TA emissions into ‘real world’ emissions and the mark-up multiplication factor used to determine the vehicle price increase from the additional manufacturer costs is 1.235.

for Mercedes. The mutual competitiveness of more mainstream manufacturers such as Ford, GM, PSA and Volkswagen is not significantly affected.

Following the same approach **Figure 13** presents the change in total cost of ownership of passenger cars from different manufacturers for a 2020 targets based on footprint as utility parameter.

**Figure 13** TCO difference for the passenger car end user in the first five years of vehicle use with footprint as utility parameter<sup>33</sup>



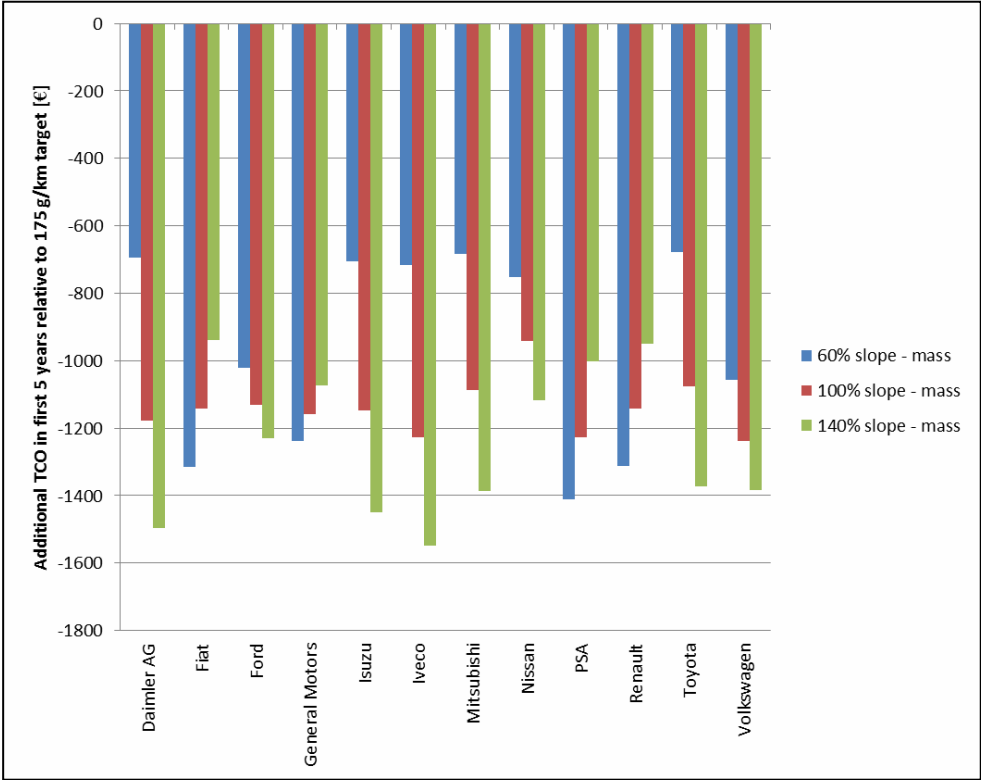
For footprint as utility parameter the picture is quite different. Still on average the changes in TCO seem larger for Japanese and Korean manufacturers (with the exception of Honda) than for European manufacturers, but the difference between Japanese and Korean manufacturers are larger. The TCO change for Mercedes is larger than for some Japanese and Korean manufacturers, but as these are not direct competitors this may have limited impact on mutual competitiveness.

Especially for manufacturers with a product portfolio focussing on larger cars TCO changes are less sensitive to the slope of the limit function than is the case for mass as utility parameter. TCO changes for BMW are again markedly lower than for Mercedes. The mutual competitiveness of more mainstream manufacturers such as Ford, GM PSA and Volkswagen is significantly affected with TCO changes for Ford much lower than for the other three.

**Figure 14** and **Figure 15** show the change in TCO as seen by users of light commercial vehicles from different manufacturers, resulting from moving from the 2017 target of 175 gCO<sub>2</sub>/km to the 2020 target of 147 gCO<sub>2</sub>/km, based on mass resp. footprint as utility parameter.

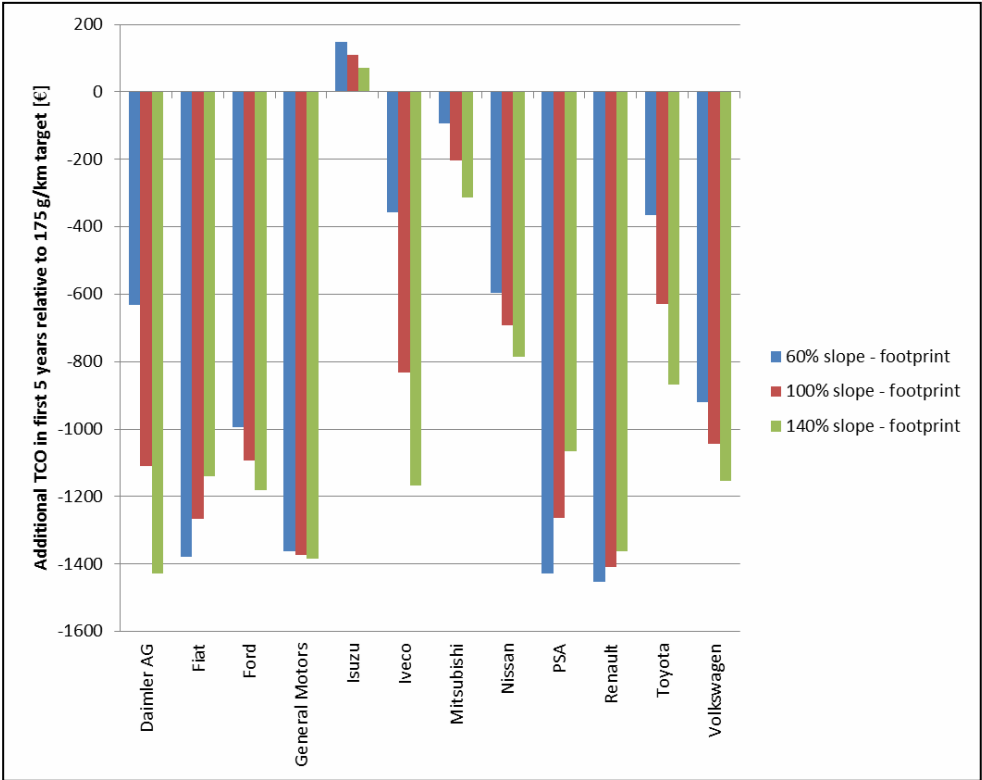
For mass as utility parameter the differences in impacts on TCO for different manufacturers are quite small. Sensitivities with respect to the slope are in line with the manufacturers' average mass compared to the overall average mass of vans sold in Europe. No distinction is visible between European manufacturers and Japanese and Korean companies. A target based on mass as utility parameter, therefore, does not appear to have significant impacts on mutual competitiveness of LCV manufacturers.

**Figure 14** Change in TCO for the LCV end user in the first five years of vehicle use with reference mass as utility parameter<sup>34</sup>



<sup>34</sup> The oil price assumed is \$ 120/barrel with an annual mileage of 23,500 km. A factor of 1.195 is used to convert TA emissions into 'real world' emissions and the mark-up multiplication factor used to determine the vehicle price increase from the additional manufacturer costs is 1.11.

**Figure 15** Change in TCO for the LCV end user in the first five years of vehicle use with footprint as utility parameter<sup>34</sup>



For footprint (**Figure 15**) the impacts on TCO are much more scattered. For this utility parameter the attractiveness of products from European manufacturers is markedly increased compared to those from Japanese and Korean manufacturers. Sensitivity to the slope of the limit function is particularly high for Daimler AG and IVECO, and to a somewhat lesser extent for Toyota.

**What is the effect on competitiveness of incumbents compared to new entrants?**

Incumbents on the EU market have the advantage of large sales and a wide product portfolio allowing them to optimise costs for meeting the target through internal averaging. This options is generally not or less available to new entrants.

New entrants could apply for derogation. In the absence of a historical sales-averaged CO<sub>2</sub> emission value the Commission shall determine an equivalent reduction target based upon the best available CO<sub>2</sub> emissions reduction technologies deployed in passenger cars of comparable mass and taking into account the characteristics of the market for the type of car manufactured.

New entrants focussing on electric or fuel cell vehicles could have an advantage, as these vehicles count as zero emissions. They also pool their target with other manufacturers. In this way the emission credits resulting from selling zero-emission vehicles could be “sold” to incumbent manufacturers. If these are willing to pay for such credits, this would prove that pooling is also beneficial for them, so that costs for compliance are reduced for both the new entrant and the incumbent manufacturers.

### **What is the effect on the competitiveness of component suppliers?**

The implementation of the 2020 targets is expected to have positive economic impacts for component suppliers in the automotive industry, resulting from the demand for additional components. As the current Regulations are technology neutral and affect all manufacturers, further implementation of the 2020 targets is expected to have negligible impacts on the mutual competitiveness of European component suppliers.

Impacts on competitiveness between European suppliers and companies from outside on the European market and on foreign markets may depend on the extent to which other regions adopt similar CO<sub>2</sub> regulation. This aspect is more generally assessed in the next section.

The demand for new advanced components may spur competition among suppliers, whereby the most innovative companies are expected to be able to capture a larger share of the market. This is to be considered an indirect but generally positive consequence of the implementation of the 2020 targets.

### **What might be the effect on the automotive sector's international competitiveness?**

*What is the likely impact of the assessed option on the competitive position of EU firms with respect to non-EU competitors?*

According to the Porter hypothesis advanced national / regional environmental policy stimulates innovation which in the longer term improves the competitiveness of the region / country. Whether this is also true for regulation on a market with a large number of foreign suppliers is debatable. Nevertheless, as a result of EU regulation on CO<sub>2</sub> emissions from light duty vehicles EU vehicle manufacturers might have a competitive advantage over non-EU companies, as the regulation affects their home market which generally represents a large part of their total sales. For manufacturers without or with less stringent CO<sub>2</sub> regulation on their home market it might be more expensive to adapt a small share of their production to comply with the EU regulation. However, as is shown in **Figure 6** CO<sub>2</sub> standards in different markets are rapidly converging. The Japanese standard for 2020 is close to the EU target. Only for South Korea the 2015 target is still in the proposal phase and no 2020 target has been proposed. In the short term this could mean a competitive disadvantage for Korean manufacturers on the EU market. It is likely, however, that Korea will adopt the 2015 and a target for 2020 may be expected.

This means that non-EU manufacturers have to achieve quite similar CO<sub>2</sub> emission values on their home markets, which reduces the possible competitive advantage of EU manufacturers on the EU market. At the same time, however, this also implies that the EU regulation does not place EU manufacturers in a disadvantageous position in markets outside the EU. The fact that the EU legislation is still slightly ahead of targets in other countries might even give them an advantage in other markets with CO<sub>2</sub> legislation. This would be most prominent on the US market, where many EU manufacturers are active, while US companies are generally niche manufacturers on the EU market.

The competitive position of European component suppliers relative to non-EU competitors might be improved. As the EU legislation is still slightly ahead of targets in other countries the technology-readiness of suppliers based in these countries may be expected to lag behind that of European companies. This improves the attractiveness of European suppliers for EU vehicle manufacturers and might also provide them a competitive edge in other markets. Given that EU manufacturers need the new technologies to meet the targets might also allow

EU-based suppliers to increase their margins and improve their profitability. This would bring them in a better position to expand business to other markets.

As argued above the impacts of the implementation of the 2020 targets on the costs of purchasing and using vehicles affects the costs of business operations for all similar vehicle users alike. For EU firms using vehicles therefore no change in competitive position with respect to non-EU competitors on the EU market is to be expected.

***What is the likely impact of the assessed option on trade and trade barriers?***

In line with what is argued under the previous point, the regulation is not effectively causing trade barriers for non-EU manufacturers. The regulation is not expected to have an impact on existing trade barriers.

Possible impacts on trade volumes and balances could result from changes in competitiveness of vehicle manufacturers and component suppliers as described above. Improved competitiveness of EU-firms on the EU market may lead to lower imports, while improved competitiveness of EU-firms on non-EU markets may lead to higher exports.

