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PART 2/2

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

amending Regulation (EU) 2019/1242 as regards strengthening the CO_2 emission performance standards for new heavy-duty vehicles and integrating reporting obligations, and repealing Regulation (EU) 2018/956

{COM(2023) 88 final} - {SEC(2023) 100 final} - {SWD(2023) 89 final}

10. ANNEX 1: PROCEDURAL INFORMATION

1.1. 10.1 Lead DG, Decide Planning/CWP references

The Directorate-General for Climate Action (DG CLIMA) is the lead service for the preparation of the initiative (PLAN/2021/11035) and the work on the impact assessment. Commission Work Programme 2022, "Commission Work Programme 2022" (COM(2021) 645 final), Annex "A European Green Deal", 2.c.

1.2. 10.2 Organisation and timing

The revision of the HDV Regulation was announced in the Sustainable and Smart Mobility Strategy.

An inter-service steering group chaired by DG CLIMA, was set up in 2021 with the participation of the following Commission Services and Directorates-General: SG, COMM, COMP, ECFIN, ECHO, EMPL, ENER, ENV, ESTAT, FPI, GROW, JRC, JUST, MOVE, NEAR, REFORM, RTD, SANTE, TAXUD, TRADE. Three meetings took place between October 2021 and July 2022 to discuss the draft impact assessment and the related key public consultation documents.

1.3. 10.3 Consultation of the RSB

An informal upstream meeting with Regulatory Scrutiny Board (upstream meeting) took place on 29 April 2021. DG CLIMA submitted the draft Impact Assessment to the Regulatory Scrutiny Board on 20 July 2022 and, following the Board meeting on 14 September 2022, issued a negative opinion' on 16 September 2022.

The Board's main findings were the following and these were addressed in the revised impact assessment report, as indicated below.

Main RSB findings	**Response**
The report does not clearly identify the remaining CO2 emission reduction gap that the initiative aims to address.	Section 2.1.1 has been updated to quantify the CO2 emissions reduction gap that the initiative aims to address. It better explains the new context, with reference to the Climate Target Plan, Fit for 55 package and REPowerEU. Section 2.1.1, together with the revised Section 1.3, explains in detail the interaction with other policy initiatives, and it explains how the impact of such initiatives has been factored-in in the analysis.
The report does not sufficiently describe the dynamic baseline justifying the added value of the initiative.	Section 5.1 has been significantly expanded to present the evolution of the dynamic baseline, including in quantitative terms. The methodological approach to the definition of the baseline is also explained in more details. Since the baseline is based on the REPowerEU scenario, also the latter is now described in Section 5.1 and in Annex 4.
The cost benefit analysis presented in the report is incomplete and unclear. The report does not present and	A new Section 6.9 has been added to the report, in which the overall costs and benefits of the most relevant combinations of options

compare the overall costs and benefits of each option and subsequently the most relevant combinations of options. It is not clear on the choices left open for the decision-makers.	are presented. Therefore now the report provides a complete cost benefit analysis, including the monetisation of the environmental benefits. Section 8.1.1 has been modified to ensure clarity on ther preferred options, and on the choices which are left open for the decision-makers

The Board also mentioned the following improvements needed, which were addressed in the revised impact assessment report as indicated below.

<u>**RSB opinion: "what to improve"**</u>	<u>**Response**</u>
The report should clearly identify and specify the remaining CO2 emission reduction gap that the initiative seeks to address.	The remaining gap and its evolution over time are presented in section 2.1.1 and in Table 6.
It should better justify the need to revise the Regulation so soon after adoption, given the lack of data on its effectiveness.	Section 1.5 explains why an evaluation of the current regulation is not possible. Explanations have been added to the same section and to Section 2.1.1 to justify why the revision is nevertheless needed. Additional information and references to other studies and publications on the "need to act" have also been added to section 2.1.2 and 6.2.1
It should further elaborate on the articulation of the proposal with other initiatives that directly influence the HDV CO2 emissions and explain if and to what extent those initiatives would provide a contribution from the HDV sector to the EU climate targets and what precisely the remaining gap this initiative would address is.	Section 1.3 has been expanded to better describe the interlinkages with other initiatives, complementarities and mutual reinforcements. For the remaining gap, see above.
It should be clear how the estimates of the gap relate to the Fit for 55 or REPowerEU scenarios.	It has been clarified, in Section 2.1.1 and throughout the report, including in Chapter 6, that the context of the REPowerEU Scenario is considered in all scenarios used for the IA, so to include not only the new climate ambition (55% net greenhouse gas emissions reduction by 2030 economy-wide), but also the new energy targets (renewable shares of 45%, and 13% energy efficiency target).
It should clearly define the criteria for determining a "fair" or "sufficient"	It has been clarified throughout the report that

contribution of the HDV sector to the achieving the CO2 reduction targets and explain how these would be implemented in practice.	the analysis considers a “cost-effective” contribution of the HDV sector to the new climate objectives, based on the existing analytical work underpinning the Fit for 55 package and the new scenarios analysed for the present Impact Assessment.
The report should present the dynamic baseline both in qualitative and quantitative terms more clearly. In particular, it should explain how the provisions in the current Regulation, all relevant policy initiatives and expected market and technological developments were taken into account. The report should also explain differences compared to the scenarios used for the Fit for 55 package. In this respect, it should explain how the baseline takes into account the revised renewable and energy efficiency targets proposed in the REPowerEU Plan. It should also clarify how more recent market developments were taken into account, including announcements by EU HDVs manufacturers. The definition of problem related to ”missed benefits” due to zero emission vehicles not being sufficiently deployed on the market is vague and should be reformulated to allow it to be measurable.	Section 5.1 has been significantly expanded to present the evolution of the dynamic baseline. Since the baseline is based on the REPowerEU scenario, also the latter is now described in Section 5.1 and in Annex 4. Section 6.1 has been updated, and a new section 6.1.2 has been added to describe the differences compared to the scenarios used for the Fit for 55 package. In addition, Annex 4 presents further info on such differences. Section 5.1 better has been updated to better explain how the targets proposed in the REPowerEU plan have been taken into account. Section 2.3.3 has been improved to clarify how the manufacturers’ announcements have been considered. The problem 2 has been reformulated in Section 2.1.2 to make it more clear and precise. In the same section now also clarifies how this problem can be measured.
The report should provide a complete and transparent cost benefit analysis that is understandable and meaningful for decision makers. The issue of technology availability in terms of zero emission HDVs, the necessary operating infrastructure and sufficient quantities of green energy being available should be sufficiently reflected when assessing the risks of targets not being achieved. The report should be clear on whether	A complete and transparent cost benefit analysis has been added to the new Section 6.9. The issue of technology availability and readiness has been clarified in Section 1.2. Section 1.1 has been expanded to further elaborate on the availability of green energy. Annex 7 (notably Section 16.4) also explains that the power sector is projected to decarbonised at a faster pace than any other sectors in the scenarios, consistently with the Climate target Plan, Fit for 55 package and REPowerEU scenarios.

each of the combinations of options is effective in closing the identified HDV CO2 reduction gap in a “fair” manner, clearly indicating potential over or under delivery.	The cumulative impact, in terms of CO_2 savings, is presented in Section 6.2.1.3.1. Chapter 7.2.1 clarifies which option is the most likely to deliver the reduction required from the HDV sector to deliver on climate targets. In the same Section, Table 6 also shows the gap under different options and Section.
The report should monetise the environmental benefits and bring the estimates into the cost benefit analysis. It should clearly specify the appraisal period and consistently use it in the analysis. Both the costs and benefits for each option (and subsequently the most relevant combinations of options) should be presented in an aggregated way, discounted over the appraisal period and the Benefit Cost Ratios and net benefits calculated. This should help to better assess and compare the proportionality of different combination of measures and better inform decisions on issues left open for decision makers, such as the appropriate target level.	The environmental benefits have been monetised in the new Section 6.9. The appraisal period is now consistent throughout the report. A complete and transparent cost benefit analysis for the most relevant combinations of options has been added to the new Section 6.9. The different sub-section of Section 6 now clarify that the relevant costs and benefits are discounted, and how.
As modelling is the main source of information and data for the assessment of the impacts, the report should provide as much additional data and analysis as possible to support the credibility of the analysis. The main and most relevant assumptions underpinning the models should be transparently presented in the report and the details of the models included in the Annex. Uncertainties, in particular the ones influencing the results, should be clearly identified and analysed. The results of the sensitivity analysis should also be included in the Annex to the report. A sensitivity analysis of the 3 key elements of the Total Cost of Ownership should be included. Key information on the methodologies underpinning the economic analysis of the REPowerEU Plan as well as the monetisation of environmental benefits	Section 5.1 and Section 6.1 have been expandd to provide addtitional data and information on the main assumptions and on the model used. Section 5.1 also provides additional information on model results. Annexes 4 and 9 have also been improved to the same aim. Two sensitivity analysis (one on techology costs and another on energy prices) have been performed. Their results are presented in Section 6.2.1.1.1 and in more detail in Annex 9. The sensitivity analysis confirms the trends observed in the main scenarios assessed in terms of impacts. The description of the REPowerEU scenario has been added to Section 5.1 and Annex 4. Environmental benefits have been monerised in the new Section 6.9

should be summarised and included.	
The report should systematically include the views of stakeholder groups, including dissenting views, when analysing the impacts of the different options. It should clarify whether a dedicated SME test has been carried out. It should further elaborate the distributional impacts, including whether some Member States will be more affected than others.	Section 6 has been expanded to include the views of stakeholder groups, including dissenting ones. The new Section 6.1.3 clairfies that the SME test has been performed. Section 6.2.1.2 have been expanded to describe how transport operators can be affected in different Member States
The report should clarify whether the monitoring and reporting obligations are already in place for the vehicle groups brought into scope and should add a separate section on the one in, one out approach and be clear on the costs and savings in scope of that approach taking the above into account.	A new section 6.11 “One in, One out” has been added to the report. It explicitely mentions that all the monitoring and reporting obligations are already in place for all the vehicle groups, including the ones currently not within the scope of the current Regulation.

DG CLIMA consulted in writing the ISG in October 2022 and then submitted the revised draft Impact Assessment to the Regulatory Scrutiny Board on 8 November 2022. The board then issued, on 6 December 2022, a positive opinion with the following reservations.

Main RSB findings	**Response**
The report does not sufficiently discuss the constraints and risks arising from the potential underdeployment of key technologies and infrastructures	Section 6.3.1 has been expanded explaining the issue related to the availability of the relevant technology and the infrastructure.
The analysis of proportionality of the most relevant combinations of options is not sufficiently developed.	The ratio between benefits and costs for the most relevant combinations of options has been added to Section 6.10.2

The Board also mentioned the following improvements needed, which were addressed in the revised impact assessment report as indicated below.

RSB opinion: “what to improve”	**Response**
The report should further elaborate on the issue of constraints arising from the potential under deployment of key technologies and supporting infrastructure for zero emissions HDVs, and the risk of insufficient availability of green electricity.	Section 6.3.1 has been expanded explaining the issue related to the availability of the relevant technology and the infrastructure. The expected share of green electricity has been added to Section 6.3.1.1.3.

All uncertainties, in particular the ones influencing the incremental results, should be better reflected in the modelling with their potential impact on the model results clearly highlighted.	The uncertainties of technology costs and energy prices are assessed in Section 6.2.1.1.1 and in more detail in Annex 9
The report should further improve the analysis of proportionality. Proportionality considerations should include all costs and benefits. Although the report presents the net impacts for the most relevant combinations of options, it should also calculate the Benefit Cost Ratios so that the available choices in terms of differences in efficiency are clear. The report should also more clearly present the effectiveness of the most relevant options (in terms of CO2 emission reduction capacity).	The ratio between benefits and costs for the most relevant combinations of options has been added to Section 6.10. The CO2 emission savings of the most relevant options is added in paragraph 6.10.1
The cumulative costs and benefits of the politically most relevant combinations of options should be clearly presented in the relevant section of the report, including in the chapter on the preferred option. Given that the prefered option on the ambition of the targets is to be established at the political level, this chapter as well as Annex 3 should clearly recall the key impacts of each of the three identified target level options in terms of costs and benefits, so that the available trade-offs, related uncertainties and implementation risks are clearly identified and presented.	The costs and benefits of the politically most relevant combinations of options have been added to chapter 8 and to Annex 3.
The report should elaborate on and assess in more detail the impact of the most relevant combinations of options on the international competitiveness of the EU HDV sector	Section 6.3.1.1.6 has been expanded to better elaborate on the impact on competitiveness
In view of the uncertainties and dynamics of technological and infrastructure deployment, the report should clarify when an evaluation will be conducted.	A possible date for the evaluation has been added to Section 9

1.4. 10.4 Evidence, sources and quality

The preparation of the Impact Assessment has benefitted from several sources of evidence and analysis.

The Impact Assessment report builds on a range of scenarios developed with the PRIMES-TREMOVE model to perform the quantitative assessment of the economic, energy and environmental impacts. This analysis is complemented with other modelling tools, such as E3ME (for the macro-economic impacts) and the JRC DIONE model developed for assessing impacts at manufacturer (category) level (see Annex 4 for more details on the models used and other methodological considerations).

Monitoring data on CO_2 emissions and other characteristics of the new heavy-duty vehicle fleet was sourced from the annual monitoring data as reported by Member States and collected by the European Environment Agency (EEA) under Regulation (EU) 2019/1242.

Further information, as the quantitative and qualitative assessment of impacts and the analysis of the input from stakeholders, was supported by a specific technical support contract commissioned from external contractors. The analysis included a substantial literature review aiming at informing the assessment with the latest academic and research findings on the relevant topics.

11. ANNEX 2: STAKEHOLDER CONSULTATION (SYNOPSIS REPORT)

1.5. 11.1 Introduction

This annex provides a qualitative and quantitative analytical overview of the results of all stakeholder consultation activities, among others: 'call for evidence' on the impact assessment, public consultation and targeted consultations.