***Does the option concern an area in which international standards, common regulatory approaches or international regulatory dialogues exist?***

There are no international standards for new vehicle CO<sub>2</sub> emissions. However, there are international approaches to measuring fuel consumption and CO<sub>2</sub> emissions established under UNECE. Development of a new World Light Duty Vehicle test procedure (WLTP) is ongoing. The implementation of the 2020 targets is consistent with the existing, internationally agreed test procedure and is intended to be amended to become consistent with a new procedure as soon as this is adopted.

***Is it likely to cause cross-border investment flows, including the relocation of economic activity inward or outwards the EU?***

There are no constraints on cross-border investments in the automotive sector. Since projections are for a generally stagnant market for LDVs in the EU, it is unlikely that there will be substantial inward investment. What investment flows there are do not seem likely to be affected by the Regulations.

**What is the effect on the competitiveness of other sectors in the automotive supply chain?**

Indirect impacts on other sectors in the vehicle manufacturing supply chain might arise due to demand for different materials. However, the levels of light-weight construction assumed in the cost curves, used to assess the feasibility of the 2020 targets, do not yet require widespread application of alternatives for steel. In as far as advanced steels and innovative construction technologies are required, various projects by the steel industry have shown that this sector is ready and able to supply such new products and assist the automotive industry with their application<sup>35</sup>. Due to transport costs there might be some preference for European car manufacturers to source steel from steel companies within the EU. Innovations in light-weight construction might require closer cooperation between automotive and materials

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<sup>35</sup> See e.g. the projects Super Light car (<http://www.superlightcar.com>) and FutureSteelVehicle (<http://www.worldautosteel.org>)

industry which could increase car manufacturer's interests to work with EU producers. Together with the fact that the regulation is spurring innovation in the materials production sector, this may improve the long term competitiveness of the European industry in this sector.

### **What is the effect on the competitiveness of car dealers and distribution networks?**

While the implementation of the 2020 targets may have economic impacts on car dealers and distribution networks (e.g. through pressure on dealer margins) it is not expected that their mutual competitiveness will be directly affected. Indirect effects could result from the impacts of the regulation on the car manufacturers represented by these dealers, but such effects are not considered intrinsic to the nature of the regulation.

### **What is the effect on the competitiveness of suppliers of complementary or alternative goods?**

It is not expected that there will be major impacts on markets for complementary goods, i.e. suppliers of alternative forms of passenger mobility or goods transport. For passenger mobility alternatives are bicycles and motorcycles on one side and collective transport services such as public transport or aviation on the other side. Changes in the costs of driving cars are too small to have significant impacts on the modal split. For goods transport by means of light commercial vehicles there are hardly any alternatives.

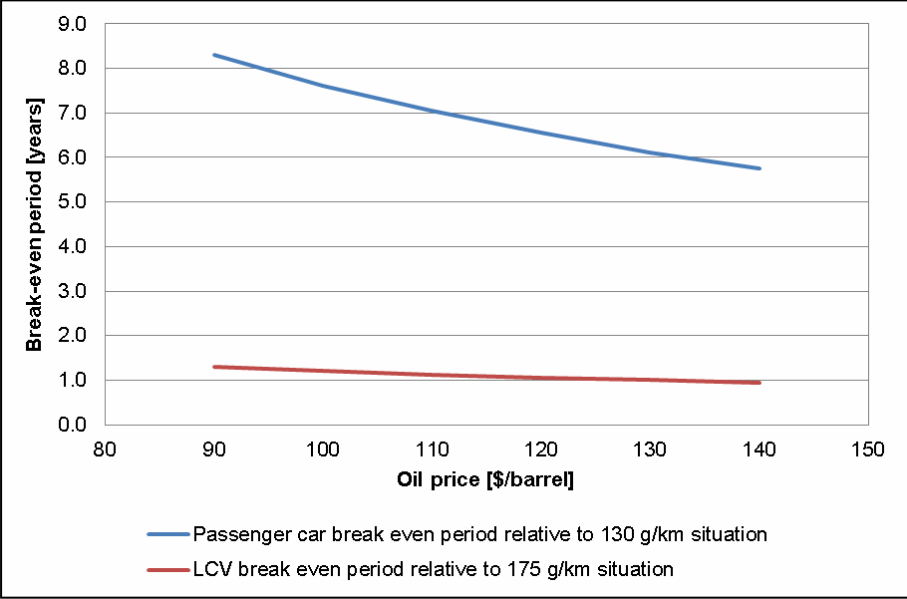
### **What is the effect on the competitiveness of vehicle users?**

The implementation of the 2020 targets may also directly or indirectly affect the competitiveness on the EU market of European businesses which use passenger cars and light commercial vehicles. Direct effects could exist for companies with a large share of transport activities in their operations. The use of light duty vehicles for passenger or goods transport or for providing other types of services, however, will mainly be part of operations undertaken by such companies on the European market or even on national markets. Possibly affected competitiveness of such companies using light duty vehicles will thus mainly concern competition relative to each other on the European and national markets. The implementation of the 2020 targets impacts on the costs of purchasing and using vehicles and may thus affect the costs of business operations, but it affects the costs of vehicles for all similar users alike, as companies competing on the same market will have similar fleets and vehicle use patterns. Consequently a change in overall costs resulting from the regulation is not expected to have significant impacts on the mutual competitiveness of companies which use light duty vehicles.

Users of passenger cars and light commercial vehicles will benefit from the lower fuel costs and the lower total cost of vehicle ownership. This is especially the case for light commercial vehicle users, where the payback period of the additional vehicle costs associated with applying CO<sub>2</sub>-reducing technologies is of the order of 1 year (see **Figure 16**). These changes will lead to further indirect impacts as costs of using energy and of carrying out the transport elements of business will decrease. As mentioned above this is not expected to affect the competitiveness of companies competing on the European market, but may to some extent benefit the global competitiveness of internationally operating companies and of the European economy as a whole.



**Figure 16** Period in which the fuel cost savings break even with the price increase resulting from the 2020 targets relative to the situation of maintaining the 130 gCO<sub>2</sub>/km target for passenger cars beyond 2015 resp. the 175 gCO<sub>2</sub>/km target for van beyond 2017.



**What is the effect on the competitiveness in the fuel supply sector?**

As mentioned in section 2.5.1 the proposed policy leads to a 25% reduction in the consumption of oil-based fuels by light-duty vehicles. This is to be considered a desired consequence of achieving the policy’s goals with respect to reduction of GHG emissions and improvement of energy security. In first order this reduced demand is expected to affect different fuel producers alike.

The consequences for individual companies in terms of the resulting impacts on business (profitability, market share, etc.) will be different and will depend on their individual ability to respond to the challenge of declining sales in Europe. As such the impacts on individual fuel producers can be considered a consequence of the companies’ current competitiveness rather than an impact of the regulation on their competitiveness. Nevertheless oil companies with a large market share in Europe might be affected more strongly than oil companies that are mainly focussed on the US or Asia. So from a global perspective, regulation may affect the competitiveness of these companies. **Table 12** shows that there is a large number of smaller fuel supply companies that operate largely or entirely on the European market. These companies might be expected to be affected more than larger, globally operating companies such as ExxonMobil, BP and Shell.

**Table 12** Sales of petrol and diesel in Europe as share of the total petrol and diesel sales of various fuel supply companies<sup>36</sup>

	European fuel sales as share of total fuel sales
BP	38%
Cepsa	100%
Chevron / Texaco	-
Eni	100%
ExxonMobil	25%
Galp	100%
Hellenic Petroleum	100%
MOL	100%
Neste	95%
Omv	100%
Petroplus	-
PKN Orlen	100%
Repsol	90%
Shell	33%
Statoil	100%
Total S.A.	63%

### **What is the effect on the competitiveness of other businesses?**

More generally the implementation of the 2020 targets may change the costs of intermediate products and hence also the costs of final products through changes in transport costs. On the EU market this will only affect the competitiveness of companies operating in the same market if they have very different shares of transport costs in their product costs. For products offered on a global market, the change in transport costs due to regulation may also affect global competitive position of European companies. For both situations, however, it must be stated that transport costs are generally a small share of overall product costs. Furthermore the implementation of the 2020 targets only affects the costs of transport by passenger cars and vans, which may be expected to be only a fraction of total transport costs. Direct or indirect impacts on competitiveness in the EU market through changes in the cost price of intermediate and final products are therefore assumed negligible.

In any case impacts on other businesses from the implementation of the 2020 target for vans can generally be considered positive due to the fact that the regulation reduces the total cost of ownership of light commercial vehicles in Europe. If at all significant, the impact on the competitiveness of European companies on the global market would improve as a result of this.

For companies using passenger cars as part of their operations the TCO may increase relative to the situation in which the 130 gCO<sub>2</sub>/km is maintained, although this depends on the depreciation period (e.g. 3 or 5 years) and the extent to which the increased vehicle price also results in increased residual value. Generally, however, personnel costs vastly outweigh costs of driving in professional applications of passenger cars, so that impacts of the

<sup>36</sup> Based on information from companies' websites

implementation of the 2020 targets on competitiveness can be considered insignificant for these applications.

### **What is the effect on SME competitiveness?**

There are two main categories of SMEs that might be affected by the implementation of the 2020 targets. One category is SMEs operating as small volume vehicle manufacturers or as suppliers to the automotive industry. The other category consists of SMEs which use passenger cars of light commercial vehicles.

ESCA, representing the smallest vehicle manufacturers, has been involved in the consultation process and has indicated that it does not have particular concerns with the 2020 targets. Small volume manufacturers are eligible for derogation and will be allowed to set individual targets that are compatible with their innovative and economic capabilities. As already mentioned in section 4.4.2, this will avoid strong increases in production costs for these SMEs, so that competitiveness of their projects with respect to purchase price will not be affected or could even be improved. At the same time the derogation will imply that fuel consumption of vehicles manufactured by SMEs will not go down at the same pace as that of products from large volume manufacturers. From the perspective of usage costs, therefore, the competitiveness of products from SMEs may deteriorate. In the light commercial vehicle market, which is more sensitive to fuel costs, this could be a relevant impact. In the passenger car market small volume manufacturers mainly produce sports vehicles, for which fuel consumption is less of an issue.

The main indirect effects could arise for SMEs that supply components to vehicle manufacturers. SMEs represent a significant number of companies in this sector ( $\approx 3000$ ). The main impact will be an increased demand for CO<sub>2</sub> reducing technologies and other measures to be deployed in vehicles. However, it is difficult to foresee how that would affect the competitiveness of such SMEs.

First of all it should be noted that the technologies required to meet the 2020 targets only concern a limited share of all components supplied to the automotive manufacturing industry. And many of the key-technologies, especially those related to engine and powertrains, may be expected to be produced by the larger Tier-1 suppliers. Only the drive to reduce weight could affect specifications of a larger number of vehicle components (e.g. including seats, dashboards, etc.). SMEs seem equally well placed to cater for such innovations as large companies. In general SMEs are more flexible with respect to minor changes in products and production processes. On the other hand they may have more difficulty to obtain financial means to deliver more radical product innovations or invest in major changes their production process.

Other indirect effects can arise from the use of vehicles. Since the impact of the implementation of the 2020 targets is beneficial in terms of total vehicle cost of ownership (with especially short payback times for vans) this indirect effect is likely to benefit SMEs along with other vehicle operators. Overall their competitiveness compared to other SMEs or to larger companies is not expected to change as a result of this regulation.

As European SMEs may be assumed to be mostly operating on the European market, impacts on competitiveness in other, global markets is less relevant for this category of companies.

**Conclusions** - the conclusions of this annex are outlined in section 2.5.1.

## 7.10. Impacts on the economy and employment – input-output model

An input-output model is essentially based on the work of Leontief, who developed a way to connect changes in final demand to changes in output, based on matrices of monetary flows between industries. Leontief used a matrix of intermediate demand coefficients (A), of final demand (D) and of output (X).

Given that demand and production need to be in balance (correcting for import and export), the basic equation is:

$$AX + D = X \quad (1)$$

Equation (1) can be inverted, to give (2)

$$(I - A)^{-1}D = X \quad (2)$$

Equation 2 is the basis of a methodology to analyse effects of changes in final demand (consumer demand) and its effect on output. It results in the level of output necessary to satisfy a certain final demand. On the basis of equation 2 multipliers can be calculated showing how 1€ extra demand leads to additional expenditure in production.

The numbers shown in the two scenarios in **Table 13** are based on the inverse of the Leontief matrix for the EU-27 matrix. The tables show how extra consumption changes macroeconomic indicators relating to production, labour, GDP, exports and imports. Each column represents a weighted increase in household consumption, keeping the demand for other goods constant. 'Other goods' category covers all sectors except fuel and vehicles.

Two tables are presented because of the difficulty to know how the targets will impact on imports and exports. The two scenarios show the extremes of the range. In Scenario A, both imports and exports are set to zero as shares of production and demand. In Scenario B it is assumed that exports are a fixed share of production and imports are a fixed share of final demand. In reality the impact will be somewhere between these scenarios, and so they can enable the likely range of impact to be calculated.

**Table 13:** Total effect of extra consumption on macro-economic indicators in two scenarios

Scenario A*	Vehicles	Fuels	Other goods
Consumption	1	1	1
Labour	0,55	0,31	0,45
Production	3,00	2,73	1,98
GDP	1,17	1,13	1,21
Export	0,00	0,00	0,00
Import	0,00	0,00	0,00

\* In scenario A exports and imports are set at zero for the affected sectors.

Scenario B*	Vehicles	Fuels	Other goods
Consumption	1	1	1
Labour	0,82	0,18	0,46
Production	4,36	1,47	2,01
GDP	1,69	0,68	1,22
Export	0,70	0,19	0,14
Import	0,19	0,63	0,13

\* In scenario B exports and imports remain a fixed proportion of expenditure in the sectors as overall expenditure varies.

**Table 13** shows that fuel consumption has only a small effect on production, relative to other sectors. Increased vehicle consumption has a proportionally large effect on production, labour and demand. In scenario B, replacing €1 of fuel expenses by €1 of vehicle purchase causes a total effect on labour expenditure of €0.64 (0.82€ – 0.18€), the total effect on GDP is 1.01€ (1.69€– 0.68€). The comparable effects in scenario A are €0.24 impact on labour and €0.04 on GDP. Where there is no perfect substitution between fuel and vehicle purchase the multiplier for other goods is used in the calculation.

It should be noted that there are limitations with this type of analysis, in particular:

- Input-output tables are partial models and do not take full market equilibrium into account.
- The impacts demonstrated are short term. Over the longer term adjustments will take place in the economy which will adjust the underlying consumption relationships.
- The changes are assumed to take place at the same time. However fuel savings accrue over the life of the vehicle. To adjust for this the NPV of the fuel savings is used.
- Leontief methodology assumes fixed input-output coefficients, meaning that no substitution between inputs to the production process is possible. The same is true for labour and capital. The effect on labour is calculated by multiplying the change in output from the Leontief inverse, with the share of wage.
- The numbers presented are scale independent, no returns to scale are taken into account.
- The analysis calculates the effect on trade surplus and government budget, but does not calculate the secondary effects of changes in these accounts on expenditures and/or investment. This requires additional assumptions which increase the complexity of the analysis substantially.
- The calculations do not take into account potential losses in consumer utility, as consumer preferences are forced from fuel to vehicle purchase.

- The impact on exports should be treated with caution since this factor is assumed to remain constant for each sector. It cannot necessarily be assumed that this will remain the case if vehicle technology changes.

Despite these limitations Input-Output analysis gives a good insight into the macro-economic linkages flowing from improvements in vehicle fuel efficiency. A number of Input-Output based studies have been performed exploring the macro-economic impacts of vehicle efficiency standards<sup>37</sup>, many of which look at the US market. These studies tend to show comparable effects to those reported here.

To establish the impact of the 2020 car target for one car, the net present value (NPV) fuel savings are taken from **Table 3** assuming an oil price of \$110/barrel. Tax is excluded since tax reductions would need to be compensated elsewhere and would not be expected to affect the overall government expenditure. The additional car purchase cost of €1158 is the average of the cost scenario 2 values given in **Table 8**. The excess fuel savings over vehicle purchase cost are assumed to be spent on other goods. These values are multiplied by total car sales to establish the aggregate impact on the economy. In 2011 some 13,111,209 cars were registered in the EU and this value is used.

The impact of these changes on the indicators is shown in **Table 14** below.

**Table 14:** Aggregate macro-economic impact of implementing 2020 targets

	<b>Scenario A</b>	<b>Scenario B</b>	<b>Central value</b>
<b>Labour</b>	€5,5bn	€13bn	€9bn
<b>Production</b>	-€5bn	€50bn	€22bn
<b>GDP</b>	€1,6bn	€22bn	€12bn

As can be seen there is predicted to be a substantial increase in production, labour, and GDP. Since it is clear that the correct result is between both scenarios, a central value is given as the best estimate.

These macro-economic changes can be disaggregated across different sectors. **Table 15** shows how changes in fuel or vehicle production will impact on other sectors, enabling a calculation of which would benefit from increased fuel demand or vehicle purchase respectively. The table illustrates the clear link between vehicle manufacturing and demand for basic metals, wholesale trade, chemicals and rubber. Fuel consumption has relatively limited effect on other sectors.

<sup>37</sup> For example: 'More jobs per gallon: how strong fuel economy/GHG standards will fuel american jobs'; CERES, 2011; 'Potential long term impacts of changes in US vehicle fuel efficiency standards'; Bezdek, R.H., Wendling, R.M., 2005; 'Energy efficiency and job creation: the employment and income benefits of investing in energy conservation technologies. Report no ED922, American Council for an Energy-Efficient Economy'; Geller, H., DeCicco, J., Laitner, S., 1992; 'Employment impacts of achieving automobile efficiency standards in the United States'; Dacy, D.C., Kuenne, R.E., McCoy, P., 1980

**Table 15:** Disaggregated impact of extra fuel or vehicle technology consumption

<i>Sector</i>	<i>Leontief multiplier for fuel</i>	<i>Sector of economy</i>	<i>Leontief multiplier for vehicle purchase</i>
Refined petroleum	0.52	Motor vehicles, trailers and semi-trailers	1.63
Crude petroleum	0.30	Basic metals	0.32
Other business	0.08	Other business services	0.27
Chemicals	0.07	Fabricated metal products, except machinery and equipment	0.19
Trade	0.04	Wholesale trade and commission trade services, except of motor vehicles and motorcycles	0.15
Auxiliary transport	0.03	Chemicals, chemical products and man-made fibres	0.15
Electrical energy and gas	0.03	Machinery and equipment n.e.c.	0.14
Other sectors	0.39	Rubber and plastic products	0.13
TOTAL	1.470	Electrical machinery and apparatus n.e.c.	0.12
		Auxiliary transport	0.08
		Other sectors	1.190
		TOTAL	4.37

## 7.11. The limit value curve – explanation of the slope

### The limit value curve approach

The utility based approach adopted in the legislation results in the CO<sub>2</sub> reduction obligation being defined as a linear function of a so-called "utility" parameter (e.g. mass or footprint) reflecting the utility of vehicles. The Regulation targets are set according to this limit value function expressed as a formula (annex I to the Regulations). The limit value curve approach ensures that vehicles with a larger utility parameter (currently mass) are allowed higher emissions than lower utility vehicles while ensuring that the overall fleet average meets the target.

The result of this approach is that only a manufacturer's fleet average is regulated, they are still able to make vehicles with emissions above their indicative targets if these are offset by other vehicles which are below their indicative targets. To comply with the Regulation, a manufacturer has to ensure that the overall sales-weighted average of all its new cars or vans does not exceed the point on the limit value curve for its average utility parameter.

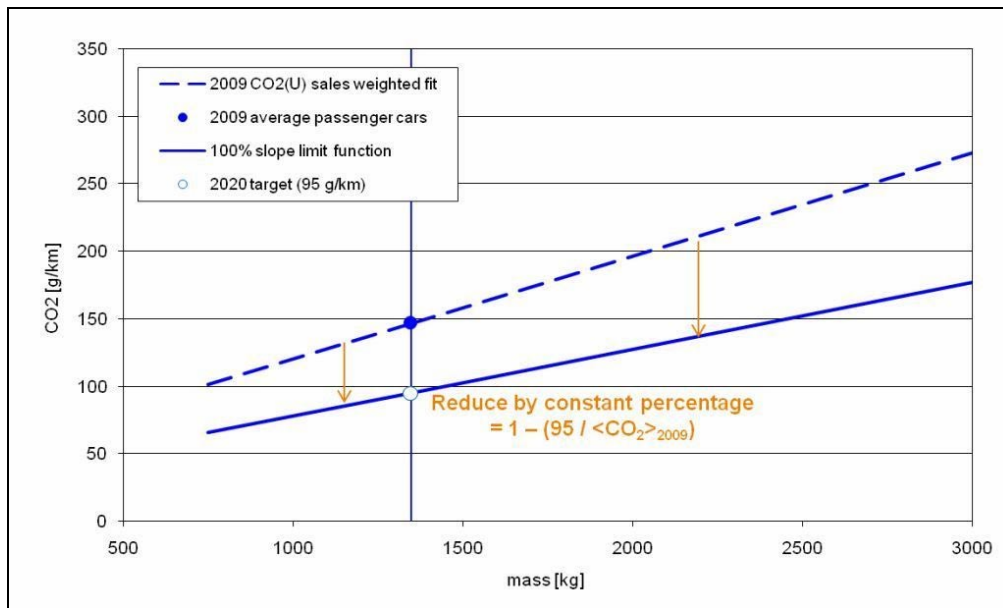
### Defining the slope

To define the slope, the starting point is the observed trend in terms of market distribution of vehicles' sales in a base year. For the current car study, the analysis performed was in comparison to the average slope of the 2009 fleet. This line is the 100% limit value function for 2009.

To translate that to the 100% limit value function for a future year with a given target, the base year line is moved downwards by an equal percentage emissions reduction across the range of the utility parameter to reach the desired limit value. The effect of this is to slightly rotate the curve clockwise. This is shown in **Figure 17**. The resulting line is the 100% limit value function for the target year and new fleet CO<sub>2</sub> target.

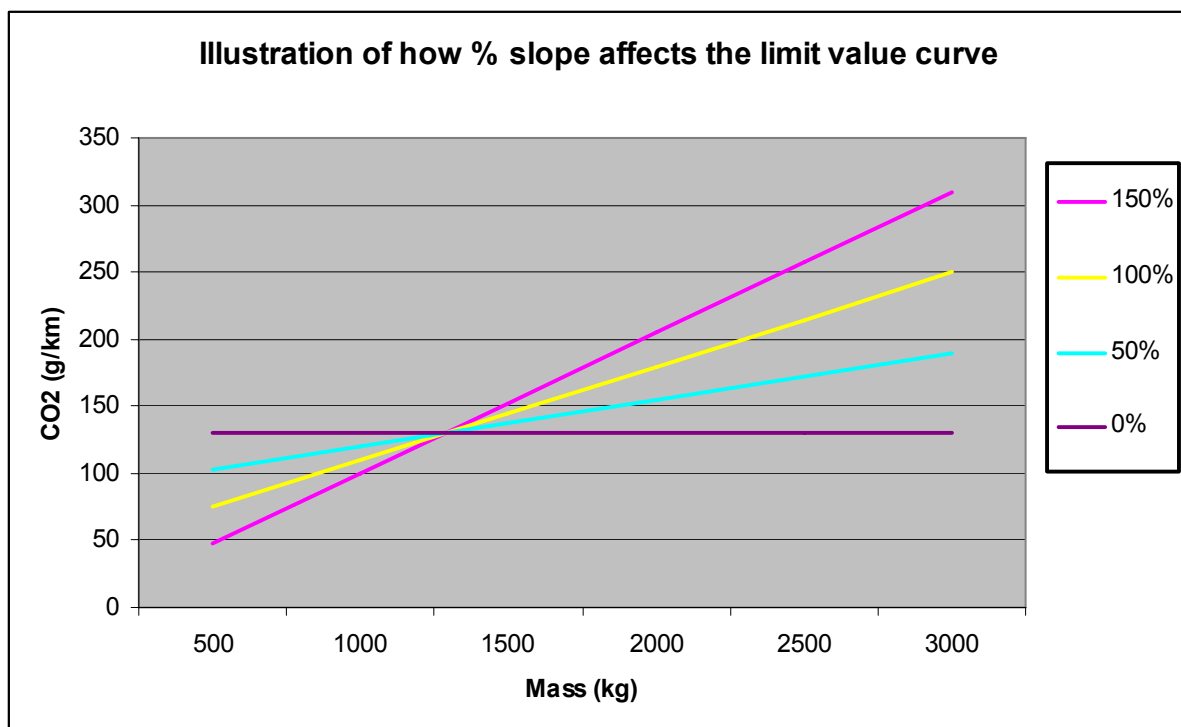


**Figure 17** 100% limit value function for 2009 baseline (dotted) and translation to 95 gCO<sub>2</sub>/km target limit value function (solid)



To facilitate discussion and setting the relevant slope of the curve, a horizontal line which passes through the fleet average utility parameter and CO<sub>2</sub> target is defined as the 0% limit value function. This is shown for illustrative purposes in **Figure 18** below. For such a limit value function every manufacturer regardless of the composition of their fleet would need to achieve the target level of CO<sub>2</sub> emissions and there would be no account taken of utility.