To ensure that the public interest of the Union is well reflected in the revision of this initiative, the Commission sought wide feedback from stakeholders, based on a Consultation Strategy, through the following elements:

- An open public consultation based on a questionnaire conducted online from 20 December 2021 to 14 March 2022
- Coetaneous feedback on the Call for Evidence for the impact assessment (20 December 2021 until 14 March 2022)
- Meetings with relevant associations representing industry (vehicle manufacturers, components suppliers, transport operators, etc.), NGOs, etc.
- Bilateral meetings with Member State authorities, vehicle manufacturers, suppliers, transport operators, social partners and NGOs
- Position papers submitted by stakeholders or authorities in the Member States

The following relevant stakeholder groups have been identified:

- Member States (national, regional authorities)
- Vehicle manufacturers
- Component suppliers
- Vehicle purchasers (freight and passenger transport operators, procuring entities)
- Energy suppliers
- Environmental and transport NGOs
- Social partners
- Research and academia

The main purpose of the consultation was to verify the completeness and accuracy of the information available to the Commission and to enhance its understanding of the views of stakeholders regarding different aspects of the possible revision of the HDV CO_2 Regulation. Stakeholders' views have been an important element of input to this impact assessment. A detailed summary and the results of both the public consultation and the feedback on the call for evidence are presented below.

1.6. 11.2 Public consultation

An on-line public consultation was carried out between 20 December 2021 and 14 March 2022 via 'Have Your Say' portal[1], based on the on the EU Survey tool[2]. Respondents found a questionnaire entailing mostly multiple choice but also open questions with wide room for including additional views and comments in open format. The consultation was divided into seven sections, starting with a question on the objectives, followed by others

[1] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13168-Reducing-carbon-emissions-review-of-emission-standards-for-heavy-duty-vehicles_en

[2] https://ec.europa.eu/eusurvey/runner/HDVCO2reviewsurvey2021

related to policy design. At the end of the questionnaire stakeholders were invited to provide final comments and to submit any relevant documents. The key issues addressed were as follows:

1. The objectives of the reviewed CO_2 performance standards for heavy-duty vehicles.
2. New and existing targets:
   - The ambition and timing of the future CO_2 emission targets for regulated vehicles (revising existing targets).
   - The possibility to extend the scope to unregulated vehicles (setting new targets for other type of vehicles).
   - Possible targets for all new vehicles to be zero emission.
3. Incentives mechanisms for zero- and low-emission HDV.
4. Contribution of renewable and low-carbon fuels.
5. Other elements of the regulatory approach:
   - Pooling
   - Exemptions for small volume manufacturers.
   - Excess emission premiums.
   - Energy efficiency standards for trailers.
6. Potential impacts of the review.

The Commission made available all the documents under consultation into all official EU languages. Stakeholders could reply in any official EU language, though the use of English language was encouraged. Detailed contributions by stakeholders including their annexed documents were published on the 'Have your say' portal.[3]

1.7. 11.3 Results of the public consultation

11.3.1 Distribution of replies

The results of the public consultation are presented below for each key element. The replies are differentiated across stakeholder groups and summarised as factually as possible. The summary considers diverging views between or within stakeholder groups.

The consultation received 137 valid replies in total,[4] of which 64 (47% of the total) were received from company / business organisations[5] and 44 (32%) from business associations, which include automotive manufacturers, fuel and electricity suppliers, as well as other entities representing the automotive industry; nearly 80% of the responses received were from industry organisations. There were 12 responses from EU citizens

[3]https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13168-Reducing-carbon-emissions-review-of-emission-standards-for-heavy-duty-vehicles/public-consultation_en
[4] A total of 138 contributions were received, but one of them was submitted twice.
[5] Most respondents that classified themselves as a 'company / business organisation' were individual companies, although there were some company groupings under this heading. It is not clear why the latter chose to identify themselves as a 'business organisation', rather than under the alternative category of 'business association'.

(9% of the total) and 9 (7%) from NGOs. The 6 responses from public authorities (4% of the total) were all from national administrations, representing five different Member States and Norway. The remaining 2 responses (1% of the total) were from organisations that classified themselves as 'Other'.

When considering the responses to individual questions by stakeholder category, these are grouped as follows: *industry*, meaning 'business associations' and 'company / business organisations' (covering 79% of responses); *citizens* (9%); *public authorities* (4%); and *other stakeholders* (8%) that covers the remaining categories (i.e., NGOs and organisations that classified themselves as 'Other'). The breakdown by category is presented in Table 1 below.

The six respondents self-identified as 'public authority', are National authorities: the National Ministers of Transport / Communications from Finland, Latvia and Italy, the Environment Ministry of Estonia, the Environment Agency of Germany and the Norwegian Public Roads Administration, a public body in Norway. No contributions from National Parliaments were received.

Table 1: Distribution of respondents by category

Category	Number of respondents	Percentage of total number of respondents
Company/business organisation	64	47%
Business association	44	32%
EU citizen	12	9%
NGO (Non-governmental organisation)	9	7%
Public authority	6	4%
Other	2	1%
Total	**137**	**100%**

Responses from industry stakeholders are further broken down by industry sub-category. The distribution within these sub-categories is presented in following **Table 2**.

Table 2: Business structure of industry respondents

Category	Number of respondents	Percentage of total number of respondents
Vehicle manufacturers	17	16%
Component suppliers	10	9%
Industry (representing manufacturers and suppliers)	4	4%
Logistics and transport operation	17	16%
Suppliers of fuels and gases	41	38%
Suppliers of alternative zero-emission fuels (electricity and hydrogen)	9	8%
Other	10	9%
Total	**108**	**100%**

There was no obvious campaign, although it was possible, based on an analysis of the qualitative responses, to identify a few coordinated responses that were similar in one or many elements. There were two major sets of coordinated responses that amounted to over 10 responses in each case, the first from suppliers of fuels and gases and the second from vehicle manufacturers and suppliers of components and materials. In addition, there were several other sets of coordinated responses from fuel and gas suppliers, although from smaller numbers of respondents. In addition, there were smaller sets of coordinated responses from NGOs and from transport operators.

Contributions were received from respondents based in 14 Member States. Together the responses from Germany (37), Belgium (29) and Italy (15) contributed nearly 60% of the total number of responses. No responses were received from 13 Member States: Bulgaria, Croatia, Cyprus, Czechia, Greece, Hungary, Lithuania, Luxembourg, Malta, Portugal, Romania, Slovakia and Slovenia. In addition, responses were received from stakeholders from five non-EU countries, including Japan (2), the UK (2) and the USA (2).

A detailed factual summary is provided in the Summary Report[6] published on this consultation.

11.3.2 Summary of replies on the key elements of the open public consultation

NOTE: This should be regarded solely as a summary of the contributions made by stakeholders on this open public consultation. It cannot in any circumstances be regarded as the official position of the Commission or its services. Responses to the consultation activities cannot be considered as a representative sample of the views of the EU population.

The results for each of the elements are as follows.

OBJECTIVES

Stakeholders were asked to rate (on a scale of 1 to 5, where '5' represented the highest importance and '1' indicated 'no importance') the importance of ***a number of objectives for the future HDV CO_2 Regulation***.

Two objectives were supported by the overwhelming majority of respondents, i.e., those relating to the need to meet the EU's CO_2 emissions reductions targets. The longer-term objective of ***reducing CO_2 emissions from new HDVs in a cost-effective way in line with the climate neutrality objective by 2050*** received most support, as this was considered to be important or very important[7] by 92% of respondents (119 respondents, with seven 'no responses'). The earlier 2030 objective, i.e., ***reducing CO_2 emissions from new HDVs in a cost-effective way in line with the 2030 overall climate target of at least -55%,*** was considered to be important or very important by 88% of respondents (116 respondents, with five 'no responses'). The pattern was similar by stakeholder category, as for both objectives most respondents in each category considered the objectives to be important, with the lowest support from *industry* respondents in each case (90%; 91, seven 'no responses' for the 2050 objective; and 85%; 88, five 'no responses' for the 2030 objective). Of the main industry sub-categories, those that were

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[6] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13168-Reducing-carbon-emissions-review-of-emission-standards-for-heavy-duty-vehicles/public-consultation_en

[7] i.e. respondents that gave this a rating of either a '4' or '5'.

least supportive of these objectives were those representing *vehicle manufacturers* (79%; 11, three 'no responses' for the 2050 objective; and 57%; eight, three 'no responses' for the 2030 objective) and *transport operators* (76%; 13, zero 'no responses' for both the 2050 objective and 2030 objectives).

In addition, four objectives were supported by many respondents. The objectives of ***reducing EU energy consumption and import dependence on fossil fuels*** and ***strengthening technical and industrial leadership and stimulating employment in the EU value chain of HDVs*** were both considered to be important by 60% of respondents (78, six 'no responses'; and 75, 11 'no responses', respectively). A small majority of respondents considered another two objectives to be important: ***fostering innovation in zero-emission technologies for HDVs*** (55%; 72, seven 'no responses'); and ***contributing to the reduction of air pollution and other environmental problems*** (54%; 70, eight 'no responses').

The level of responses to each of these four objectives was similar in the different stakeholder categories, although there were differences in each case in terms of which category most (and least) supported each objective. The objective of ***reducing EU energy consumption and import dependence on fossil fuels*** was least supported by *public authorities*, as only half (50%; six, zero 'no responses') considered this to be important, whereas *citizen*s were more likely to consider this to be important (64%; seven, one 'no response'). On the other hand, support for the objective of ***strengthening technical and industrial leadership and stimulating employment in the EU value chain of HDVs*** was highest amongst *public authorities* (67%; four, zero 'no responses') and lowest amongst *citizens* (50%; six 6; zero 'no responses'). *Industry* respondents were least supportive of the objectives of ***fostering innovation in zero-emission technologies for HDVs*** (50%; 51, seven 'no responses'), whereas all *public authorities* (100%; six, zero 'no responses') considered this to be important, and *industry* was also least supportive of ***contributing to the reduction of air pollution and other environmental problems*** (48%; 48, eight 'no responses'), which was most strongly supported by *citizens* (75%, nine, zero 'no responses').

By industry sub-category, *transport operators* were most supportive of the objectives of ***reducing EU energy consumption and import dependence on fossil fuels*** (76%; 13, zero 'no responses) and ***strengthening technical and industrial leadership and stimulating employment in the EU value chain of HDVs*** (69%; 11, one 'no response'), while *suppliers of electricity and hydrogen* were most supportive of the objective of ***contributing to the reduction of air pollution and other environmental problems*** (75%; six, one 'no response'). *Suppliers of components and materials* were least likely to think that each of these objectives was important (40%, four responses, zero 'no responses' for the first two; 30%, three responses, zero 'no responses' for the third). The objective of ***fostering innovation in zero-emission technologies for HDVs*** was considered to be most important by *vehicle manufacturers* (86%; 12, three 'no responses') and least important by *suppliers of fuels and gases* (18%; seven, three 'no responses').

Slightly less than a majority of respondents believed that the remaining three objectives were important, i.e., ***reducing the total cost of ownership of vehicles*** (49%; 65, five 'no responses'), ***promoting the market uptake of ZEV by making them more affordable*** (47%; 61, seven 'no responses') and ***reducing the fuel consumption costs of vehicles*** (45%; 60, five 'no responses'). By stakeholder category, *citizens* were most supportive of the objectives of ***reducing the fuel consumption costs of vehicles*** (75%; nine, zero 'no responses') and of ***reducing the total cost of ownership (TCO) of vehicles*** (58%; seven, zero 'no responses'), while *public authorities* (100%; six, zero 'no responses') were most supportive of the objective of ***promoting the market uptake of ZEV by making them***

more affordable. In each case, the more negative overall response was driven by *industry* respondents, who were least likely to believe that each of these objectives was important (39%, 40, five 'no responses' for the objective relating to ***fuel costs***; 45%, 46, five 'no responses' for the objective relating to ***TCO***; and 40%, 40, seven 'no responses' for the objective relating to ***ZEV uptake***). By industry sub-category, most *transport operators* was in favour of each of these objectives (65%, 11, zero 'no responses' for the objective relating to ***fuel costs***; 82%, 14, zero 'no responses' for the objective relating to ***TCO***; and 82%, 14, zero 'no responses' for the objective relating to ***ZEV uptake***). The overall negative response from industry was driven by responses from *suppliers of fuels and gases* (28%, 11, one 'no response; 30%, 12, one 'no response'; and 5%, 2, three 'no responses', respectively) and, to a lesser extent, *component and materials suppliers* (20%, two, zero 'no responses' for the first two; and 30%, three, zero 'no responses' for the third one).

FUTURE CO2 EMISSIONS TARGETS FOR NEW HDV

Revising existing targets

Stakeholders were asked to rate (on a scale of 1 to 5, where '5' represented the highest importance and '1' indicated 'no importance') the importance of ***four actions relating to the strengthening of existing targets, or the introduction of new targets, for the vehicle groups that are already regulated***.

Overall, there was more support for the action that was farthest into the future, i.e., new, strengthened CO_2 emissions target for 2040 (and to a lesser extent for 2035) than for strengthening current targets, i.e., those for 2030, and particularly before 2030. Whereas nearly two-thirds of respondents (62%; 80, eight 'no responses') thought that ***new strengthened targets for 2040*** were important, fewer, and still a majority (58%; 75, seven 'no responses'), felt that ***new strengthened targets for 2035*** were important. However, there was no majority, either that believed in the importance or not, for strengthening the targets for 2030 and earlier. However, more respondents felt that ***strengthening the 2030 target*** was important (38%; 50, seven 'no responses') than did not (23%; 30)[8], whereas more respondents believed that ***strengthening the targets before 2030*** was not important (45%; 59, seven 'no responses') than those that did (32%; 42).

The more ambivalent overall response to strengthening the existing targets (for both 2030 and before 2030) was driven by the *industry* respondents, as a small majority of these did not think that strengthening the target before 2030 was important (52%; 53, seven 'no responses'), while they were more ambivalent towards strengthening the target for 2030 (30% (30, seven 'no responses') thought that this was important, whereas 26% (26) did not). Half of *industry* respondents believed that it was important to have new strengthened targets for 2035 (50%; 50, seven 'no responses') and a majority thought that strengthened targets for 2035 were important (58%; 59, seven 'no responses'). The importance of strengthened targets similarly tended to increase amongst all groups the farther into the future the targets were, although most *'Other' stakeholders* (73%; eight, zero 'no responses') and *citizens* (58%; seven, zero 'no responses') felt that it was important to strengthen the targets before 2030, as did half of *public authorities* (50%; six, zero 'no responses').