**Figure 18** Illustrative curves showing variation between 0 and 150% slope



The straight line function is described mathematically with a formula of the form  $Y = aX + b$ . The parameter  $a$  determines how steeply the line slopes. If  $a=0$  the line is horizontal (called

0% slope). If **a** has the value determined by establishing the 100% slope then the line is the 100% function. If **a** is greater than this the slope is greater than 100%, if it is less then the slope is less than 100%.

### **The formula in the legislation**

Within the legislation, the limit value function is described in a formula. The limit value curve for the 130 gCO<sub>2</sub>/km target for cars is: Permitted specific emissions of CO<sub>2</sub> = 130 + a × (M – M<sub>0</sub>)

Where:

- M = mass in kg
- M<sub>0</sub> = 1372.0
- a = 0.0457

Parameter 'a' in the formula determines the slope of the limit value function.

### **Effect of the slope**

The slope of the utility curve affects the distribution of effort between vehicles depending on their position on the curve. The slope of the curve does not change the overall outcome in terms of average gCO<sub>2</sub>/km, it only defines the distribution of reduction effort between vehicles with different values of utility parameter (currently mass). This is because it is rotated around the point set by the average vehicle parameter (1372 kg in case of cars) and the average CO<sub>2</sub> target to be achieved by the overall fleet (130 gCO<sub>2</sub>/km for cars).

If the curve has a lower slope (below 100%), the degree of effort required is proportionately greater from vehicles with a larger parameter (e.g. mass). If the curve is steeper (above 100%) then the effort required is proportionately greater from vehicles that have a smaller parameter. Because of this differential effect on different vehicles, changing the slope alters the amount of effort required from different manufacturers. For the current studies, the range from 60 to 140% has been analysed.

### **Changes since the legislation was adopted**

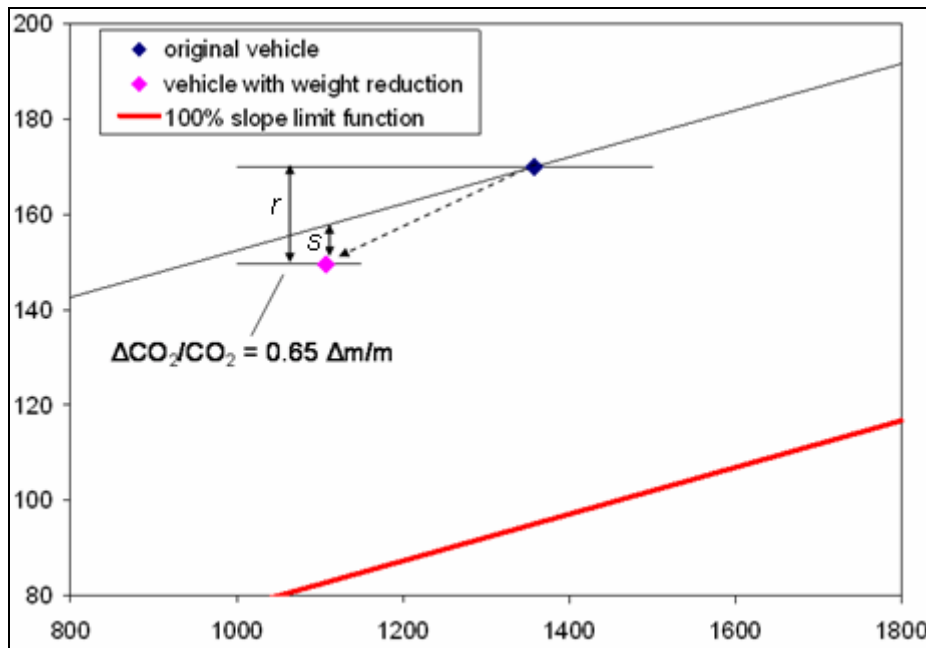
The slope of the curve in the current car Regulation is a 60% slope based upon the car fleet distribution in 2006. As a result of the way manufacturers have responded to the legislation, the current (2009) data shows a flatter line of best fit through the fleet data. So the 100% line through the 2009 data has a similar slope to the 60% line based on the 2006 data. This change in baseline year can cause confusion. The slope of the limit value function is ultimately selected on the basis of an appropriate burden sharing amongst manufacturers. This choice can as easily be made on the basis of 2006 fleet data, 2009 data or indeed an average of the two because ultimately what counts is a mathematical slope which delivers an acceptable burden sharing amongst manufacturers which limits the impact on inter-manufacturer competition and which is socially equitable. In simple terms, any desired slope of the limit value function can be expressed in terms of the 100% slope line of the vehicle emission data plotted as a function of mass (or footprint) of any particular year. For example, the 60% slope of the 2006 fleet data which delivers the 95 g/km target (in absolute terms 0.0333) is the equivalent of a 67% slope relative to the 2009 fleet data.

**7.12. Explanation of the effective change of the distance to target when applying light-weighting technologies in case of a mass-based limit function, and its impact on costs for meeting the 2020 target.**

In a CO<sub>2</sub> regulation system differentiating the target by manufacturer based on mass as the utility parameter, CO<sub>2</sub> reductions resulting from light-weighting (vehicle weight reduction) are not fully counted towards achieving the manufacturer's target. Since applying weight reduction to a vehicle lowers the vehicle-specific (or equivalently the manufacturer's specific) target (see **Figure 19**), the distance to target of the manufacturer is effectively reduced (*s* in **Figure 19**) less than the reduction in CO<sub>2</sub> emissions (*r* in **Figure 19**).

The fact that under a mass-based regulation the target changes with reduced vehicle weight reduces the cost-effectiveness of light-weighting as a CO<sub>2</sub> emission reduction technology. Under a footprint-based regulation the change in distance to target would equal the full CO<sub>2</sub> emission reduction resulting from light-weighting. In the assessment that has been carried out in support of the current review, identical cost curves were used to assess both mass and footprint based limit functions. It is desirable to understand what the impact on the cost of meeting the target would be if the reduced effectiveness of weight reduction under a mass-based limit function is taken into account.

**Figure 19** Schematic representation of the effective reduction of the distance to target when applying a weight-reducing technology under a CO<sub>2</sub> regulation using a mass-based limit function.



This is a 1<sup>st</sup> order assessment. The fact, that the regulation allows the value of  $M_0$  to be adjusted periodically in the limit function  $CO_2 = \text{overall target} + a \times (M - M_0)$  if a change in average weight is observed, provides the possibility to at least on average reward the full impact of applied weight reduction. Nevertheless it creates a first mover dilemma. The first manufacturers that start applying weight reduction are confronted with a more stringent target. If all manufacturers apply weight reduction to the same extent and  $M_0$  is subsequently adjusted, then mass reduction would be fully rewarded. But if only a few apply weight reductions and many manufacturers don't, then a correction of  $M_0$  only partially compensates

the reduced effectiveness for the first movers, while providing a more lenient target to all other manufacturers that did not apply weight reduction.

The assessment here therefore applies only to the situation in which the utility-based limit function is not adjusted in response to observed changes in average vehicle mass. By analogy it will also apply to a lesser extent to the situation where unequal mass reduction takes place.

## Methodology

The mass reduction  $\Delta M$  of a vehicle translates into a reduction  $\Delta CO_2$  of the vehicle's CO<sub>2</sub> emissions reduction (under the assumption that engine power is adjusted to maintain constant vehicle performance) according to the following formula:

$$\Delta CO_2 / CO_2 = 0.65 * \Delta M / M \quad (1)$$

In order to determine the extra costs resulting from the stricter target caused by applying mass reduction, new cost curves are constructed that simulate the eroding of the effective reduction of the distance to target resulting from applying mass-reducing technologies under a mass-based limit function. In these cost curves, the CO<sub>2</sub> reductions from light-weighting are corrected (lowered) for the stricter CO<sub>2</sub> target they induce. This is done by replacing the actual CO<sub>2</sub> emission reduction associated with weight reduction with the effective change in the distance to target. In detail this is done using the following method, analogous to Figure 19 and reported in **Table 16**:

- The average mass  $M$  and average CO<sub>2</sub> emissions  $CO_2$  are calculated per segment.
- Application of these average values in the 100% slope mass-based utility function results in the average distance to target for all vehicles sold within a segment.
- For each level of weight reduction, defined in the technology tables, the  $\Delta M$  in [kg] can be determined by inserting the initial relative reduction potential of the mass reducing technologies into equation 1 for  $\Delta CO_2$  (e.g. 2% for mild weight reduction for a small petrol vehicle). For  $M$  the average mass of the segment is used and for  $CO_2$  the average CO<sub>2</sub> emissions per segment.
- Subtracting the initial CO<sub>2</sub> emission reduction of the mass reducing technologies from the average CO<sub>2</sub> emissions of every segment gives the remaining average CO<sub>2</sub> emissions within every segment when that technology is applied.
- The average CO<sub>2</sub> emissions that have to be met within every segment are determined by applying the corrected average mass ( $M - \Delta M$ ) of every segment in the limit function.
- The alternative distance to target, resulting from applying a mass reducing technology, is the result of subtracting the adjusted average CO<sub>2</sub> emission targets that have to be met within every segment from the remaining average CO<sub>2</sub> emissions within every segment after application of weight-reducing technology.
- Finally, the effective relative reduction of the distance to target is determined by dividing the difference between the distance to target with and without the mass reducing technology applied by the initial average CO<sub>2</sub> emissions per segment. As can be seen in **Table 16**, these 'new' reduction potentials (reductions of the distance to target) are lower than the actual CO<sub>2</sub> reduction of that technology.

## Impact on the effectiveness of light-weighting

In **Table 16** below the 2009 average values per segment for mass and CO<sub>2</sub> emissions were chosen as baseline for calculating the adjusted potential for light-weighting under a mass-based limit function. Formally reduction potentials of technologies are defined relative to 2002 baseline vehicles. The reason to deviate from that definition here lies in the fact that according to formula (1) the absolute impact of a given mass reduction on CO<sub>2</sub> emissions decreases with decreasing CO<sub>2</sub> emissions of the baseline vehicle. Using the 2002 baseline data would thus lead to a smaller erosion of the potential of light-weighting under a mass-based limit function than when 2009 data are used.

Based on the assessment made in the car study<sup>38</sup>, light-weighting is a relatively expensive technology which only becomes cost effective higher up the cost curves. As cost effectiveness further decreases when the effect of distance to target relative to a mass-based limit function is taken into account, it is expected that light-weighting would only be applied later towards 2020. In order not to underestimate the erosion of light-weighting potential it was considered appropriate to base the assessment on the 2009 baseline CO<sub>2</sub> values.