The importance of strengthening the targets amongst *transport operators* was relatively consistent, no matter what the year, e.g., they considered strengthening the target before

[8] Respondents that gave this a rating of either a '1' or '2'.

2030 as important as having a new strengthened target for 2040 (53%; eight, two ‘no responses’ in each case). However, this was not typical, as the importance of strengthening a target amongst most industry sectors also increased the farther in the future the target was. For example, a majority of *vehicle manufacturers* did not consider strengthening the targets before 2030 (71%; 12, zero ‘no responses’) and for 2030 to be important (59%; 10, zero ‘no responses’), whereas a majority considered it important to have new strengthened targets for both 2035 (59%; eight, zero ‘no responses’) and 2040 (82%; 14, zero ‘no responses’). Of the main industry sectors, *suppliers of fuels and gases* were least likely to consider it important to strengthen any targets, e.g., only 5% (2, four ‘no responses’) felt that strengthening the targets before 2030 was important, and only two-fifths believed that new strengthened targets for 2040 were important (39%; 15, three ‘no responses’).

Setting new targets for other types of vehicles

Stakeholders were asked to rate (on a scale of 1 to 5, where ‘5’ represented the highest importance and ‘1’ indicated ‘no importance’) ***the importance of setting new CO_2 emissions reductions target for other vehicle groups***.

A majority of respondents thought that it was important to set new targets for six of the seven vehicle categories mentioned in the questionnaire, with vocational vehicles being the exception. Indeed, there was an overall majority, as well as a majority in all stakeholder groups, that believed it was important to set new targets for: ***medium lorries*** (78%; 98, 12 ‘no responses’); ***urban buses*** (70%; 86, 14 ‘no responses’); ***heavy trailers*** (69%; 81, 19 ‘no responses’); and ***coaches*** (69%; 83, 17 ‘no responses’). Overall, a small majority felt that it was important to set new targets for ***lorries of less than five tonnes*** (52%; 65, 13 ‘no responses’) and for ***lorries of between five and 7.5 tonnes*** (54%; 68, 12 ‘no responses’), although in both cases, just short of a majority of *industry* responses felt that these were important (45% (43, 13 ‘no responses’) and 46% (44, 12 ‘no responses’,) respectively). Just short of a majority, felt that setting new targets for ***vocational vehicles*** was important (47%; 57, 16 ‘no responses’), as the *industry* view on this was ambivalent (42% (39, 16 ‘no responses’ for and 43% (40) against) and two-thirds of *public authorities* did not think that setting such standards was important (67%; six, zero ‘no responses’).

Of the industry sectors, a higher proportion of respondents representing *transport operators* considered setting new targets for ***lorries of less than five tonnes*** and for ***lorries of between five and 7.5 tonnes*** to be important (80%; 12, two ‘no responses’ in both cases), whereas around two-thirds of *vehicle manufacturers* did not think setting standards for these vehicles was important (65% (11, zero ‘no responses’) and 59% (10, zero ‘no responses’), respectively. Most respondents from most industry sectors believed that setting standards for ***medium lorries*** was important, with the exception of *vehicle manufacturers* (47%; eight, zero ‘no responses). Similarly, a majority from most sectors supported setting standards for ***heavy trailers***, except for *transport operators* a small majority of which did not believe that this was important (53%; eight, two ‘no responses’). At least half of respondents from all industry sectors felt that setting standards for ***urban buses*** was important, ranging from half of *transport operators* (50%; six, five ‘no responses’) to all electricity and hydrogen suppliers (100%; nine, zero ‘no responses’).

For ***coaches***, the picture was more mixed, as the vast majority of *suppliers of components and materials* (86%; six, three ‘no responses’), *fuels and gas suppliers* (86%; 31, five ‘no responses’) and *electricity and hydrogen suppliers* (88%; seven, one ‘no response’) felt that standards for coaches were important, whereas a lower proportion of *transport* *operators* (42%; five, five ‘no responses’) and *vehicle manufacturers* (35%; six, zero ‘no responses’) believed that setting such standards was important. The picture with respect to ***vocational vehicles*** was similarly mixed, as a small majority of *transport operators* (55%; six, six ‘no responses’) and *suppliers of fuels and gases* (53%; 19, five ‘no responses’) felt that setting standards for these vehicles was important, whereas over three quarters of *vehicle manufacturers* did not (81%; 13, one ‘no response’).

Setting targets for all new vehicles to be zero emission

Stakeholders were asked, for different vehicle types, by when they believed that ***the CO_2 emission standards should become so strict that all new HDVs in that category would be zero emission***.

The majority of respondents believed that the CO_2 standards should not oblige all new vehicles to be zero emission by a certain date for three out of the four categories listed, i.e., ***coaches*** (60%; 76, 10 ‘no responses’), ***long-haul lorries*** (59%; 78, five ‘no responses’) and ***urban/regional delivery lorries*** (52%; 70, three ‘no responses’). For the fourth vehicle category, ***urban buses***, this was also the most common response, although its support fell marginally short of a majority (49%; 62, 11 ‘no responses’). For each vehicle category, the result was driven by *industry* respondents, as a majority of these felt that the CO_2 standards should not oblige all new vehicles to be zero emission by a certain date in all cases (ranging from 57% (55, 11 ‘no responses’) for ***urban buses*** to 68% (67, 10 ‘no responses’) for ***coaches***).

On the other hand, nearly two thirds of *‘Other’* stakeholders (64%; seven, zero ‘no responses’) and half of *public authorities* (50%; three, zero ‘no responses’) believed that by 2030 the CO_2 standards should effectively only allow zero emission ***urban buses***. The date at which a majority of *‘Other’* stakeholders (64%; seven, zero ‘no responses’) and of *public authorities* (67%; four, zero ‘no responses’) believed that the CO_2 standards should effectively only allow zero emission ***urban/regional delivery lorries*** was 2035[9]. This was also the date by which a majority of *‘Other’* stakeholders (55%; six, zero ‘no responses’) and half of *public authorities* (50%; three, zero ‘no responses’) believed that the CO_2 standards should effectively only allow zero emission ***long-haul lorries***. While most *‘Other’* stakeholders (55%; six, zero ‘no responses’) believed that the CO_2 standards should effectively only allow zero emission ***coaches*** by 2035, a majority of *public authorities* felt that this date should be 2040 (67%; four, zero ‘no responses’).

The date by which a majority of respondents in the various industry sectors believed that the CO_2 standards should effectively only allow zero emission vehicles varied significantly. At least half of the respondents from *suppliers of electricity and hydrogen* (56%; five, zero ‘no responses’), *vehicle manufacturers* (53%; eight, two ‘no responses’) and *suppliers of components and materials* (50%; five, zero ‘no responses’) selected 2035 (or 2030) as the date by which the CO_2 standards should effectively only allow zero emission ***urban buses***. On the other hand, the overwhelming majority of *suppliers of fuels and gases* (93%; 38, zero ‘no responses’) felt that the CO_2 standards should not oblige all new urban buses to be zero emission by a certain date. The year 2035 was the earliest date by which the majority of an industry sector, *transport operators*, felt that the CO_2 standards should effectively only allow zero emission ***urban/regional delivery lorries***, whereas a majority of *vehicle manufacturers* (53%; nine, zero ‘no responses’)

[9] Taking account of those that selected either 2030 or 2035.

and *suppliers of fuels and gases* (93%; 38, zero ‘no responses’) felt that the CO_2 standards should not oblige all new delivery lorries to be zero emission by a certain date.

For ***coaches*** and ***long-haul lorries***, the earliest date at which at least half the respondents from an industry sector believed that the CO_2 standards should effectively only allow zero emission vehicles was 2040 (*transport operators* and *suppliers of electricity and hydrogen* in both cases). For both of these vehicle types, the majority of *suppliers of fuels and gases* (95% in both cases (39, zero ‘no responses’ and 38, one ‘no response’, respectively), *suppliers of components and materials* (70%; seven, zero ‘no responses’ in both cases) and *vehicle manufacturers* (59%; seven, zero ‘no responses’ in both cases) believed that the CO_2 standards should not oblige all new vehicles to be zero emission by a certain date.

Additional comments on the levels of the future targets

Stakeholders were asked whether they had any additional comments on the levels of the future targets. The vast majority of *suppliers of fuels and gases* took a very similar line, including those from SMEs. They argued that an approach based on tailpipe emissions, as is currently the case in the HDV CO_2 Regulation, was not an appropriate basis for setting future targets, as it did not take account of the potential of other fuels, such as low carbon and renewable fuels, to contribute to the decarbonisation of transport. Consequently, they argued either for a well-to-wheel (WTW) or a lifecycle approach to be used as the basis for determining emissions in order to inform future targets. Other issues raised by these stakeholders were an opposition to the implied ban on internal combustion engine vehicles (ICEVs), as this would ignore the potential role of low carbon and renewable fuels, and opposition to amending the targets for 2030 or earlier, as it was important to provide manufacturers with regulatory stability.

Many *vehicle manufacturers* provided a similar response, which underlined that, while the industry was focusing on providing ZEVs, ICEVs would still be needed for some applications beyond 2040, so a general phase out date for ICEVs should be avoided. They also underlined the importance of a stable regulatory framework, so that manufacturers were able to meet the needs of the market and that targets beyond 2030 were highly dependent on enabling conditions, including the market uptake prior to 2030, the policy framework and the existence of the necessary infrastructure. Some also noted that small lorries contributed only a small amount to total emissions, while others supported targets for urban buses (although noted that these were already in the Clean Vehicle Directive. On the other hand, a minority of vehicle manufacturers noted that urban buses and urban freight could be zero emission before other types of HDVs, so it was suggested that all new urban buses should be zero emission from 2025 or that all HDVs should be zero emission from 2035 (or maybe even 2030), as zero emission models were already coming onto the market, even for the heaviest HDVs, while battery prices were declining, and their performance was improving.

From the perspective of *transport operators*, it was suggested that operators should be allowed to be able to choose to use low carbon fuels to reduce their emissions, while there were concerns about the availability of energy sources for zero emission vehicles. It was also noted that targets for urban buses were already set under the Clean Vehicle Directive and suggested that any target for urban delivery lorries needed to reflect cities’ vehicle access regimes. There was also a call for financial support and tax incentives for smaller operators to transition to low emission mobility. Others called for the current 2030 target to be brought forward to 2027, and a new target of a 65% reduction be introduced for 2030 to pave the way for a 100% reduction by 2035 (and 2040 for long haul lorries), or that for short distance transport the 100% reduction could be set for 2030.

The additional comments from *suppliers of components and materials* reflected comments made by respondents from other industry sub-sectors. Many called for the HDV CO_2 Regulation to consider all fuels, so be based on a WTW approach, whereas others suggested that as buses were already increasingly zero emission, the Regulation should support the transition to 100% zero emission buses even more quickly, while cost parity with diesel coaches and long-haul could be achieved around 2027, thus opening the possibility of most vehicles being zero emission from 2030. Some of the responses from *suppliers of electricity and hydrogen* supported a WTW or lifecycle approach to determining the CO_2 emissions of HDVS, whereas others called for urban buses to be included in the Regulation and given the current 2030 target for 2027 and for all new HDVs to be zero emission from 2040.

Several of the additional responses from *NGOs* called for all new HDVs to be zero emission from 2035, except for urban buses, for which 2027 was considered to be more appropriate, and vocational vehicles (2040). Others called for the 2030 target to be doubled to a 60% reduction followed by a 95% reduction target for 2035 and for all new HDVs to be zero emission from 2040, or for all buses and urban delivery lorries to be zero emission from 2030. On the other hand, a minority of NGO respondents called for the use of a WTW approach in determining the CO_2 emissions of new HDVs.

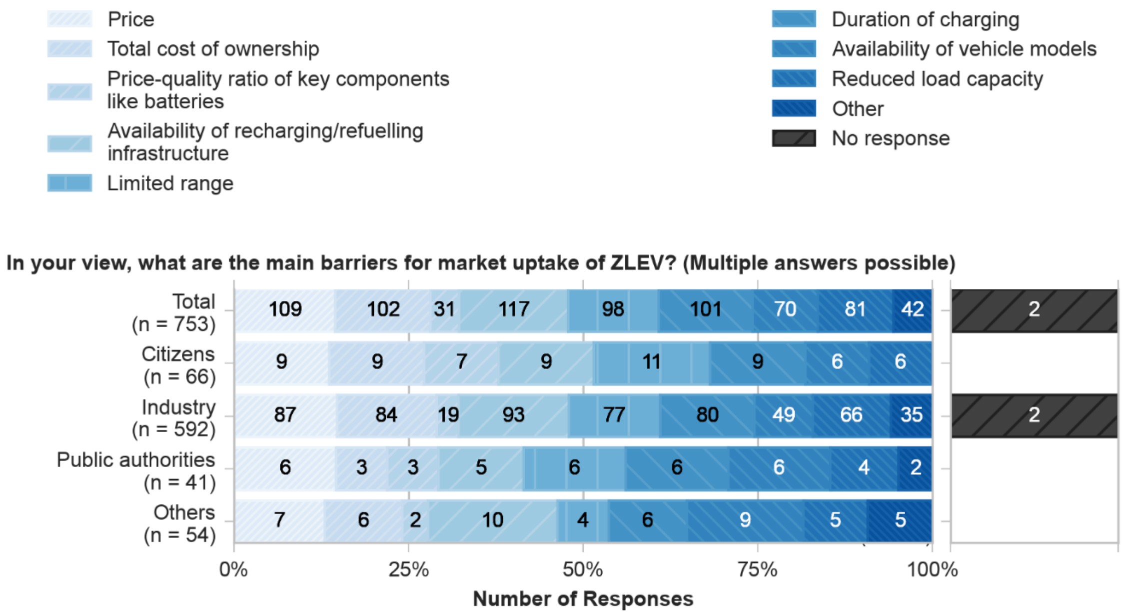
The main relevant themes in the responses from *citizens* were that low carbon fuels also have a role to play, and that financial support was needed for operators and public authorities to support their transition to low and zero emission mobility. The responses from *public authorities* suggested that: advanced fuels should be allowed to play their role in decarbonising HDVs; electrification should be encouraged were possible (although the relevant infrastructure was also needed), although ICEV efficiency should still be improved; and, as a result of the impact of falling battery prices on TCO, a 100% target could be set for 2035 at the latest.