**Table 16** Estimated CO<sub>2</sub> reduction potential and costs for light-weighting technologies relative to a 2009 baseline vehicle.

Calculation of adjusted CO <sub>2</sub> reduction potential for mass reducing technologies	pS	pM	pL	dS	dM	dL
Mass [kg] - average 2009	1039	1349	1829	1153	1491	1948
CO <sub>2</sub> [g/km] - average 2009	134.8	165.6	247.6	118.5	148.8	201.6
Distance to mass-based limit function with 100% slope [g/km]	55.4	71.0	129.5	33.5	47.2	77.7
Mild light-weighting - reduction potential	2%	2%	2%	2%	2%	2%
Medium light-weighting - reduction potential	6%	6%	6%	5%	5%	5%
Strong light-weighting - reduction potential	12%	12%	12%	11%	11%	11%
ΔMass mild light-weighting [kg]	32	42	56	27	34	45
ΔMass medium light-weighting [kg]	96	125	169	89	115	150
ΔMass strong light-weighting [kg]	192	249	338	195	252	330
Resulting CO <sub>2</sub> mild light-weighting [g/km]	132.1	162.3	242.7	116.8	146.5	198.6
Resulting CO <sub>2</sub> medium light-weighting [g/km]	126.7	155.7	232.8	112.6	141.3	191.5
Resulting CO <sub>2</sub> strong light-weighting [g/km]	118.6	145.7	217.9	105.5	132.4	179.4
Adjusted target mild light-weighting [g/km]	77.8	92.6	115.4	83.7	99.8	121.7
Adjusted target medium light-weighting [g/km]	74.7	88.5	109.8	80.6	95.9	116.6
Adjusted target strong light-weighting [g/km]	70.0	82.4	101.6	75.4	89.2	107.8
Adjusted distance target mild light-weighting [g/km]	54.3	69.7	127.3	33.1	46.7	76.9
Adjusted distance target medium light-weighting [g/km]	52.0	67.2	122.9	32.0	45.4	74.9
Adjusted distance target strong light-weighting [g/km]	48.6	63.3	116.3	30.1	43.2	71.6
Adjusted reduction potential mild light-weighting	0.84%	0.77%	0.89%	0.40%	0.37%	0.41%
Adjusted reduction potential medium light-weighting	2.51%	2.32%	2.66%	1.33%	1.22%	1.36%
Adjusted reduction potential strong light-weighting	5.03%	4.63%	5.32%	2.94%	2.69%	2.99%

## Impact on cost of meeting the target

<sup>38</sup> Tables 8 and 9 in the car study

Applying the adjusted reduction potentials to the technology packages results in modified cost curves. These show that the cost to reach a certain reduction potential is higher than the original cost curve. This is only the case from the first point on the curve that includes a mass reducing technology. These adjusted cost curves result from the necessity for a manufacturer to apply extra CO<sub>2</sub> reduction technologies to meet their target.

Application of the adjusted cost curves in the assessment model used to determine the lowest possible costs for every manufacturer to meet its target, leads to average additional manufacturer costs shown in **Table 17**. The impact of a mass-based limit function on the effectiveness of light-weighting is found to lead to an increase in the average additional manufacturer costs for meeting the target from € 2188 to € 2249 per sold vehicle for the highest cost scenario compared to the 2009 situation.

**Table 17** Comparison between the average additional manufacturer costs based on the original cost curves and those based on cost curves that are corrected for the effectively reduced impact of mass reducing technologies under a mass-based limit function.

Average additional manufacturer costs relative to 2009	Cost [€]
Original cost curve	2188
Adjusted cost curve corrected for the effective reduction in distance to target for light-weighting options under a mass-based limit function	2249

## Conclusions

In the assessment of mass as utility parameter presented in the car study this was considered not to affect the cost-effectiveness of light-weighting technologies used by manufacturers to reach their targets under the CO<sub>2</sub> regulation. However, use of light-weighting technologies under a mass-based limit function not only reduces a vehicle's CO<sub>2</sub> emissions but also its target. As a result light-weighting is a less attractive option when a mass-based limit function is used. The reduced effectiveness of light-weighting would lead to increased costs of meeting the target, relative to use of a footprint-based limit function under which the effects of light-weighting are fully rewarded. For the 95 gCO<sub>2</sub>/km 2020 target, the impact on the additional costs per vehicle is of the order of €60 per car on a total additional manufacturer cost compared to 2009 of around €2200 per vehicle, ie about 3%.

The impact is limited due to the relatively high costs assumed for the light-weighting technologies. If light-weighting would be cheaper, this option would appear lower on the cost curve and the change in effectiveness due to a mass-based limit function would be greater. Now the impact only occurs higher up the cost curves, with the additional costs amounting some €1000 at the end of the cost curves.

Therefore, the impact of a mass-based limit function on the cost of meeting the target could be higher than assessed here if light-weighting technologies are cheaper than currently estimated. Studies underlying the US car CO<sub>2</sub> regulation indicate that this might be the case.

### 7.13. Cost scenarios in the car analysis

The cost curves are constructed on the basis of information regarding the CO<sub>2</sub>-reducing technologies and their application in different types of vehicles, their CO<sub>2</sub> reduction potential and the associated cost.<sup>39</sup>

**Cost scenario 1** (referred to on **Figure 20** and **Figure 21** as the 2020 cost curve) is the basic scenario and concerns cost curves constructed on the basis of information obtained from the main stakeholders concerned, including the automotive manufacturers (incl. ACEA) and component suppliers, information from the literature review and expert judgement within the consortium led by TNO.

Further to the critical evaluation of the cost curves under cost scenario 1, three more alternative cost scenarios were developed:

**Cost scenario 2** (referred to in **Figure 20** and **Figure 21** as scenario a) is based on scenario 1 but takes into account the observed significant progress in CO<sub>2</sub> reduction in the European new passenger car fleet in the 2002-2009 period. Since this progress had not been accompanied by the vehicle price increase, and does not appear to be explained through deployment of new technologies, it could be interpreted as an indication that part of the observed reductions in type approval CO<sub>2</sub> emissions in that period may need to be attributed to other causes than application of technologies included in the cost curves in cost scenario 1. Due to the strong non-linearity of the cost curves the possibility that other causes may be responsible for part of the observed reductions between 2002 and 2009 could have a significant impact on the assessment of cost for moving from the 2009 values to the 2020 target values. This results in cost curve in scenario 2 which is lower than scenario 1 for a given level of reduction.

**Cost scenario 3** (referred to in **Figure 20** and **Figure 21** as scenario b) takes into account the technical input to the US Environment Protection Agency's (EPA) studies in support of the US legislation on CO<sub>2</sub> emissions from light duty vehicles which seem to suggest that the costs of reducing CO<sub>2</sub> emissions in passenger cars could be lower than estimated in cost scenario 1. To test the possible impact of the most striking differences between US data and cost and reduction figures used in scenario 1, a selection of data on cost and reduction potential derived from the EPA studies, specifically for full hybrids and the various levels of weight reduction, has been used by the contractors to construct a modified technology table. Using the same methodology as in the basic scenario alternative cost curves have been constructed on the basis of the table based on the EPA data. This variant was created to allow for an indicative assessment of the possible implications that information from the EPA studies underlying the US CO<sub>2</sub> legislation for cars might have for assessment of the costs of meeting the European target for 2020. This approach results in a cost curve lower than scenario 2.

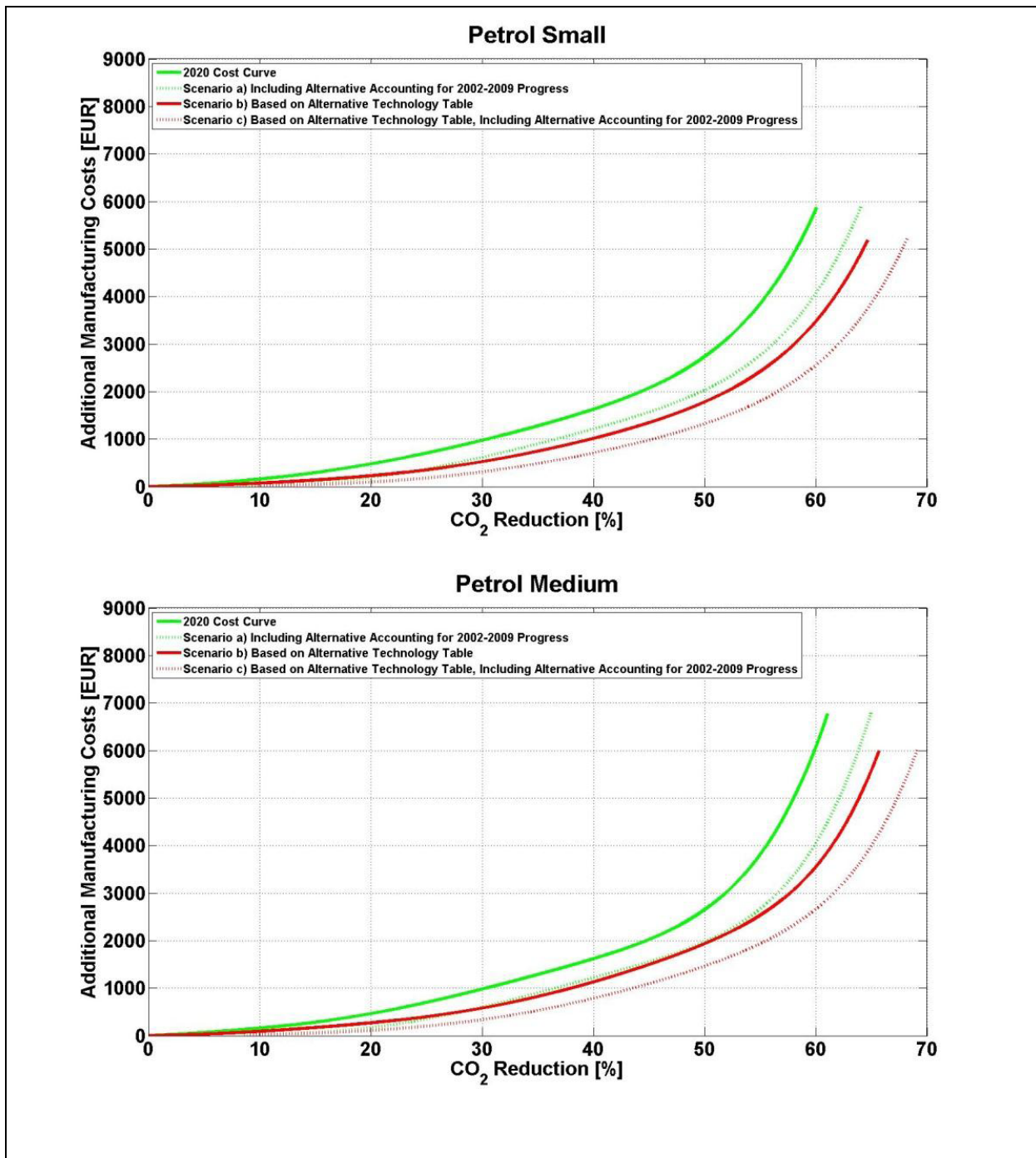
**Cost scenario 4** (referred to on **Figure 20** and **Figure 21** as scenario c) is a combination of cost scenario 2 and 3 using the alternative cost assumptions based on the EPA study and taking into account the progress in CO<sub>2</sub> reduction in the European new passenger car fleet in the 2002 - 2009 period that is not attributed to application of technologies included in the cost curves in scenario 1. This approach results in the lowest cost curve as compared to scenarios 1-3.

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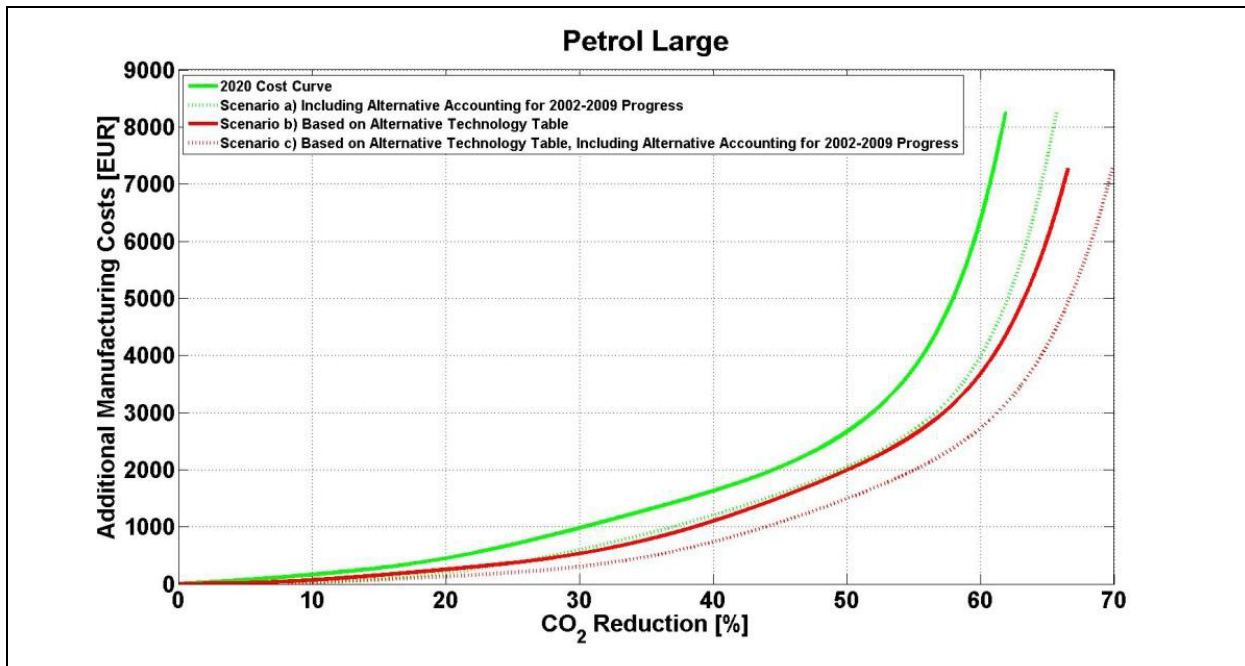
<sup>39</sup> For details of this methodology see section 2 of the car study.

The following figures depict these differences for different car segments.

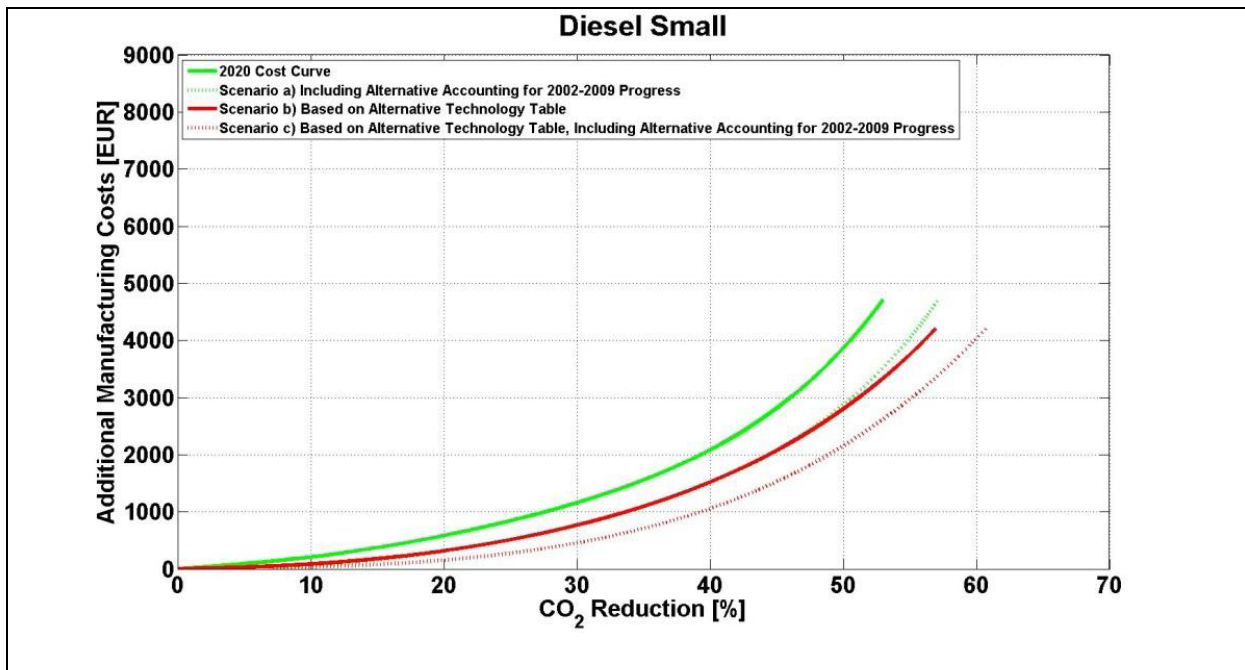
**Figure 20** Comparison of cost scenarios 1 - 4 for petrol cars

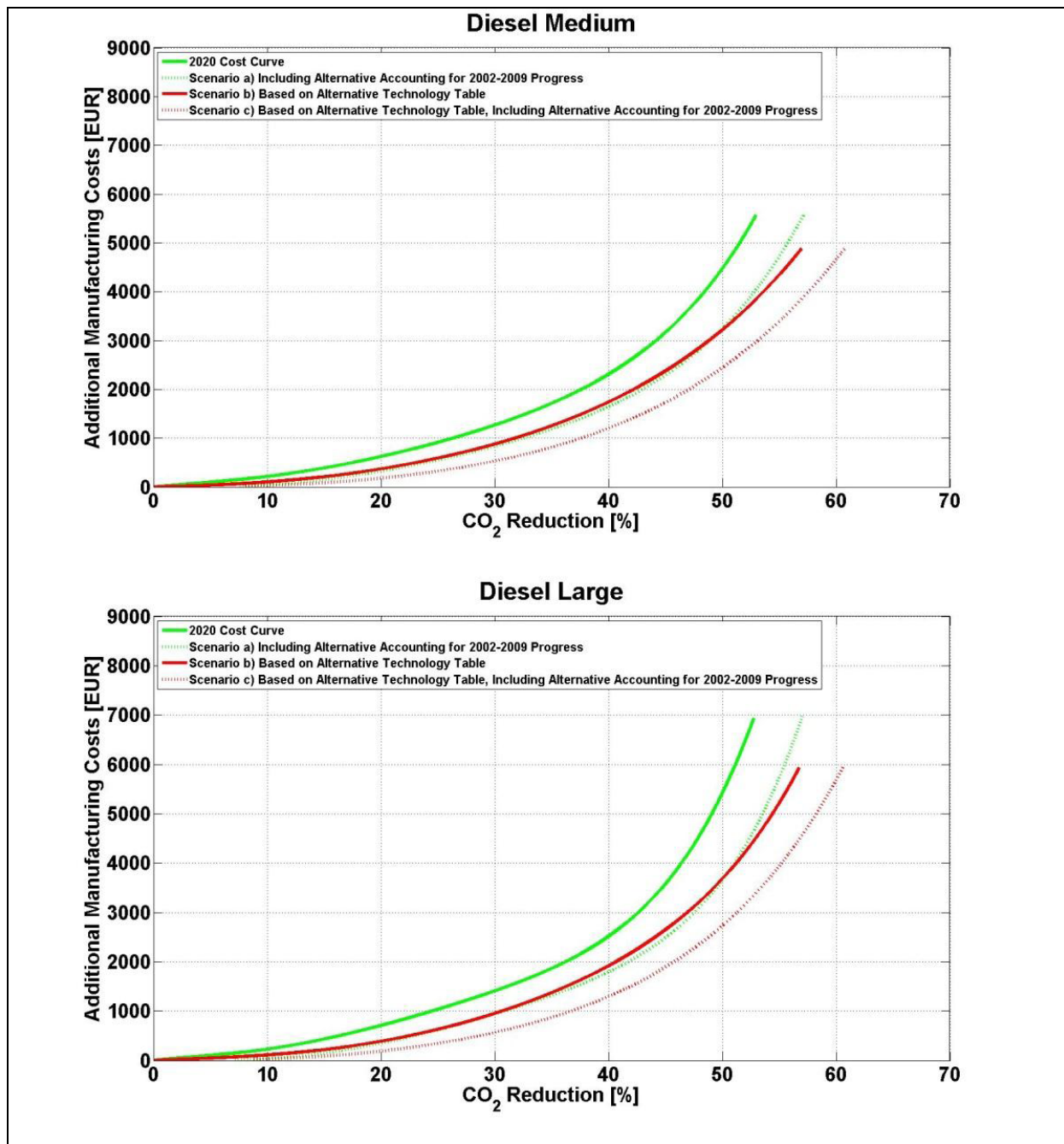






**Figure 21** Comparison of cost scenarios 1 - 4 for diesel cars





There are a number of reasons for believing that the lower rather than the higher cost scenarios are more credible.

Information is available that certain important technologies are available at lower cost than assumed in the underlying analysis. For example stop-start systems are assumed to have a 2020 cost of €200 yet these are reportedly supplied for around €40. Hybrid systems are one of the more expensive technologies and a system offering 15% CO<sub>2</sub> reduction is assumed to cost around €1500. However it is reported that Valeo has developed such a system which will cost around €800<sup>40</sup> to manufacturers.

The US based cost analysis was much more extensive than that which has been performed for the Commission. A major aspect of the work was a tear-down analysis of lower CO<sub>2</sub> emitting

<sup>40</sup> <http://www.decisionatelier.com/Valeo-l-hybridation-a-moins-de-800.html>

vehicles to assess the additional manufacturing costs. The ICCT has undertaken a study to convert these US assessments to EU conditions and to supplement it with additional data on technologies more specific to the EU market. This analysis results in a cost curve that is lower than that in scenario 4 of the Commission analysis.

The cost curves relate to the cost of reducing CO<sub>2</sub> emissions from a vehicle on a standard test cycle under test procedures. However, there is considerable evidence that some part of the reductions that have been reported may arise from the flexibility inherent in the test procedures rather than deployment of technology. This is discussed in more detail in Annex 7.7.

In view of these various factors suggesting that lower cost curves may be more appropriate, and in recognition of the uncertainties that exist, it seems most sensible to use the central cost curves, i.e. scenario 2 and 3 as providing the most probable scenario within this impact assessment.

## 7.14. Discarded options

### Phase-in

The options considered for this modality are:

- (1) No phase-in of the 2020 target
- (2) Inclusion of phase-in of the 2020 target over the period 2017 - 2020 or 2020 - 2023

Option 2 would involve a phasing-in of the 2020 target. This might be carried out over a period of 3 years as with the previous targets. Two variants are considered: a) the phase-in occurs over the period 2017-2020; b) the phase-in occurs over the period 2020-23.

### *Cars*

The assessment<sup>41</sup> of variant a) of option 2 is based on step-wise declining targets leading to 95 gCO<sub>2</sub>/km in 2020, which is similar although not identical to a percentage of the fleet complying in earlier years with 95 gCO<sub>2</sub>/km. This reduces total CO<sub>2</sub> emissions compared to a "worst case". However, in view of the current trajectory of new car emissions (shown in **Figure 1**), it might have no practical impact. In contrast, it would make the obligation on manufacturers more onerous since they would have to comply in multiple years with a target, not just in 2020, reducing their flexibility.

By contrast variant b) of option 2 would lead to increased CO<sub>2</sub> emissions compared to compliance in 2020. This undermining of the level of ambition in the Regulation would run contrary to the intention of the Council and Parliament and to the desire for regulatory certainty for the automotive sector which is keen to recoup investments in CO<sub>2</sub> reducing technology. A weakening is not warranted since manufacturers will have had 11 years to prepare their plans for compliance and as shown<sup>42</sup>, this is more than adequate. Any combined variant (phase-in starting before 2020 and ending after) would suffer the negative aspects of both variants (more CO<sub>2</sub> and less flexibility).