INCENTIVISING ZERO- AND LOW-EMISSION HDVS

Main barriers to the market uptake of zero and low emission vehicles

Stakeholders were asked to select what, in their view, were the ***main barriers for the market uptake of zero and low emission vehicles*** (ZLEVs). A graphical summary is shown in **Figure 1**.

Figure 1. Main barriers to the market uptake of zero and low emission vehicles identified by the respondents

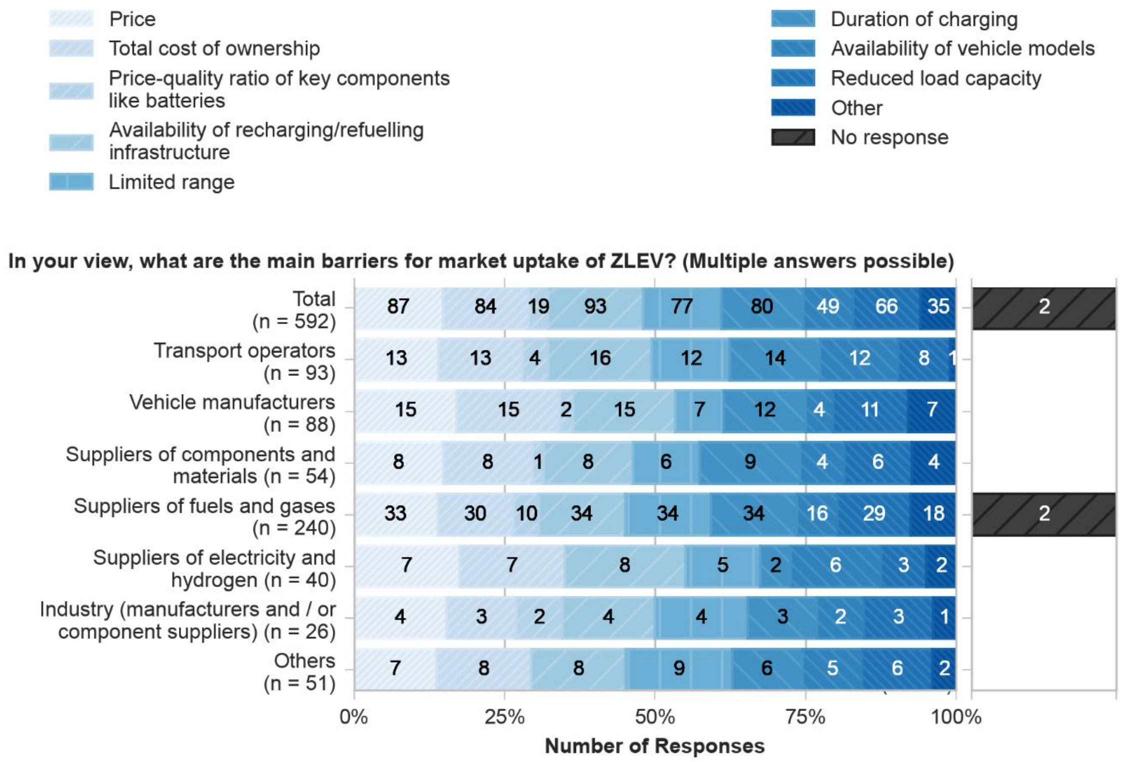


Of the options provided, four were identified as a main barrier by more than three quarters of respondents, which were ***availability of recharging/refuelling infrastructure*** (87%; 117 responses; two ‘no responses’), ***price*** (81%; 109 responses), ***TCO*** (76%; 102 responses) and ***duration of charging*** (75%; 101 responses). More than one response could be selected. As a result, the total number of responses to this question is higher than the number of participants.

Most of the other barriers proposed were identified by most respondents: ***limited range*** (73%; 98 responses); ***reduced load capacity*** (60%; 81 responses); and ***availability of vehicle models*** (52%; 70 responses). The only option listed in the question that a minority of respondents thought was a main barrier was the ***price-quality ratio of key components***, which only 23% (31) of respondents felt was a barrier.

The main barriers identified by *industry* respondents reflected the overall values, in terms of order and the proportion of respondents identifying the respective barriers, as can be seen in below **Figure 2**. *Vehicle manufacturers* identified the availability of recharging/refuelling infrastructure, price and TCO as the main barriers (88%; 15 responses, zero ‘no responses’, in each case), which reflected the views of *electricity and hydrogen suppliers* (respectively, 89% (8 responses), 78% (7) and 78% (7), with zero ‘no responses’ in each case). On the other hand, *suppliers of fuels and gases* identified the main barriers as: availability of recharging/refuelling infrastructure, limited range and duration of charging (83%; 34 responses, zero ‘no responses’, in each case), followed by price (80%; 33 responses).

Figure 2. Main barriers to the market uptake of zero and low emission vehicles identified by the respondents (industry only)



Those respondents (42, 31% of the total) that ***responded 'other'***, i.e., they felt that there were additional barriers to ZLEV uptake that were not listed in the main question, were asked to elaborate on these. Many *suppliers of fuels and gases* (both large companies and SMEs) identified the availability of renewable electricity as a barrier to the uptake of ZLEVs, while other *fuel and gas suppliers* (both large companies and SMEs) suggested that HDVs were hard to electrify. Several *vehicle manufacturers* expanded on their response by underlining the importance of taking account of zero emission technology in the Weights and Dimensions legislation and of the proposed Alternative Fuels Infrastructure Regulation (AFIR) in addressing the barrier relating to the availability of recharging/refuelling infrastructure. Other issues mentioned by other respondents included a lack of information on alternative technologies, including on their TCO, and uncertainty around the resale value (or recycling costs) of ZLEVs.

Amending the ZLEV incentive scheme for the period before 2030

Stakeholders were asked to express their views on whether ***the current ZLEV incentive scheme, as set out in the Regulation, should be amended before 2030***. Overall, nearly two-thirds (62%; 76 responses, 15 'no responses') of respondents felt that the ZLEV incentive scheme should be amended before 2030, which was similar to the proportion of *industry* (61%; 58, 13 'no responses') and *public authority* respondents (67%; four, zero 'no responses') that held this view. Support was greater amongst *'Other'* stakeholders, as all of these (100%; 10, one 'no response') believed that a change to the ZLEV incentive scheme was needed before 2030, whereas only just over one third (36%; four, one 'no response') of *citizens* held this view.

By industry sub-category, the proportion of *vehicle manufacturers* (59%; 10, zero 'no responses'), *transport operators* (60%; nine, two 'no responses') and *suppliers of fuels* *and gases* (60%; 21, six 'no responses') that supported an amendment prior to 2030 was similar to that of the industry respondents overall. However, the views of those belonging to some industry sub-categories differed significantly, such as those of *suppliers of electricity and hydrogen*, of which the vast majority (88%; seven, one 'no response') supported an amendment, whereas only a fifth (22%; two, one 'no response') of *suppliers of components and materials* wanted to see a change to the incentive scheme before 2030.

Those respondents that felt that there was a need to ***amend the ZLEV incentive scheme before 2030*** were asked to explain how it should be amended. A common response from *vehicle manufacturers* was that the level of the cap in the ZLEV benchmark was not sufficient to deliver the necessary share of zero emission vehicles and so should either be increased or removed. They also called for more (unspecified) meaningful incentives for the long-haul sector, while emphasising that a stable regulatory framework was important for the commercial vehicle industry. Other *vehicle manufacturers* called for: the incentive to reward zero emission HDVs that cover long distances (of over 500km or 600 km) with a single refuelling or recharging; for the possibility of transferring ZLEV credits to other manufacturers; for the benchmark to be increased in line with the ambition of the Green Deal; for the incentive to focus only on ZEVs; and for subsidies to support manufacturers.

From the perspective of *transport operators*, there was a call for the focus to be only on ZEVs and for relevant tax and toll exemptions. For smaller operators, in particular, there was a call for more financial support for investment in cleaner lorries, as well as improved access to credit, targeted scrappage schemes and public procurement that rewarded cleaner vehicles. Calls for more financial support to support the turnover of the fleet and for a focus on ZEVs also came from other respondents. Responses from *suppliers of fuels and gases* (both large companies and SMEs) called for the ZLEV incentive scheme to be amended to also cover vehicles that were able to use various low carbon and renewable fuels, rather than only focus on electric and hydrogen vehicles, or define a ZLEV incentive scheme based on a WTW approach.

Other responses, including several from *NGOs*, called for LEVs and 'unregulated' ZEVs to not count in the context of the mechanism from 2027, and for only ZEVs with a certified electric range of 400 km or more to count from 2027, in which case the benchmark could be 15%, until 2030 at which point the incentive should be removed. Others called for the introduction of mandatory targets (supported by a flexible credit scheme) or the introduction of a bonus/malus scheme, along with a focus on ZEVs. *Suppliers of electricity and hydrogen* called for: the setting of higher multipliers in the incentive, particularly for long-haul FCEVs; the benchmark to be raised in line with the increased ambition of the HDV CO_2 Regulation; or for the ZLEV incentive to be removed.

ZLEV incentive scheme for the period from 2030

In relation to the ZLEV incentive scheme for the period from 2030, stakeholders were asked to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement') with the statement: ***In addition to the CO_2 targets, a mechanism incentivising ZEV, and possibly ZLEV, should be maintained beyond 2030***.

A majority of responses overall, and in each of the three main stakeholder categories, were in agreement with this statement[10]. Overall, a slight majority of respondents (57%; 71, 12 'no responses') agreed that a ZLEV mechanism should be maintained beyond 2030, as did over half of *industry* respondents (59%; 58, 10 'no responses'), nearly two-thirds of *citizens* (64%; seven, one 'no response') and over three-quarters of *public authorities* (80%; four, one 'no response'). The exception was '*Other'* stakeholders, as less than a fifth (18%; two, zero 'no responses') supported maintaining the mechanism. Of the industry sub-categories, *vehicle manufacturers* were most in agreement that the ZLEV mechanism should be maintained after 2030 (88%; 15, zero 'no responses'), while a majority of respondents from most of the other industry sub-categories also agreed with this. The exceptions were the fuel and energy suppliers, as only half of *electricity and hydrogen suppliers* (50%; four, one 'no response') and less than a third of *fuel and gas suppliers* (29%; 10, seven 'no responses') agreed with retaining the ZLEV mechanism from 2030.

Vehicles eligible for the ZLEV incentive from 2030

Stakeholders were then asked to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement') with statements on the ***vehicles that should be eligible for the incentive system from 2030***. Overall, a majority of respondents disagreed that only ZEVs should be incentivised (61%; 65, 31 'no responses') and that ZLEVs should be incentivised as in the current Regulation (54%; 59, 27 'no responses').

The negative response relating to ***only incentivising ZEVs*** in the ZLEV mechanism was driven by opposition from *industry* respondents, of which over two-thirds (70%; 55, 29 'no responses') disagreed with this option. *Public authority* respondents and *citizens* were evenly split (40%, two, one 'no response' for and against; and 45%, five, one 'no response' for and against, respectively), whereas *'Other'* stakeholders agreed with focusing the mechanism only on ZEVs (73%; eight, zero 'no responses'). By industry sub-sector, a majority of *suppliers of electricity and hydrogen* (83%; five, three 'no responses') and of *vehicle manufacturers* (58%; seven, five 'no responses') also agreed that the mechanism should only on ZEVs from 2030. The overall negative response to only focusing the mechanism on ZEVs was driven by responses from other industries, notably *suppliers of fuels and gases*, nearly all of which disagreed with a focus on ZEVs (97%; 28, 12 'no responses'), and *suppliers of components and materials*, three quarters of which disagreed (75%; six, two 'no responses').

On the other hand, industry respondents were divided on whether the mechanism should continue to ***incentivise ZLEVs as in the current Regulation***, as nearly half (48%; 40, 25 'no responses') agreed with this, and marginally fewer (45%; 37) disagreed. In this case, the negative response overall was driven by other stakeholder categories, all of which disagreed with maintaining the eligibility criteria for ZLEVs as in the current Regulation, ranging from 60% of *public authorities* (three, one 'no response') to all *'Other'* respondents (11, zero 'no responses'). By industry sub-category, a majority of *transport operators* (69%; nine, four 'no responses'), *vehicle manufacturers*[11] (67%; 10, two 'no responses') and *suppliers of components and materials* (57%; four, three 'no responses')

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[10] i.e. respondents that gave this a rating of either a '4' or '5'.

[11] The apparent support from vehicle manufacturers for both focusing the ZLEV mechanism only on ZEV and for maintaining its current eligibility requirements can be explained by the number of 'no responses' in each case. Overall, seven manufacturers agreed that the mechanism should only focus on ZEV, while seven disagreed, were neutral or did not answer with respect to maintaining the current eligibility criteria.

agreed with maintaining the vehicles eligible for the ZLEV mechanism as in the current Regulation.

Those respondents that indicated their support for an ***'Other' option*** (83% (45 out of 54) of which were industry respondents), were asked to provide a further explanation. A common theme in the responses from *suppliers of fuels and gases* (large companies, SMEs and their representative organisations) was that the ZLEV incentive should not focus only on tailpipe emissions, rather that it should take account of the lifecycle emissions of the vehicle and fuel/energy source used, thus supporting the use of various low carbon and renewable fuels. Other *fuel and gas suppliers* called for a crediting system for low carbon and renewable fuels. Several *vehicle manufacturers* proposed removing or increasing the cap so that this was more in line with the uptake of ZEVs that is needed, while others called for hydrogen ICE vehicles to be considered as a ZEV.