### *Vans*

The 2020 target for vans requires less reduction from the first target (i.e. 16% for vans vs. 27% for cars), although this is distributed over 3 years, compared to 5 for cars. However, 2010 van baseline emissions at around 181 gCO<sub>2</sub>/km are much closer to the 2020 target than the equivalent 2010 car emissions. Given the current trajectory, the first target for vans can be expected to be met before 2017 increasing the time to reach the second target. Similar to cars, in view of the reduction trajectory variant a) of option 2 might have no practical impact. Manufacturers are expected to reduce their average emissions smoothly rather than in abrupt steps.<sup>43</sup> As with cars, this variant would be more onerous for manufacturers. However, the short time between the two targets would even more significantly reduce flexibility.

<sup>41</sup> Section 15 of the car study

<sup>42</sup> Section 5 of the car study

<sup>43</sup> If the OEMs were to reduce the average emissions from 2010 to comply with the 2017 and 2020 targets exactly when these become fully mandatory, it would mean on average less than 1 gCO<sub>2</sub>/km yearly reduction until 2017 and more than 9 gCO<sub>2</sub>/km from 2017 to 2020. This is rather unlikely and a smoother reduction path over the period 2010-2020 is more probable leading to certain overachievement of the 2017 target.

Variant b) of option 2 has the same weaknesses as for cars. Manufacturers will have had 9 years to prepare for compliance and as shown<sup>44</sup>, the 2020 compliance cost is expected to be lower than estimated in 2009<sup>45</sup>.

In view of these assessments option 2 is discarded for both cars and vans.

### Super-credits

The options considered for this modality are:

- (1) No prolongation of super-credits
- (2) Prolongation of super-credits
- (3) Modification of super-credits

The Regulations are based upon CO<sub>2</sub> emissions from the vehicle and ignore those from other parts of the energy supply chain. Therefore certain types of vehicles, essentially using substantial proportion of hydrogen or electricity for their propulsion during the test procedure will be measured as having very low emissions<sup>46</sup>. The Regulations incorporate provisions that count vehicles with emissions below 50 gCO<sub>2</sub>/km a multiple number of times for the period up to 2016 for cars and 2018 for vans. It was argued that this multiplier would provide a strong incentive for vehicles meeting this criterion to be marketed. Option 2 would introduce multipliers for low emission vehicles up to 2020 for cars and vans.

The effect of introducing such a multiplier depends on the proportion of vehicles complying with it and is assessed for various scenarios<sup>47</sup>. Depending on the scenario, total CO<sub>2</sub> emissions will increase by between 3% and 15% using a multiplier of 3.5. This is because conventional vehicles are allowed to emit more CO<sub>2</sub> if low-emitting vehicles count as more than one. Option 3 would also result in increased CO<sub>2</sub> emissions although the impact would be somewhat smaller if a lower multiplier was used.

The CO<sub>2</sub> increase shows that super-credits weaken the stringency of the Regulation. This runs counter to the need to provide certainty for the industry that there is a market and need for CO<sub>2</sub> reducing technology. This increase has longer term implications since the higher emissions continue during the period when those vehicles are used i.e. till around 2030. The effect of introducing a multiplier is identical for vans apart from the fact that the negative impacts are somehow mitigated by the limited number of vehicles that can benefit from it<sup>48</sup>.

These negative impacts can be limited by introducing low multipliers and a threshold on the number of vehicles which can benefit from super-credits, e.g. by capping it at a low share of the manufacturer's registrations. The Vans Regulation already includes such provision for the short-term target by capping the cumulative number of vehicles which can use super-credits over 4 years at 25,000 vehicles per manufacturer. Finally, in view of lower 2020 targets (95

<sup>44</sup> Section 3 of the van study

<sup>45</sup> The impact assessment accompanying the Commission's proposal for a regulation setting emission performance standards for light commercial vehicles SEC(2009) 1454

<sup>46</sup> For example the Opel Ampera has combined test cycle emissions of 27 gCO<sub>2</sub>/km.

<sup>47</sup> Section 13.3 of the car study and section 6.2.3 of the van study

<sup>48</sup> According to the Vans Regulation a maximum of 25,000 vans per manufacturer registered over 4 years can benefit from a super-credit.

and 147 gCO<sub>2</sub>/km) and to reflect expected technical progress in the development of advanced hybrid and electric vehicles by 2020, the threshold of 50 gCO<sub>2</sub>/km would be too high as it would cover too large a share of the overall fleet.

While promoting extremely low CO<sub>2</sub> emission vehicles may be a desired policy goal, it should not be pursued through a measure that undermines the overall CO<sub>2</sub> savings of the policy and reduces its overall cost-effectiveness. This approach runs counter to the aim of ensuring technology neutrality since it advantages manufacturers deploying very low tailpipe technologies for a small part of their fleet and fewer reductions for the rest compared to another who achieves reductions across the whole of their fleet.

Because options 2 and 3 increase CO<sub>2</sub> emissions, reduce the stringency of the target below that politically agreed, reduce the cost-effectiveness of the Regulations and do not respect the principle of technological neutrality these options are discarded for both cars and vans.

### **Banking and borrowing**

Banking and borrowing is familiar from different regulatory environments. The rationale is that a desired level outcome should be achieved by a certain time, but the optimal route to that point may differ between economic actors. In view of this, allowing those actors to bank over-compliance in some years and borrow by under-complying in others, while still achieving the end goal increases flexibility and therefore should lower the cost of achieving the goal. To enable banking and borrowing it is necessary to define an expected trajectory of compliance and then assess borrowing or banking against that baseline. This option is mutually exclusive with phase-in and excess emissions premia.

The most appropriate baseline against which banking and borrowing could be compared is a straight line trajectory towards the objective. However the starting point of the trajectory has a substantial impact on the outcome. Car CO<sub>2</sub> monitoring shows that manufacturers are likely to exceed their target in 2015. This implies that if the starting point for the baseline is taken as 130 gCO<sub>2</sub>/km in 2015, manufacturers can be expected to be in over-compliance and therefore able to bank surplus savings. It follows that their overall fleet would not need to meet the 95 gCO<sub>2</sub>/km target in 2020 but only later - if borrowing were permitted beyond 2020. Similarly simply assuming that the 2015 target is the baseline to 2019 would create a large surplus of borrowing which would effectively halve the 2020 ambition. A more appropriate baseline for comparison is between the current emissions from monitoring and the 2020 objective.

The time period for which banking and borrowing would be permitted is an important parameter. The longer, the more the flexibility undermines the CO<sub>2</sub> reduction goal. The car study makes clear that this should be limited to 5 to 10 years. If borrowing were permitted beyond 2020, it would be necessary to know what trajectory would be followed and this cannot be done in the absence of a post 2020 target.

#### *Cars*

The banking and borrowing option assessed will finish with a neutral balance in 2020, i.e. manufacturers must still comply with their 2020 emission target. The trajectory to be assessed follows a straight line between monitored emissions in 2010 and the 95 gCO<sub>2</sub>/km target in 2020.

The assessment<sup>49</sup> shows that banking and borrowing slightly reduces manufacturer compliance costs. This is because more, cheaper technology can be implemented early in the reduction trajectory, and then less effort made towards the end of the period when costs would be higher. The illustrations show a cost saving of some 1% per car.

Against this potential benefit are a number of risks. Manufacturers that over-comply early in the period may be less able to introduce the innovations needed for 2020 models to meet their target. There will be less competitiveness benefit and reduced certainty for suppliers of advanced technology. There is a risk that some manufacturers might under-comply early in the period but then not manage to over-comply sufficiently to return to a neutral situation in 2020. Banking and borrowing would prevent the application of excess emissions premia in the period to 2020 which removes a strong incentive for manufacturers to ensure they are on a good path to meeting their 2020 target. Complications also arise in how banking and borrowing would apply to pooling. Finally banking and borrowing would introduce additional bureaucratic and administrative procedures.

### *Vans*

Banking and borrowing has not been analysed in detail for vans. It has also been discarded as an option because of the 3-year gap between the two targets which is fairly short, and expectation of greater stability in the market distribution of sales between van classes. In view of the lower stringency of the 2020 van target compared to that for cars, the scheme would bring little benefit in terms of flexibility and carry administrative burden. As for cars, banking and borrowing prevents use of excess emissions premia up to 2020 removing a strong incentive for manufacturers' compliance and creates problems in relation to pooling.

In view of the above considerations, the option is discarded for both cars and vans.

### **Combining car and van targets**

Until now CO<sub>2</sub> legislation has been implemented separately for cars and vans. A reason for that is that these vehicle categories represent different markets with to a large extent unrelated vehicle models. Given the different characteristics and applications of cars and vans, the two categories may have different CO<sub>2</sub> emission reduction potentials from a technical and economic perspective. On the other hand there is some overlap between the categories. A large share of class I and II vans are car derived. Even dedicated van platforms often share engine and other powertrain components with cars. Some vehicles could in theory be covered by either the van or car Regulation depending on how they are registered. However, at present, the limit value curve slopes of the two Regulations differ. This means it is attractive for manufacturers to register small vans below 1157,5 kg as cars, since they will benefit from a less stringent target, and to register cars above this threshold as vans. However, there are legal limitations to how far this can be done<sup>50</sup>.

There are several possibilities to combine the targets for these two categories which are assessed<sup>51</sup>:

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<sup>49</sup> Section 15.3 of the car study

<sup>50</sup> According to Commission Regulation (EU) No 678/2011 amending Directive 2007/46/EC a vehicle can be categorised as N1 if, inter alia, the seating compartment is separated from the loading area and vehicle's bodywork meets certain criteria regarding the loading and cargo areas.

<sup>51</sup> Section 12 of the car study

- Allow pooling between cars and vans.
- Combine the van and car Regulation with a single limit value curve
- Bring car derived vans under the car Regulation.

Pooling between the two categories could in principle ensure a cost-effective means of meeting a target for light-duty vehicles. However, there is no such overall target. Also in view of the differences in stringency of the 2020 targets for cars and vans and thus significant differences in marginal costs, manufacturers would be likely to over-comply with the van target rather than try to fully meet the car target. This flexibility would benefit those manufacturers producing both categories of vehicles and thus not be competitively neutral.

Setting a combined linear limit value curve for both categories of vehicles would result in either unattainable van targets (in case of mass-based function) or unachievable car targets (in case of footprint-based function). Such combined functions would be detrimental to manufacturers of only one category of vehicles.

The main drawback to the option addressing the technical overlap between cars and car-derived vans is the need for a precise legal definition of which vans would qualify for inclusion in the (possibly adapted) car target. This would be very difficult to establish and would require subjective judgment as to the status of a vehicle. This could give rise to arbitrariness and provide perverse incentives. Also, this option reduces the room for manufacturers' internal averaging to meet the target for the remaining vans.

In view of these conclusions this option is discarded.

### **Mileage weighting**

The legislation is based upon average new vehicle CO<sub>2</sub> emissions per km. In reality different classes of vehicles are driven different distances annually and over their lifetime, which means that overall CO<sub>2</sub> reductions can differ depending on the distribution of CO<sub>2</sub>/km reductions across the vehicle fleet. The ultimate goal of lowering total vehicle CO<sub>2</sub> emissions might be more cost effectively achieved from a larger reduction in vehicles that travel further and a corresponding reduction in effort for vehicles that travel less. In view of this, the option considered is to introduce a mileage weighting factor to the CO<sub>2</sub> emission values based on an estimate of the relative distances travelled by different vehicle classes and fuels.

#### *Cars*

Broadly speaking the assessment<sup>52</sup> shows that larger cars drive further than smaller cars and diesel further than petrol. Mileage weighting based upon the estimated values could lead to slightly lower overall costs of compliance. Total overall cost savings amount to around 2%.

However, there are significant distributional impacts. Diesel cars, because they must make substantially more reduction effort, have costs between €300 and €1100 higher per car. In contrast petrol cars have compliance costs between €400 and €650 lower per car.

The approach could be open to challenge due to the lack of sufficiently strong evidence on the mileage of different vehicle classes. Implementation of the measure could be complex. Since

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<sup>52</sup> Section 16 of the car study



the mileage distribution between small and large cars is similar for petrol and diesel, a comparable effect for size could be achieved by lowering the slope of the limit value curve. In view of these factors it is thought unwise to proceed with the option. In addition, as summarised in section 5 of annex 7.4, the stakeholders were not in favour of this modality. It is therefore concluded that this approach should be discarded.