NGOs again called for LEVs and 'unregulated' ZEVs to not count in the context of the mechanism from 2027, and for only ZEVs with a certified electric range of 400 km or more to count, in which case the benchmark could be 15%, from 2027. In addition, they proposed that the incentive should cover only medium and heavy lorries, whereas ZEV targets should be set for other vehicle categories, such as small lorries, vocational vehicles, urban buses and coaches. Some *transport operators* also called for the incentive to be based on the electric range of the vehicle, e.g. it should apply to ZEVs with a range of more than 200 km only, with increasing incentives for ZEVs with higher ranges.

Type of ZLEV incentive from 2030

Stakeholders were then asked to express their views on ***the incentive type*** in the same way, i.e. to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement'). A majority of those expressing an option did not agree with any of the options proposed. The most positive was for retaining a benchmark, as just short of a majority overall agreed with this (47%; 44, 44 'no responses'), whereas a majority disagreed with including both a bonus/malus (60%; 56, 43 'no responses') and a mandate (55%; 53, 41 'no responses').

A small majority of *industry* respondents (55%; 37, 41 'no responses') agreed with the ***maintenance of the benchmark***, whereas a small majority of *citizens* (55%; six, one 'no response') and '*Other'* stakeholders (64%; seven, zero 'no responses') disagreed with this (*public authority* respondents were split 50-50). Most *vehicle manufacturers* (80%; 12, two 'no responses') agreed with the maintenance of the benchmark, as did a majority of *transport operators* (58%; seven, five 'no responses'). On the other hand, *suppliers of components and materials* were more ambivalent (25%, two, two 'no responses' agreed; 13%, one disagreed).

The negative response to changing the incentive to a ***bonus/malus*** was driven by *industry* respondents. Nearly three-quarters of these (72%; 49, 40 'no responses') disagreed with changing the incentive to a bonus/malus from 2030, whereas nearly three-quarters of *'Other'* stakeholders (73%; eight, zero 'no responses') agreed with this. By industry sub-category, the least negative response was from *transport operators*, as half of these (six, five 'no responses') disagreed with changing the incentive to a bonus/malus, whereas *suppliers of components and materials* disagreed overwhelmingly (88%; seven, two 'no responses') with this.

Similarly, the negative response to changing the incentive to a ***mandate*** was driven by *industry* respondents, as nearly two thirds (65%; 45, 39 'no responses') disagreed with this. On the other hand, a majority of both *'Other'* stakeholders (82%; nine, zero 'no responses') and *public authorities* (75%; three, two 'no responses') agreed with changing the incentive to a mandate from 2030. *Transport operators* were also the least negative of the industry sub-categories towards changing the incentive to a mandate, as just short of a majority (46%; six, four 'no responses') agreed with this. On the other hand, most of the *fuel and gas suppliers* (84%; 16, 22 'no responses') and of *vehicle manufacturers* (73%; 11, two 'no responses') disagreed with having the post 2030 incentive in the form of a mandate.

Those respondents that indicated their support for an ***'Other' option*** (84% (36 out of 43) of which represented industry), were asked to provide a further explanation. A common response from *vehicle manufacturers* was that a mechanism should be considered that focused on incentivising the deployment of long-haul vehicles. Many other respondents repeated comments made in relation to previous open questions on the ZLEV incentive scheme, including *fuel and gas suppliers*, many of which called for a technology-neutral bonus/malus.

Link between the ZLEV incentive and the 2030 CO2 emissions reduction target

Stakeholders were then asked to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement') with the statement: ***The ZLEV benchmark levels should increase when targets levels become more stringent***. A very slight majority (51%; 47, 44 'no responses') agreed with this statement, although only 20% disagreed (19). The stakeholder group that was least in agreement with this option was *industry,* although even in this group twice as many respondents agreed (45%; 31, 39 'no responses') than disagreed (23%; 16). Over three-quarters of *'Other'* stakeholders (78%; seven, two 'no responses') and nearly two-thirds of c*itizens* (64%; seven, one 'no response') agreed with the statement, whereas only 50% of *public authorities* (two, two 'no responses') did. Of the industry sub-groups, over three-quarters of *vehicle manufacturers* (81%; 13, one 'no response') supported an increased benchmark when targets become more stringent, as did two thirds of *electricity and hydrogen suppliers* (67%; four, three 'no responses'). On the other hand, there was little agreement that the benchmark should be increased in the event of a more stringent target amongst *suppliers of components and materials* (17%; one, four 'no responses') or *suppliers of fuels and gases* (14%; three, 20 'no responses').

Vehicles covered in a ZLEV incentive scheme for the period from 2030

Finally, stakeholders were asked to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement') for the vehicles that ***should be included in a ZLEV mechanism from 2030***. Overall, at least half, although no more than three-quarters, of respondents agreed with each type of vehicle mentioned being covered by the ZLEV incentive scheme, i.e. ***heavy lorries*** (above 16 tonnes; 74%; 87, 20 'no responses'); ***small and medium*** lorries (70%; 81, 22 'no responses'); ***coaches*** (63%; 70, 25 'no responses') and ***urban buses*** (51%; 57, 26 'no responses').

Public authorities and *industry* respondents were most in agreement with the ZLEV incentive scheme covering both heavy and small/medium lorries (80%, four, one 'no response' in both cases for public authorities, with 77%, 69, 18 'no responses' and 72%, 63, 20 'no responses', respectively, for industry), although a majority in all stakeholder categories agreed with this. The level of agreement for the incentive to cover coaches was similar amongst all stakeholder groups, whereas for urban buses, there were significant differences, ranging from all *public authorities* (four, two 'no responses') agreeing that buses should be covered, whereas just over a third (36%) of *'Other'* stakeholders agreed.

Of the main industry sub-categories, *vehicle manufacturers* were the most supportive of the incentive scheme covering heavy lorries (94%; 15, one 'no response'), medium and small lorries (88%; 14, one 'no response') and coaches (87%; 13, two 'no responses'), whereas the majority of *vehicle manufacturers* (53%; eight, two 'no responses') did not agree that the incentive should cover buses. A majority of respondents in all industry sub-categories agreed that the incentive scheme should cover both heavy and medium/small lorries, and at least 50% of respondents in each sub-category agreed that the incentive should cover coaches, with the exception of *suppliers of components and materials* (33%; three, one 'no response). Most *transport operators* (83%; 10, five 'no responses) agreed that the incentive scheme should cover urban buses, whereas in other sub-categories, agreement was no higher than 50%.

Additional comments on the ZLEV (or ZEV) incentive system.

Finally, on the ZLEV incentive scheme, respondents were asked if they had any ***additional comments on the ZLEV (or ZEV) incentive system***. A common theme raised by *vehicle manufacturers* was the importance of increasing (or removing) the cap associated with the benchmark, and of ensuring that the incentive system "meaningfully and effectively" incentivised ZEVs. Many *suppliers of fuels and gases* (large companies, SMEs and their representative organisations) made comments similar to those that they had made in response to previous questions, as they called for a move away from the focus on tailpipe emissions towards an approach that took account of the potential benefits of renewable and low carbon fuels. Many *NGOs* also reiterated previous comments, although one noted that, as manufacturer commitments were already way more than the benchmark, the current ZLEV incentive system was no longer needed, although a bonus/malus (with a suitably high benchmark) and a mandate for HDV categories not covered by VECTO could be useful. A *supplier of electricity and hydrogen* suggested that mandatory ZEV sales targets should be set (50% by 2030; 100% by 2040), supported by a flexible credit-trading scheme, or failing that a bonus/malus scheme should be introduced.

It was suggested by some respondents that there was no need to incentivise the uptake of low and zero emission buses in the HDV CO_2 Regulation, as the uptake of these vehicles was already covered by the Clean Vehicle Directive, while others argued that the incentive should not incentivise technologies that are already common. Other comments repeated calls to only focus on ZEV or argued that there was no need for a ZLEV incentive from 2030.

CONTRIBUTION OF RENEWABLE AND LOW CARBON FUELS

In relation to renewable and low carbon fuels, stakeholders were first asked to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement') with the statement: ***A mechanism should be introduced in the HDV Regulation so that compliance assessment considers the contribution of renewable and low-carbon fuels.*** Over two-thirds (68%; 90, four 'no responses) of respondents agreed that such a mechanism should be introduced, which was driven by the responses from *industry*, of which nearly three-quarters (73%; 77, three 'no responses) supported the introduction of such a mechanism. On the other hand, *public authorities* were split 50-50 (three in agreement, three that disagreed; zero 'no responses'), and '*Other'* stakeholders disagreed with the introduction of such a mechanism (60%; six, one 'no response'). Respondents in the majority of the industry sub-categories were generally strongly in favour of the inclusion of such a mechanism, with the support greatest including all *suppliers of fuels and gases* (100%; 41, zero 'no responses'). The exception was *vehicle manufacturers*, who were more ambivalent about the inclusion of a renewable/low carbon fuel mechanism, as less than a third (29%; five, zero ‘no responses) agreed with this and nearly half (47%; eight) disagreed.

Effects of a system to account for renewable and low carbon fuels

Stakeholders were then asked to express their level of agreement (on a scale of 1 to 5, where ‘5’ represented the highest agreement and ‘1’ indicated ‘no agreement’) with seven statements on the ***potential effects of introducing a system to account for renewable and low-carbon fuels***.

The majority of respondents agreed with only one of the seven statements; between 64% and 75% of respondents disagreed with each of the other statements. The one statement with which the majority agreed was that ***more renewable and low-carbon fuels will be made available for road transport*** if a system to account for renewable and low-carbon fuels was introduced. Three-quarters of respondents (75%; 97, seven ‘no responses’) agreed with this statement, which was driven by responses from *industry* (81%; 83, six ‘no responses’) and, to a lesser extent, *citizens* (58%; seven, zero ‘no responses’), while half of *public authority* respondents agreed with the statement (50%; six, zero ‘no responses’). On the other hand, half of *‘Other’* stakeholders did not agree with this statement (50%; five, one ‘no response’). Respondents from most industry sectors also agreed with the statement, including all *suppliers of fuels and gases* (100%; 41, zero ‘no responses’), the exception being *vehicle manufacturers*, as only two fifths of these agreed (41%; seven, zero ‘no responses’), although only one quarter disagreed (24%; 4).

The overall negative response for each of the other statements was driven in each case by *industry* respondents, as half or more of ‘*Other’* stakeholders agreed with each statement, whereas *public authorities* and *citizens* were more evenly divided. Most respondents from most industry sectors disagreed with each statement, with the exception of *suppliers of electricity and hydrogen* and *vehicle manufacturers*, who tended to be more ambivalent than respondents from other industry sub-categories and they even agreed with at least one of the six statements.

For these six other statements, the *least negative* response, if a system to account for renewable and low-carbon fuels was introduced was for: ***Renewable and low-carbon fuels in road transport will come at the expense of other sectors facing steeper challenges to decarbonise (e.g. aviation/maritime)***. Nearly two thirds of respondents overall (64%; 82, nine ‘no responses’), and nearly three-quarters of *industry* respondents (73%; 73, eight ‘no responses’), disagreed with this statement. Respondents in most of the main industry categories also disagreed, the exception being *transport operators*, who were more ambivalent (20% (three, two ‘no responses’) disagreed, whereas 27% (two) agreed). On the other hand, *public authorities* and ‘*Other’* stakeholders were more likely to agree with this statement (66% (four, zero ‘no responses’) and 60% (six, one ‘no response’), respectively).

Overall, two-thirds of respondents disagreed with the following statements, if a system to account for renewable and low-carbon fuels was introduced:

- ***Such an accounting system will no longer ensure clear responsibilities and accountability for vehicle manufacturers and fuel suppliers*** (66%; 82, 13 ‘no responses’).
- ***Air pollution co-benefits would not be achieved in the same degree*** (67%; 84, 11 ‘no responses’).

Again, for both of these, results were driven by a negative response from *industry* stakeholders (73% (71, 11 ‘no responses’) and 75% (74, nine ‘no responses’), respectively). Similarly, respondents from most industry sub-categories disagreed with both statements, the exceptions being *vehicle manufacturers*, as a majority agreed with that such a system would lead to unclear responsibilities (60%; nine, two 'no responses'), and *suppliers of electricity and hydrogen*, a majority of which agreed that there would be air pollution co-benefits (63%; five, one 'no response'). *'Other'* stakeholders agreed with both statements (60%; six, one 'no response' in both cases), while half (50%; three, zero 'no responses') of *public authorities* agreed with each statement.

The rate of negative responses was slightly higher for the final three statements, if a system to account for renewable and low-carbon fuels was introduced:

- ***The HDV Regulation would need to be made stricter more rapidly to foster the deployment of ZEV*** (70%; 87, 12 'no responses').
- ***These incentives for deploying low-carbon and renewable fuels could weaken the development of innovation in zero-emission technologies*** (71%; 91, eight 'no responses').
- ***Incentives for these fuels will be incompatible with EU efforts to increase efficiency and reduce energy consumption in HDV*** (75%; 96, nine 'no responses').

The pattern by stakeholder group was similar, in that the negative responses were driven by the scale of negative responses from *industry* respondents, the majority of which from most industry sub-categories also disagreed with each statement. Having said that, *vehicle manufacturers* (31% (five, one 'no response') agreed and 50% (eight) disagreed) and *suppliers of electricity and hydrogen* (29% (two, three 'no responses') both agreed and disagreed) were more ambivalent for the second statement, that such a system could weaken the development of zero emission technologies. Furthermore, a majority of *suppliers of electricity and hydrogen* (57% (four, two 'no responses') agreed with the first statement, that, if such a system was introduced, the HDV Regulation would need to be made stricter to foster the deployment of ZEVs. For each of these three statements, *public authorities* were split 50:50 (50%; three agreed and three disagreed, zero 'no responses'), while most '*Other'* stakeholders agreed with the second and third statements (60%; six, one 'no response' in both cases) and half agreed with the first (50%; five, one 'no response').

<u>*Design of a system to account for renewable and low carbon fuels*</u>

Stakeholders were asked to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement') with two statements on the ***design of the mechanism to account for renewable and low-carbon fuels***.

Overall, nearly two-thirds of respondents (65%; 75, 22 'no responses') were in favour of a ***'fuel crediting system'***, if a system to account for renewable and low-carbon fuels was introduced. This positive response was driven by *industry* respondents, of which nearly three-quarters (72%; 64, 19 'no responses') agreed with this approach. On the other hand, just short of an overall majority supported the use of ***'carbon correction factors'*** (47%; 52, 26 'no responses'), which reflected the response of *industry* stakeholders, as just short of a majority of these (49%; 42, 22 'no responses') agreed with this. A majority of respondents from most industry sectors agreed with the use of a 'fuel crediting system', including all *fuel and gas suppliers* (100%; 37, four 'no responses'), while agreement with the use of 'carbon correction factors' was more ambivalent in most sectors.

The notable exception, for both options, were *vehicle manufacturers*, the majority of which disagreed with introducing both a 'fuel crediting system' (67%; eight, five 'no responses') and 'carbon correction factors' (64%; seven, six 'no responses'). Similarly, a majority of *'Other'* stakeholders disagreed with the introduction of both options (56% (five, two 'no responses') and 63% (five, three 'no responses'), respectively), while a majority of *public authority* respondents disagreed with the introduction of a 'fuel crediting system' (67%; four, zero 'no responses') and half disagreed with the use of 'carbon correction factors' (50%; three, zero 'no responses').

Finally, respondents were asked if they had any ***additional comments on the introduction of a possible mechanism for renewable and low carbon fuels under the HDV CO_2 Regulation***. Responses from *fuel and gases suppliers* (including SMEs) re-emphasised their support for a crediting system to account for renewable and low carbon fuels, to respect technology neutrality and take account of WTW or lifecycle emissions. Most additional comments from *vehicle manufacturers* suggested that renewable and low carbon fuels had a role to play in decarbonising transport, so supported the introduction of a mechanism that accounted for these to provide more flexibility for manufacturers to comply with the overall CO_2 reduction targets, as long as the issue of responsibility was sufficiently considered. Other manufacturers were concerned with how the division of responsibilities between manufacturers and fuel suppliers would be addressed, so supported the continued focus of the Regulation on tailpipe emissions.

Responses from *transport operators* also took different perspectives, with some supporting the introduction of a mechanism to account for the use of renewable and low carbon fuels, while others were concerned that this would make the legislation more complex and reduce transparency. Some *suppliers of components and materials* supported the introduction of a mechanism, as they saw an important role for renewable and low carbon fuels in decarbonising transport, whereas others were concerned that such a mechanism might slow down the transition to ZEVs. Several *suppliers of electricity and hydrogen* noted that such a mechanism was needed to establish a link between the HDV CO_2 Regulation and the Renewable Energy Directive, although another felt that encouraging cleaner fuels should be left to the latter Directive.

Several responses from *NGOs* argued that the inclusion of such a mechanism would risk undermining the effectiveness of the HDV CO_2 Regulation and that such fuels should be governed by the Renewable Energy and Fuel Quality Directives, while others underlined that such fuels were more urgently needed in other sectors. On the other hand, a minority of NGO respondents supported such a mechanism, as such fuels could help to decarbonise transport. From the perspective of *public authorities*, such a mechanism was supported due to the perceived need to continue to use gas-powered vehicles beyond 2035, whereas others argued that these fuels were needed more in other sectors and that such a mechanism would over-complicate the HDV CO_2 Regulation. Responses from *citizens* ranged from underlining the potential of such fuels to suggesting that what was needed was a clear roadmap to phasing out fossil fuels.

OTHER ELEMENTS OF THE REGULATORY APPROACH

Stakeholders were asked to express their opinion on other elements of the potential regulatory approach for the future HDV CO_2 Regulation. First, stakeholders were asked whether, in their opinion, ***provisions on pooling should be included***. Only a minority of those who responded expressed a view one way or the other (41%, 47, 23 'no responses'), with a quarter (26%; 30 responses) supporting the inclusion of provisions on pooling and fewer against (15%; 17 responses; the remainder were 'neutral'). By stakeholder category, *industry* respondents were less in favour of including provisions on pooling (22%, 19, 20 'no responses'), than other categories, e.g. a majority of *'Other'* stakeholders (56%; five, two 'no responses') and half of *public authorities* (50%; six, zero 'no responses') supported the inclusion of such provisions. However, by industry sub-category, nearly half of the responses from *vehicle manufacturers* (47%; seven, two ‘no responses’) were in favour of including provisions on pooling, as opposed to less than one quarter that opposed this (20%; three).

Those who ***agreed with the inclusion of the provisions on pooling*** were asked how a pooling mechanism would need to be designed. Seventeen respondents – 11 from industry (of which six were *vehicle manufacturers*), five NGOs and one citizen – supplied additional comments. Similar responses from *vehicle manufacturers* supported pooling within legal entities, in order to take account of the different product cycles for different types of HDV and noted that this should be based on CO_2 emissions (not ZEVs) and not distort the market. Another manufacturer proposed that a credit trading system be introduced, as exists in California. An *industry* stakeholder warned against allowing pooling between large companies and suggested that, if pooling were allowed, it should be between a large manufacturer and a small-scale manufacturer, which would incentivise the latter. Some of the *NGO* respondents made a similar suggestion, i.e., that pooling between new and established manufacturers could be explored.

Those who ***disagreed with the inclusion of the provisions on pooling*** were asked for their reasons. Twelve respondents – eight from industry, two public authorities and two citizens – explained their position, some of which mirrored the comments from those who supported the inclusion of provisions on pooling, i.e., that there was a risk that pooling could distort the market, that only pooling within legal entities be allowed; and that a credit trading system would be preferable (coupled with mandatory ZEV targets). An SME *supplier of components and materials* noted that small volume manufacturers could benefit from pooling, if it helped them form partnerships with larger manufacturers. It was alternatively suggested that pooling between HDVs and LDVs not be allowed or would be welcomed. Others argued that, while pooling was economically efficient, it did not help to reduce CO_2 emissions, and so pooling could undermine CO_2 emissions reduction.

Second, stakeholders were asked for their opinion on whether ***an exemption for small volume manufacturers should be included in the Regulation***. Again, only a minority of respondents (35%, 40, 23 ‘no responses’) expressed a view one way or the other, with less than one quarter (20%; 23 responses) supporting the inclusion of an exemption for small volume manufacturers and fewer against (15%; 17 responses). As with pooling, by stakeholder category, *industry* respondents were less in favour of an exemption for small volume manufacturers (17%, 15, 21 ‘no responses’), than some other stakeholders, e.g., a third of both *citizens* (33%; four responses, zero ‘no responses) and ‘*Other’* stakeholders (33%; three, two ‘no responses’) supported an exemption for small volume manufacturers. The industry sub-category that was most in favour of an exemption for small volume manufacturers were *transport operators*, although even amongst these only a minority supported such an exemption (40%, 6, two ‘no responses’).

Those who ***agreed with an exemption for small volume manufacturer*** were asked what for their views on the volume that would be appropriate for the threshold for such a derogation. Ten respondents – six from industry (of which three were from transport operators), two NGOs, one public authority and one citizen – shared their views on the relevant volume threshold for such an exemption. The most common proposal was 200 vehicles a year, which was suggested by several *transport operators*, while a *vehicle manufacturer* proposed 1000 vehicles a year. Responses from the NGOs and a citizen proposed that exemptions be explored for small-volume manufacturers of specific vehicles, e.g., small lorries, urban buses, coaches, trailers or vocational vehicles, without specifying a threshold.

Those who ***disagreed with an exemption for small volume manufacturer*** were asked for their reasons. Five respondents – two from industry, two NGOs and a public authority –

explained their reasons for opposing such an exemption. The two arguments against an exemption for small volume manufacturers that were raised were that we are moving towards a net zero society, so no one should be exempted as this risked giving mixed messages, and that small scale manufacturers were already innovative, so do (or should) comply with the overall CO_2 reduction standards.

Third, stakeholders were asked whether, in their opinion, ***energy efficiency standards should be set for trailers and semi-trailers***. Of those that expressed an opinion, just short of a majority agreed with the setting of energy efficiency standards (44%; 49, 25 'no responses'), whereas a small proportion disagreed (6%; seven). Between half and two-thirds of responses in each stakeholder category supported the setting of energy efficiency standards for trailers and semi-trailers, except for *industry* stakeholders, of which only two-fifths agreed (39%; 33, 23 'no responses'). However, *vehicle manufacturers* overwhelmingly supported the setting of energy efficiency for trailers and semi-trailers (87%, 13, two 'no responses').

Those who ***agreed with the setting of energy efficiency standards for trailers and semi-trailers*** were asked for their views on the standards that should be set. Thirty respondents – 22 from industry (of which nine were vehicle manufacturers), four NGOs, two public authorities, one citizen and one 'other' – expanded on their views. *Vehicle manufacturers* – as well as other respondents (including SMEs) – highlighted that the energy efficiency of road transport also depended on the trailers used (as well as the motor vehicles), and so called for transport operators to be given transparent information about the energy performance of trailers, based on appropriately updated VECTO information. An SME *supplier of components and materials* suggested that auxiliaries on trailers, such as cooling units, should be zero emission. *NGO* respondents supported the setting of such standards, as a result of their potential CO_2 emissions savings.

Those who ***disagreed with the setting of energy efficiency standards for trailers and semi-trailers*** were asked for their reasons. Six respondents – five industry and a citizen – explained their reasons for opposing such standards. The two arguments for raised were that the focus of legislation should be on the main source of CO_2 emissions, i.e., the vehicle, and that this would amount to over-regulation.

With respect to the ***allocation of revenues from excess premiums***, stakeholders were asked to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement') with three statements. Over three-quarters of respondents agreed[12] (79%, 89, 24 'no responses') that these should be ***allocated to a new or existing specific fund or programme that aimed to support the just transition by reskilling, upskilling, training and reallocation of workers in the transport sector***. Of the main stakeholder categories, there was most support for this amongst *industry* respondents (80%, 70, 21 'no responses') and least amongst *public authorities* (60%, three, one 'no response'). Amongst the different industry sub-sectors, there was almost overwhelming support for this option, with the exception being *transport operators*, even though a majority of these (58; seven, five 'no responses') still agreed with this approach.

On the other hand, most respondents (88%, 94, 30 'no responses') did not agree with ***excess emissions premiums being allocated to the general budget of the Union.*** *Industry* respondents were most in disagreement (93%, 78, 24 'no responses'), whereas only a minority of *citizens* disagreed with this option (45%, five, one 'no response'),

[12] i.e. respondents that gave this a rating of either a '4' or '5'.

although fewer agreed with it (27%; three). At least 87% of each of the main industry sub-groups disagreed with this option.

Stakeholders were also asked to indicate ***other means for allocating excess emissions premiums***. Thirty-eight respondents selected an 'other' means of allocating excess emissions premiums, of which 34 were industry respondents (10 of these were transport operators, nine were fuel and gas suppliers and eight were vehicle manufacturers). From the perspective of *transport operators*, suggestions were to use the premiums to: support innovation in the industry (including in the development of ZEVs; support hauliers in the purchase of ZLEVs; or allocate the revenues to road transport in general to ensure a just transition, or to road construction, in particular. *Fuel and gas suppliers* called for the premiums to be allocated to support the development and use of renewable and low carbon fuels in the transport sector. *Vehicle manufacturers* called for the premiums to be used to develop the necessary refuelling and recharging infrastructure and to provide market incentives, e.g., to reduce the cost of purchasing ZLEVs.

Stakeholders were also asked whether there were ***other aspects of the Regulation that needed to be addressed*** in response to which 35 respondents provided suggestions (of which 29 were from industry and five were from NGOs). Many of the twelve *fuel and gas suppliers* underlined that a WTW perspective or a technology-neutral approach should underpin the approach taken in the Regulation, to support the uptake of various renewable and/or low carbon fuels. Another common theme that was raised by different respondents was the importance of there being coherence between the revised HDV CO_2 Regulation and other EU legislation, such as: the infrastructure uptake requirements in the AFIR being consistent with the revised HDV CO_2 standards; the Energy Tax Directive; the Renewable Energy Directive; and the potential inclusion of transport in the EU emissions trading scheme. Other broader policy issues that were raised included: the importance of providing more renewable energy; a call to 'industrialise' the recycling of batteries in order to increase their overall sustainability; and that the Energy Efficiency First principle, as required by the Energy Efficiency Directive, be considered in the revision of the HDV CO_2 Regulation (on a WTW basis).

Various issues were raised by *vehicle manufacturers* and *suppliers of components and materials*, including that: it might be appropriate to treat niches or (unspecified) special vehicles differently; the introduction of engine CO_2 emission performance standards, in particular for vocational vehicles, be considered; and that some smaller end users may not be able to handle a complex regulatory system. It was also suggested that it was important to recognise an ICE vehicle using hydrogen as a ZEV, and that the current banking and borrowing mechanism in the Regulation be extended beyond 2030. Finally, it was suggested that the Commission should ensure that haulage companies based within the EU were not disadvantaged by the HDV CO_2 Regulation compared to haulage companies registered outside of the EU.

IMPACTS OF STRENGTHENING THE CO2 EMISSION STANDARDS

Stakeholders were asked to express their level of agreement (on a scale of 1 to 5, where '5' represented the highest agreement and '1' indicated 'no agreement') with fourteen statements on the ***likely impacts of strengthened CO_2 standards for HDVs***.

The majority of respondents overall, and in each stakeholder category, agreed with the following statements on impacts:

- ✓ ***New skills and qualifications for workers will be needed*** (90%; 109, 16 'no responses').
- ✓ ***Innovative SMEs will benefit from new business opportunities*** (65%; 74, 23 'no responses').