#### *Vans*

Over 90% of vans are diesel, therefore mileage weighting is unnecessary to take account of mileage differences between different fuel types. There is also insufficient evidence on the mileage of different van classes making the suitability of this measure highly uncertain. Furthermore, its implementation could be complex due to data requirements. There is a risk of a differential impact on manufacturers so in view of these factors this option is also discarded for vans.

### **Vehicle based limits**

This provision would mean setting a limit curve exceedance of whose values by any vehicle placed on the market would require payment of a penalty. This was assessed for application in addition to the fleet wide average target<sup>53</sup>.

#### *Cars*

Four variants of the vehicle based limit curve were explored – flat, linearly sloped, truncated linear and curved. Of these the linear has the lowest compliance costs and buy-out premia while the flat has the highest. Whichever approach is adopted, some manufacturers would have high buy-out costs. This would result in a large cost burden on these manufacturers without necessarily leading them to develop further technology since at present the study has not identified technologies adequate to enable their compliance.

#### *Vans*

While for cars it can be argued that there is no additional transport utility for higher emissions, this logic does not apply to vans. Larger vans offer more transport utility by offering more payload or loading space and thus may reduce the number of vehicles needed to transport a given amount of goods. Applying vehicle based limits to vans could therefore perversely lead to lower transport efficiency.

It is concluded that this approach should be discarded for both cars and vans.

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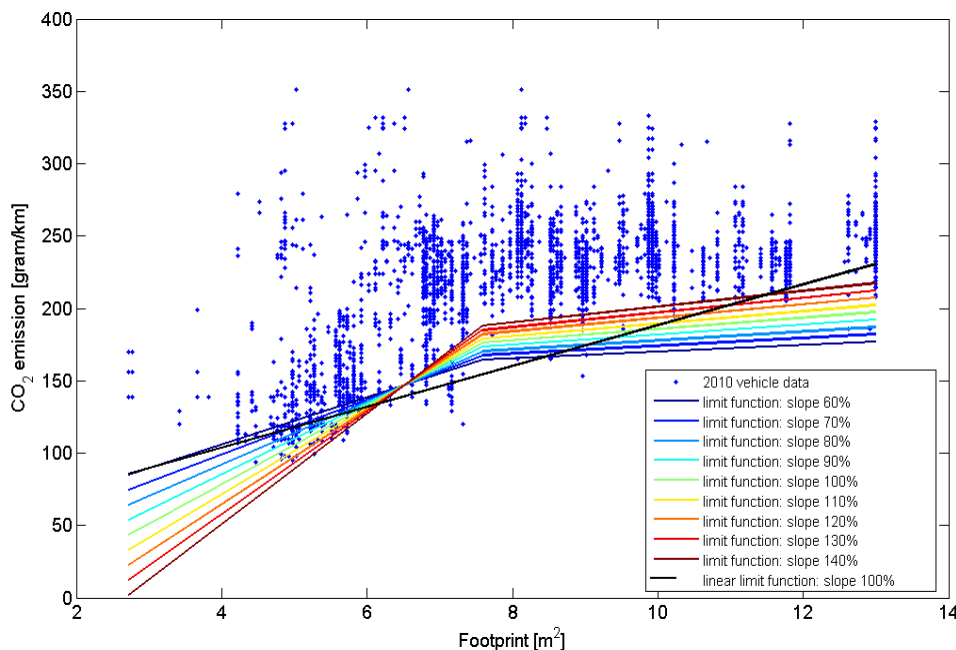
<sup>53</sup> Section 11 of the car study

### 7.15. Description of non-linear limit value curve for LCVs

The relationship between the measured CO<sub>2</sub> emissions and footprint is of quite a different format for vans and cars. In case of vans whose footprint is above around 8 m<sup>2</sup> the relationship levels off giving similar CO<sub>2</sub> emissions, even when their footprint is 13 m<sup>2</sup>. The reasons for this are not fully understood, but are thought to arise, at least in part, from the characteristics of the test procedure, e.g. the equivalent inertia dynamometer load setting does not increase beyond 2,270 kg for any vehicle weighing above 2,210 kg. Therefore, the supporting study on LCVs concludes that a non-linear function better describes the relationship between footprint and CO<sub>2</sub> for the van fleet.

**Figure 22** shows the non-linear equivalent of the 100% footprint-based limit function and a number of non-linear alternatives with different slopes. The value of the footprint where the gradient changes from being relatively steep to very shallow, is 7.6 m<sup>2</sup>, and is described as the interception point. The other notable point in the graph occurs at 6.5 m<sup>2</sup>, the value where all the lines go through the same pivot point.

**Figure 22** The non-linear equivalent of the 100% footprint-based limit function and a number of alternatives between 60% and 140% slopes. The interception point is 7.6m<sup>2</sup> and the pivot point is 6.5m<sup>2</sup>.



## 7.16. List of possible environmental impacts

<b>Environmental Impacts</b>	<b>Key Questions</b>	<b>Answer</b>
<b>The climate</b>	<ul style="list-style-type: none"> <li>• Does the policy affect the emission of greenhouse gases (e.g. carbon dioxide, methane etc.) into the atmosphere?</li> <li>• Does the policy affect the emission of ozone-depleting substances (CFCs, HCFCs)?</li> <li>• Does the policy affect our ability to adapt to climate change?</li> </ul>	<p>Yes</p> <p>No</p> <p>No</p>
<b>Transport and the use of energy</b>	<ul style="list-style-type: none"> <li>• Will the policy increase/decrease energy and fuel needs/consumption?</li> <li>• Does the policy affect the energy intensity of the economy?</li> <li>• Does the policy affect the fuel mix (between coal, gas, nuclear, renewables etc.) used in energy production?</li> <li>• Will it increase or decrease the demand for transport (passenger or freight), or influence its modal split?</li> <li>• Does it increase or decrease vehicle emissions?</li> </ul>	<p>Yes</p> <p>Yes</p> <p>No</p> <p>Yes</p> <p>Yes</p>
<b>Air quality</b>	<ul style="list-style-type: none"> <li>• Does the policy have an effect on emissions of acidifying, eutrophying, photochemical or harmful air pollutants that might affect human health, damage crops or buildings or lead to deterioration in the environment (soil or rivers etc.)?</li> </ul>	<p>Yes (secondary effect)</p>
<b>Biodiversity, flora, fauna and landscapes</b>	<ul style="list-style-type: none"> <li>• Does the policy reduce the number of species/varieties/races in any area (i.e. reduce biological diversity) or increase the range of species (e.g. by promoting conservation)?</li> <li>• Does it affect protected or endangered species or their habitats or ecologically sensitive areas?</li> <li>• Does it split the landscape into smaller areas or in other ways affect migration routes, ecological corridors or buffer zones?</li> <li>• Does it affect the scenic value of protected landscape?</li> </ul>	<p>No</p> <p>No</p> <p>No</p> <p>No</p>
<b>Water quality and resources</b>	<ul style="list-style-type: none"> <li>• Does the policy decrease or increase the quality or quantity of freshwater and groundwater?</li> <li>• Does it raise or lower the quality of waters in coastal and marine areas (e.g. through discharges of sewage, nutrients, oil, heavy metals, and other pollutants)?</li> </ul>	<p>No</p> <p>No</p> <p>No</p>

<b>Environmental Impacts</b>	<b>Key Questions</b>	<b>Answer</b>
	<ul style="list-style-type: none"> <li>Does it affect drinking water resources?</li> </ul>	
<b>Soil quality or resources</b>	<ul style="list-style-type: none"> <li>Does the policy affect the acidification, contamination or salinity of soil, and soil erosion rates?</li> <li>Does it lead to loss of available soil (e.g. through building or construction works) or increase the amount of usable soil (e.g. through land decontamination)?</li> </ul>	No No
<b>Land use</b>	<ul style="list-style-type: none"> <li>Does the policy have the effect of bringing new areas of land ('greenfields') into use for the first time?</li> <li>Does it affect land designated as sensitive for ecological reasons? Does it lead to a change in land use (for example, the divide between rural and urban, or change in type of agriculture</li> </ul>	No No
<b>Renewable or non-renewable resources</b>	<ul style="list-style-type: none"> <li>Does the policy affect the use of renewable resources (fish etc.) and lead to their use being faster than they can regenerate?</li> <li>Does it reduce or increase use of non-renewable resources (groundwater, minerals etc.)?</li> </ul>	No No
<b>The environmental consequences of firms and consumers</b>	<ul style="list-style-type: none"> <li>Does the policy lead to more sustainable production and consumption?</li> <li>Does it change the relative prices of environmental friendly and unfriendly products?</li> <li>Does it promote or restrict environmentally un/friendly goods and services through changes in the rules on capital investments, loans, insurance services etc.?</li> <li>Will it lead to businesses becoming more or less polluting through changes in the way in which they operate?</li> </ul>	No No No No
<b>Waste production / generation / recycling</b>	<ul style="list-style-type: none"> <li>Does the policy affect waste production (solid, urban, agricultural, industrial, mining, radioactive or toxic waste) or how waste is treated, disposed of or recycled?</li> </ul>	No
<b>The likelihood or scale of environmental risks</b>	<ul style="list-style-type: none"> <li>Does the policy affect the likelihood or prevention of fire, explosions, breakdowns, accidents and accidental emissions?</li> <li>Does it affect the risk of unauthorised or unintentional dissemination of environmentally alien or genetically modified organisms?</li> </ul>	No No

### 7.17. Effect on emissions of slope and autonomous mass increase

As concluded in section 5.3 changes to the slope do not directly cause any change in overall new car or van fleet CO<sub>2</sub> emissions per km. This annex explains a secondary effect on CO<sub>2</sub> emissions linked to a potential autonomous mass increase (AMI) in passenger cars. AMI is an increase in mass linked to other factors than CO<sub>2</sub> standards, such as demand for larger vehicles, additional safety requirements etc.

This is illustrated by comparing the impact of two slopes of the curve (60% based on 2006 data ( $a=0.0333$ ) and 100% based on 2009 data ( $a=0.0494$ )) which would lead to a change in target CO<sub>2</sub> as a function of mass in running order as illustrated in Figure 23. This would not lead directly to an aggregate change in CO<sub>2</sub> emissions provided the average mass of vehicles remained unchanged, although it would present different challenges to different manufacturers dependent on the average mass in running order of their vehicles.

However, this situation would be different if the autonomous mass increase (AMI) was observed and the average mass increased. If the AMI would amount to 0.82% per year, by 2030 the average mass in running order for passenger cars would have increased from 1,372 kg (as in the car Regulation) to 1,608 kg. This would lead to an increase in average mass in running order of the new car fleet of 236 kg. Even though the Regulation allows for the overall average mass to be adjusted every 3 years starting from 2016, a small secondary effect would occur for the two years between these adjustments.

From Figure 23 it is seen that the target for a heavier average fleet is greater for the slope with  $a=0.0494$  than for  $a=0.0333$ . The effect of two years' worth of autonomous mass increase (22.5 kg) would be to increase the average CO<sub>2</sub> emissions (gCO<sub>2</sub>/km) by 1.25 gCO<sub>2</sub>/km for the slope with  $a=0.0494$ , and by 0.75 gCO<sub>2</sub>/km for a slope with  $a=0.0333$ . Consequently the use of  $a=0.0494$  would for this year allow a 0.5 gCO<sub>2</sub>/km larger increase in emissions. The corresponding figures for the previous and subsequent years would be: 0.25 gCO<sub>2</sub>/km additional emissions and no additional emissions because of the adjustment of mass in the third year. On average, this secondary effect would result in around 0.25 gCO<sub>2</sub>/km additional emissions when averaged over the 3 year mass adjustment cycle. Relative to an average emissions value of around 100 gCO<sub>2</sub>/km, this secondary effect is a +0.25%, a very small change relative to the -26.9% change caused by the implementation of the 95 gCO<sub>2</sub>/km 2020 target.

**Figure 23** The 2020 target CO<sub>2</sub> as a function of mass in running order for slopes of 60% and 100%