- ✓ ***EU industry will increase investments in zero-emission technologies*** (64%; 82, eight ‘no responses’).
- ✓ ***EU import dependence on fossil fuels will decrease*** (64%; 82, eight ‘no responses’).
- ✓ ***Co-benefits in terms of better air quality can be expected*** (61%; 78, nine ‘no responses’).
- ✓ ***Growing offers of ZEV, combined with other measures strengthening sustainable corporate governance, will influence transport operators to purchase more ZEV*** (58%; 71, 15 ‘no responses’).
- ✓ ***New jobs would be to produce different power trains and batteries or to provide new services*** (57%; 70, 14 ‘no responses’).

In addition, the majority of responses overall, and in most of the main stakeholder categories (other than *industry*), agreed that ***a growing supply of zero-emission HDV will bring down their costs over time*** (52%; 67, nine ‘no responses’). A minority of respondents agreed with three other impacts, although this was driven by the responses from *industry*, as in each of the other stakeholder categories, at least 50% agreed with the impact. These impacts were:

- ➢ ***Co-benefits in terms of energy dependency can be expected*** (45%; 56, 12 ‘no responses’).
- ➢ ***EU industry competitiveness on the global market will increase*** (41%; 50, 15 ‘no responses’).
- ➢ ***Macroeconomic benefits can be expected*** (32%; 39, 16 ‘no responses’).

For two impacts, there was little agreement (other than from *citizens*, of which 50% agreed in each case). Hence, there was a low level of agreement that ***sufficient training is provided to ensure the necessary reskilling and upskilling of the existing workforce in the transport sector*** (29%; 33, 24 ‘no responses’) and that ***sufficient measures are in place to attract skilled workers to the transport sector, helping to deploy fully the potential of ZEV*** (14%; 16, 26 ‘no responses’), both overall, as well as from *industry*, *public authorities* and ‘*Other’* stakeholders. Finally, while overall there was a strong agreement that ***manufacturing job losses can occur due to decreasing production of conventional powertrains*** (72%; 86, 17 ‘no responses’), this was driven by *industry* respondents, as other stakeholders were more ambivalent.

Stakeholders were also asked whether there were ***any other relevant impacts***. Many *suppliers of fuels and gases* argued that relying on tailpipe emissions may not be the most effective means of reducing CO_2 emissions from HDVs. They also argued that the impacts and security of supply issues regarding the rare earth metals needed for ZEVs needed to be considered, whereas some renewable and low carbon fuels were already produced abundantly in Europe, such as biomethane. From the perspective of *vehicle manufacturers*, on the one hand it was considered that stronger targets would lead to more innovation, whereas on the other it was suggested that improved global competitiveness would only be achieved if all ZLEV options were kept open.

Transport operators were concerned with the availability of vehicles, and the potential negative impacts on costs, government revenues and EU competitiveness were also feared. *Suppliers of components and materials* raised similar concerns to those from other sectors, e.g. that improved global competitiveness would only be achieved if all ZLEV options were kept open and that the impacts and security of supply issues regarding the rare earth metals needed for ZEVs needed to be considered. From the perspective of *NGOs*, there could potentially be economic benefits for the consumer from the lower operational costs associated with ZEVs, as well as a reduction in noise pollution, while it was also suggested that a focus on lifecycle emissions could help diversify the agriculture sector.

Finally, stakeholders were asked whether ***additional measures should be set up to ensure a just transition towards zero-emission mobility***. Several responses from *fuel and gas suppliers* underlined that the transition could only be considered to be 'just' if it was open to the use of all potential technologies, while a concern was raised that focusing only on ZEVs could prove to be financially unsustainable and so a broader approach, which involved the use of other vehicles, was needed. From the perspective of *vehicle manufacturers*, it was suggested: that it was necessary to focus on requalification and support measures for the new jobs that would be needed; financial support be given to innovative European manufacturers (such as grants and tax exemptions); and more attention be paid to the provision of recharging and refuelling infrastructure.

From the perspective of *transport operators*, support was needed to help operators purchase ZEVs, as was the deployment of the necessary recharging and refuelling infrastructure for ZEVs. From the perspective of smaller operators, there was a call for action to address the ongoing driver shortage, to simplify the truck driver licencing regime and to develop customs regimes that did not distort competition. From the perspective of suppliers of components and materials, there was a concern about the scale of job losses that would result from the transition to ZEVs, which underlined the importance of requalification and support measures. This was also a concern of *suppliers of electricity and hydrogen*, as well as *NGOs*, some of which called on the Commission to develop an automotive transition agenda and establish a dedicated fund to finance the re-skilling of the workforce. From the perspective of *public authorities*, it was considered necessary to support all parts of the EU in the transition, and also to ensure the deployment of adequate infrastructure for recharging/refuelling for all alternative fuels and energy sources.

ADDITIONAL COMMENTS PROVIDED BY RESPONDENTS

To conclude the consultation, stakeholders were asked whether they had any ***additional comments***.

Many suppliers of fuels and gases reiterated their call for a WTW or lifecycle approach to determining CO_2 emissions in the context of the HDV CO_2 Regulation. In addition, some called for the setting of post-2030 standards to be delayed in order to wait for the advice from the newly established European Scientific Advisory Board on Climate Change and others referred to a study that had been commissioned that shows how a crediting system could work[13]. In addition, advocates of biomethane welcomed the boost in its production as foreseen by the REPowerEU initiative, although they feared that this could be hampered if the HDV CO_2 Regulation did not support the use of biomethane in HDVs.

Many *vehicle manufacturers* underlined that the rapid uptake of ZEVs depended on vehicle availability, a dense network of recharging and refuelling infrastructure and TCO parity, which required carbon pricing. In this context, they underlined the importance of the revised HDV CO_2 Regulation being consistent with the inter-institutional agreements on the Alternative Fuels Infrastructure Regulation, the EU emissions trading scheme and the Energy Tax Directive. They also noted that manufacturers must be able to move with and push the market, rather than being pushed to meet targets that cannot be delivered by demand. Alternatively, another manufacturer called for the electrification of trucks to be

[13] www.crediting-system-for-renewable-fuels.eu

recognised as the most efficient technology to deliver zero emission HDVs. They also called for a phase out date for the sale of new non-zero emission HDVs to be set for 2035 at the latest and for the revised HDV CO_2 Regulation to include an easy and well-designed credit trading mechanism.

Some *transport operators* reflected the concerns of many vehicle manufacturers (see above) and others again called for a mechanism to account for renewable and low carbon fuels. In addition, there was a call to adjust the weights and dimensions legislation to enable potential emissions savings, a warning that the forthcoming Euro 7 emissions legislation should not threaten the transition to ZEVs by being too strict or effectively requiring ZEVs before the market was ready, and a call for the revenues from the expansion of the EU ETS to transport to be used to scale up the production of ZLEVs.

From the perspective of *components and materials suppliers*, the importance of technology neutrality was also emphasised, while others noted that the CO_2 emissions from ICEVs could be substantially reduced with new technology. It was also suggested that the revised HDV CO_2 Regulation could give an additional bonus for ZEVs with highly recyclable fuel cells or batteries, in order to counter the price increases in some raw materials. From the perspective of *electricity and hydrogen suppliers*, there was a call for the revised HDV CO_2 Regulation to consider only ZEVs (rather than ZLEVs). A *public authority* called on the revised HDV CO_2 Regulation to continue to allow manufacturers to heavy ICEVs.

1.8. 11.4 Summary of the feedback received on the Call for Evidence

The feedback process on the Call for Evidence for the impact assessment sought to inform stakeholders of the substance of the initiative whilst inviting them to provide opinions on the proposed initiative and its potential economic, social and environmental impacts. It was timely coincidental to the public consultation from 20 December 2020 to 14 March 2021. As a good number of stakeholders provided contributions to both the call for evidence and the public consultation (21 out of 45 non-citizens responses), the general trends in views represented in this feedback process are similar to those given to the public consultation.

The initiative received 55 valid contributions in total[14], of which 22 (40%) by companies or business organisations, 10 (18%) by EU citizens, 7 (13%) by NGOs (including environmental organisations), 8 (14%) by companies and business associations, 4 (7%) by public authorities, 1 (2%) by non-EU citizens and 3 (6%) by ‘other’ stakeholders. Contrarily to the public consultation, none of the larger manufacturers of HDVs neither their European Association responded to this call for evidence.

A very large majority of respondents agreed on the need to increase ambition of the revised legislation, both on expanding the scope to currently unregulated vehicles and strengthening the CO_2 standards. NGOs, ZEV manufacturers, electricity and hydrogen suppliers and some public authorities showed larger ambition, even by proposing setting intermediate standards before 2030 and supporting a 95-100% reduction by 2035, while other industry representatives, fuel suppliers and transport operators called for a more prudent approach.

Environmental NGOs, ZEV and small manufacturers, some public authorities and electricity and hydrogen suppliers were in favour of setting a 100% CO_2 reduction target or setting ZEV mandates for a certain date in several or all vehicle categories. Fuel

[14] A total of 127 contributions arrived the feedback process, but 72 of them were submitted more than once.

suppliers and their associations together with some public authorities and transport operators, on the other hand, called for adopting a technology-neutral approach by including all technologies beyond zero-emission powertrains to contribute to reach carbon neutrality, i.e., adopting well-to-wheel or life-cycle analysis on climate emissions against the current tailpipe approach to enable accounting the use of renewable and low-carbon fuels in the compliance mechanism.

Many respondents called for setting an adequate policy environment for the transition towards stricter targets by securing the sufficient and adequate recharging and refuelling infrastructure and setting up carbon pricing framework conditions to enable positive TCO for transport operators.

Mixed views were recorded as regards the incentive mechanism for zero and low emission vehicles. Several respondents, as environmental NGOs, ZEV manufacturers, hydrogen and power suppliers and some public authorities considered that the current manufacturer's ambition on ZEV is sufficiently high that the current system should be no longer kept or that the current benchmark should be highly upgraded. At the same time, fuel suppliers, some components suppliers were in favour of keeping the current incentive, ensuring the continued eligibility of low-emission vehicles and considering how low-carbon and renewable fuels may score for this purpose.

Finally, there were concrete particular suggestions from small manufacturers and their associations, i.e., the possibility to retrofitting ICE vehicles with zero-emission powertrains to contribute to decarbonizing existing fleet, currently outside of the regulatory scope and to enable multi-stage manufacturers work recognition to contribute to reducing CO2 emissions by setting a CO2 credits system to which the ZEV vehicles could fully contribute to.

1.9. 11.5 Position papers on the revision

The following stakeholders complemented their views with position papers:

- AFGNV
- Amazon
- European Biodiesel Board
- Bosch
- Clean Air Task Force
- Confartigianato
- Danish Ministry of Climate, Energy and Utilities
- ENI
- E-Pure
- European Copper Institute
- Germany Federal Environmental Agency
- Federmetano
- FEV
- Fuels European Commission
- Hydrogen Denmark (Brintbranchen)
- Iberdrola
- ICCT
- MAN
- MOL Group
- Neste
- NGVA
- Pepper Motion

- Platform for Electromobility
- Region Östergötland
- Transport & Environment
- UNITI
- VDB - Association of the German Biofuel Industry
- Volta Trucks
- Zürich 5 coalition

In addition, the following stakeholders submitted by email ad-hoc position papers that were also considered in this impact assessment:

- ACEA
- CLEPA (European Association of Automotive Suppliers)
- EURAMET (European Association of National Metrology Institutes)
- Johnson Matthey (components' supplier)
- IRU (International Road Transport Union)
- Westport Fuel Systems (components' supplier)

1.10. 11.6 SMEs feedback

As this initiative is considered relevant for SMEs, their feedback was actively sought and their participation in the consultation process was especially encouraged. Several small companies and of their representative business organizations (e.g., CLCCR for small manufacturers, UETS for transport operators) were invited to provide opinions on the several options impacting directly and indirectly into their respective business. Furthermore, in addition to public consultation, several targeted round table discussions and hearings involving small and medium manufacturers (mostly specialized in manufacturing ZEV, buses and coaches and niche applications) and associations of small and medium transport operators were held during and after the consultation period.

The feedback from smaller companies has been used for assessing the impact of the initiative on their business and the design of options targeting them, namely the Small Volume Manufacturer exemption, the ZEV incentive for other vehicles and the flexibilities between manufacturers for compliance assessment.

1.11. 11.7 Use of stakeholder input for the impact assessment

Stakeholder inputs received across the several stakeholder consultation activities has been key to the impact assessment. The results from the analysis of the public consultation, the input provided through the feedback process on the Call for Evidence, as well as stakeholder views provided in position papers have been used to develop and assess the policy options. Statements or positions brought forward by stakeholders have been highlighted as such.

12. ANNEX 3: WHO IS AFFECTED AND HOW?

1.12. 12.1 Practical implications of the initiative

The following key target groups of this initiative have been identified.

- Society at large
- Transport operators
- Vehicle manufacturers
- Suppliers of components and materials
- Automotive sector workforce
- Suppliers of fuels and energy
- Other users of fuel and oil-related products

The below table summarises how these target groups are affected by this policy initiative and the corresponding impacts. In some cases the analysis showed overlaps between identified target groups (e.g. vehicle manufacturers and suppliers of components and materials) as a result of which certain effects may be repeated.

Type of stakeholder	Practical implications
Society at large	EU population. Citizens are being increasingly and negatively affected by climate change. Lowering air pollution will improve their health and wellbeing from better air quality, especially for those living in urban areas and when the uptake of zero-emission vehicles increases. Energy security of the EU will improve, as the import of fossil fuels will decrease with lower fuel consumption.
Transport operators	<u>Costs</u> Transport operators will see their capital expenditures arise as the purchase cost of more fuel-efficient vehicles, and especially ZEV, is expected to be higher than conventional vehicles in the short term (and these costs would be passed on from the manufacturer to the buyer). <u>Benefits</u> Transport operators will benefit from lower operational costs. Reducing CO_2 emissions leads to lower fuel costs, especially for zero-emission vehicles. In addition, ZEV maintenance costs are lower than for conventional HDV. Over the vehicles' lifetime, operational cost savings compensate the higher upfront costs, lowering the total cost of vehicle ownership (TCO).
Vehicle manufacturers	<u>Investment / manufacturing costs</u> Vehicle manufacturers will be required to introduce technologies, including zero-emission powertrains, to reduce CO_2 emissions from their vehicles. In the short term this is likely to result in increased production costs and investment needs for production capacity and new technologies.

	<u>Benefits</u> Since ZEV demand is expected to increase worldwide as climate and air quality policies develop and many jurisdictions introduce ambitious emission standards, manufacturers in the EU will have an opportunity to gain first mover advantage and the potential to sell advanced vehicles in other markets. The revised regulatory framework will help them to retain or even increase their global market presence
Suppliers of components and materials	<u>Investment and R&D</u> Suppliers will be differently affected by changing demands depending on their position in the supply chain and their ability to adapt to the need for new powertrains and technologies. Suppliers of components that are only used in conventional vehicles will have to adapt their production by investing in new or modified production lines and in the reskilling of their workforce. Suppliers of components of zero- and low-emission technologies will have to invest in increased production capacity and adaptation of the manufacturing processes, as well as in research and development <u>Benefits</u> Requirements leading to the uptake of ZEV may create new business activity for current and new suppliers, since they are expected to benefit from higher demand for advanced technologies.
Workforce	Jobs losses may occur in areas related to conventional fuel supply due to reduction in energy demand, including extraction, refining and supply of crude petroleum and its products, as well as in the manufacturing of conventional powertrains, as internal combustion engines. The uptake of ZEVs will lower demand for vehicle engines maintenance which will negatively affect related repairing and maintenance businesses. The need for reskilling and upskilling to provide future employees with a set of skills needed for the larger scale deployment of ZEV and innovative fuel-saving technologies is of great importance New job opportunities will arise for power and hydrogen sectors, innovative vehicles components (such as batteries and fuel cells, and the general expansion of the automotive value chain to new sectors (electronics, electrical equipment in general, software, etc.)
Suppliers of fuels and energy	<u>Adjustment costs</u> Conventional fuel suppliers will notice a reduced demand leading to less utilisation of existing infrastructure and possible decrease in revenues. The shift to zero emission will require them to to adapt the refuelling infrastructure. <u>Investment needs in new infrastructure</u> The need for investing in refuelling and recharging infrastructure and smart grids will make energy suppliers/grid operators to invest into grid expansion and innovative technologies to cope with increased demand from ZEV. <u>Benefits</u>

	There will be new business opportunities for suppliers of electricity and hydrogen as a result of the increased demand for such energy sources.
Other users of fuel and oil-related products	<u>Benefits from reduced oil prices</u> Sectors other than road transport that emit GHGs (e.g. industry, heating) products are expected to benefit from lower energy prices if demand from the transport sector decreases. This will be important for their competitiveness.

1.13. 12.2 Summary of costs and benefits

I. Overview of Benefits (total for all provisions) –		
Description	***Amount***	***Comments***
	Direct benefits	
R**educing CO_2 emissions** from HDV cost-effectively, in line with the EU climate goals while contributing to improve EU energy security.	**CO_2 emissions** CO_2 (tailpipe) emissions from heavy-duty motor vehicles, **lorries, buses and coaches,** are projected to decrease by around 730-996 Mton between 2031 and 2050, representing 35%-48% reduction compared to the baseline scenario. On **trailers and semi-trailers**, the energy efficiency standards are expected to reduce cumulative tailpipe CO_2 emissions by nearly 45 Mton between 2031 and 2050 compared to medium scenario. This represents 1.9% of CO_2 emissions reduction of the vehicle groups 4, 5, 9 and 10 or about 1.4% over HDV total. Setting a zero-emission mandate by 2030 for **urban buses** would save additional 9 Mton of CO_2 between 2031 and 2050, as compared to the medium ambition scenario, which is equal to almost half of the emissions of the regulated buses sector. **Contribution to EU energy security** Demand of fossil fuels (mostly oil products as diesel) from **lorries, buses and coaches** is expected to decrease by 215-281 Mtoe over the period 2031 to 2050 as compared to baseline and additionally about 23 Mtoe over the period 2031 to 2050 from setting energy efficiency standards for trailers, as compared to the medium ambition scenario. This is equivalent to, respectively, around €150-200 bn from motor vehicles and additional €16 bn from setting energy efficiency standards for trailers, at current oil prices (95 EUR / Brent barrel). **Reduction of energy demand** Final energy demand from **lorries, buses and coaches** is expected to decrease by nearly 131-220 Mtoe over the period 2031-2050. The cumulative expected reduction by 2050 represents savings of 11-19% with respect to baseline scenario. Additionally, nearly 42 Mtoe will be saved by more energy efficient trailers during 2031-2050 compared to the medium ambition scenario, equivalent to about 3.7% of CO_2 emissions reduction of the vehicle groups 4, 5, 9 and 10 or about 2.7% over HDV total.	By reducing CO_2 emissions, the revised HDV Regulation will directly contribute to meeting the EU climate target goals both for 2030 and 2050. Main beneficiaries are society overall Energy security of the EU will improve, as the import of fossil fuels will decrease with lower fuel consumption.
Benefits for European transport operators and users from a wider deployment of more energy-efficient vehicles: improvements in	**Net economic savings** Net economic savings for motor vehicles from different perspectives are calculated as the difference, between the policy options and the baseline, of the total costs, averaged over the new EU vehicle fleet of lorries, buses	The deployment of energy-efficient vehicles, including zero-emission

fuel savings from reduction in energy consumption and in air quality	and coaches registered in 2030, 2035 or 2040. The total costs include the capital costs, the fuel or energy carrier costs and the operation and maintenance (O&M) costs of the vehicles. For the societal perspective, they also include the external cost of CO_2 emissions[15]. The end-user perspective is presented for the first user (first 5 years after first registeration), the second user (years 6-10) and the third user (years 11-15). TCO (total cost of ownership) for **first users** of new HDV show the following economic savings ranges: 6 000 - 9 800; 17 400 - 25 800 and 29 100 - 47 000 EUR/vehicle in 2030, 2035 and 2040. TCO for second users and third users of new HDV shows similar trends, with smaller benefits. Achieved savings for **second users** equal to the ranges 5 900 - 10 900; 15 200 - 22 800 and 20 500 - 31 400 EUR/vehicle in 2030, 2035 and 2040, while for **third users** are 5 800 - 9 400; 11 000 - 15 100 and 12 200 - 17 100 EUR/vehicle in 2030, 2035 and 2040. Net economic savings from a **societal perspective** over the vehicle lifetime for the average HDV amount to the ranges 2 400 - 6 300; 18 300 - 31 900 and 33 700 - 59 800 EUR/vehicle in 2030, 2035 and 2040. **Net economic savings from reduction in energy consumption in trailers and semi-trailers** Net economic savings for trailers and semi-trailers from different perspectives are calculated as the difference, between the policy options and the baseline, of the total costs, averaged over the new EU vehicle fleet of trailers and semi-trailers registered in 2030 compared to a 2020 baseline trailer. TCO for **first users** of new trailers registered in 2030 show savings ranging from nearly EUR 9 000 for reefer drawbar trailers to EUR 29 000 semi-trailer with box body. Net economic savings over the vehicle lifetime from a **societal perspective** scale up from nearly EUR 11 500 in the case of reefer drawbar trailers to over EUR 42 500 from an average semi-trailer with box body. **Net economic savings from reduction in energy consumption in buses** Net economic savings from setting a 100% mandate for new urban buses by 2030 for 1st, 2nd and 3rd owners are positive and respectively around 21 500, 20 000 and 17 000 EUR higher than for the medium ambition scenario. From a societal perspective, the additional average saving brings an additional benefit of 37 000 EUR per regulated bus in the 2030 new fleet. **Air quality impoovements**	vehicles, will provide energy-related benefits. Transport operators and passengers will get lower energy bills. Consumers will get indirect benefits too through reduced transportation costs as a result of lower fuel expenditures by the transport operators.

[15] Based on "Handbook on the external costs of transport – Version 2019 – 1.1 (CE Delft) - https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

	A higher share of ZEVs will reduce the emission of air pollutants. Emissions of CO, NOx, PM2.5 and SO_2 from heavy duty vehicles are expected to decrease by 7 to 17% in 2035, by 15% to around 38% in 2040 and by 66 to 80% in 2050, compared to the baseline. Additional savings of air pollutants, in particular in urban areas, would appear also from setting a zero-emission mandate for urban buses. Overall costs and benefits of the most relevant combinations of options When applied to the extended scope, TL_Low, TL_Med and TL_High show an overall benefit of approximatively EUR 136, 161 and 199 billion. Setting an additional 100% mandate for regulated buses in 2030 would increase such benefits by EUR 4 and 1 billion, in TL_Med and TL_High respectively.	
Technological and innovation leadership of EU industry strengthening by channelling investments into zero-emission technologies.	Stricter CO_2 target levels are expected to drive the development and supply of zero-emission technologies, leading to a positive impact on innovation and industry's technological leadership and competitiveness. ZEV shares will raise to around (%) 20-35, 35-57 and 57-100 by 2030, 2035 and 2040 respectively. The number of additional jobs spurred by the increased economic output are estimated among the ranges 9 - 13, 22 - 41 and 38 - 83 thousand in 2030, 2035 and 2040, respectively.	Manufacturers, component suppliers, petroleum refining, power and hydrogen suppliers, electronics and electrical equipment suppliers, metal.
Costs faced by manufacturers	**Manufacturing costs per motor vehicle** The costs for manufacturers, averaged over the EU-wide new lorries, buses and coaches, correspond to 3 400 - 9 700, 5 300 – 11 800 and 6 500 - 13 100 EUR/vehicle in 2030, 2035 and 2040, respectively. **Manufacturing costs per trailer** The extra 2030 costs for manufacturers from average trailers and semi-trailers compared to a 2020 baseline vehicle are between over EUR 2 500 for drawbar trailers with box body and EUR 5 250 for a reefer semi-trailer. **Additional investments by manufacturers** The HDV motor vehicles manufacturing sector is expected to need additional investments of around (billion EUR per year) 0.46-0.98 across the period 2021-2030 and 4.36 - 8.55 for 2021-2040. This represents an increase of around (%) 0.5-1.1 for the period 2021-2030 and 4.0-7.8 for 2021-2040, compared to the annual investments needed to meet the current CO2 emission standards. The considered costs comprise direct manufacturing costs, including materials and labour, and indirect manufacturing costs (R&D, warranty costs, depreciation and amortisation, maintenance and repair, general	Manufacturers of lorries, buses, coaches and trailers

	other overhead costs).	
Macro-economic impact (GDP)	The CO_2 emissions standards alone will contribute to increase the EU-27 GDP by around (%) 0.01-0.02, 0.04-0.07 and 0.06-0.11 in 2030, 2035 and 2040, compared to the baseline.	Society as a whole
Impact on SMEs operators	Medium and small enterprises find no affordability restrictions across any of the three ambition target scenarios and different vehicles classes. Only microenterprises may find some affordability issue for purchasing new ZEV in group 5 (long haul, > 16 ton), and only in 2030 and 2035. This issue is not present for purchasing ZEV on the second-hand market. Furthermore, also thanks to the effect of stricter CO2 standards, ZEV become more affordable with time, benefitting also micro enterprises	Small and medium transport operators
Investment in zero-emission alternative fuels infrastructure	It is estimated that investments needed in publicly accessible recharging and refuelling infrastructure to support the projected market uptake of ZEV vehicles will amount to around EUR 0.16-0.5 bn per year over the period 2021-2040	Installers of recharging and refuelling zero-emission alternative fuel infrastructure
Administrative cost savings related to the 'one in, one out' approach*		
(direct/indirect)	The proposal is not leading to any significant administrative costs. The certification, monitoring and reporting obligations, which drive the administrative burden, are already set in different regulations. The heavy-duty vehicles currently not regulated are already subject to the same requirements as the regulated ones. In addition, the few policy options (Fuel2 and the flexibility options), in which an additional administrative burden could be created, would set up voluntary mechanisms, i.e. manufacturers would make use of such provisions only on a voluntary basis.	

II. Overview of costs –							
		Citizens/Consumers		**Businesses**		**Administrations**	
		One-off	**Recurrent**	**One-off**	**Recurrent**	**One-off**	**Recurrent**
Action (a)	Direct adjustment costs	N/A	N/A	N/A	<u>Manufacturing costs per motor vehicles</u> Projected costs for manufacturers and average heavy-duty vehicle (lorries, buses and coaches) are between 3 400 -9 700;5 300 – 11 800 and 6 500-13 100 EUR/vehicle in 2030, 2035 and 2040. The additional annual investment costs are projected to be (billion Euro per year): 0.46 - 0.98 across the period 2021 - 2030 and 4.36 - 8.55 for 2021 - 2040. <u>Manufacturing costs per trailer</u> Projected costs for manufacturers for average trailers and semi-trailers, compared to a 2020 baseline vehicle, are 2 500-5 250 EUR/vehicle.	N/A	N/A
	Direct administrative costs	N/A	N/A	N/A	N/A	N/A	N/A
	Direct regulatory fees and charges	N/A	N/A	N/A	N/A	N/A	N/A
	Direct enforcement costs	N/A	N/A	N/A	N/A	N/A	N/A
	Indirect costs	N/A	N/A	Indirect investments needed in publicly accessible recharging and refuelling infrastructure to support the projected market uptake of ZEV vehicles will amount to around 0.16-0.5 billion Euro per year over the period 2021-2040.	See qualitative assessment in section 3.1 of this Annex.	N/A	N/A
Costs related to the 'one in, one out' approach							
Total	Direct adjustment costs	N/A	N/A	N/A	N/A		
	Indirect adjustment costs	N/A	N/A	N/A	N/A		
	Administrative costs (for offsetting)	N/A	N/A	N/A	N/A		

1.14. 12.3 Relevant sustainable development goals (SDG)

III. Overview of relevant Sustainable Development Goals –		
Relevant SDG	**Expected progress towards the Goal**	**Comments**
SDG no. 3 **Good health and well-being**	**Reduce the number of deaths and illnesses from air pollution** Higher penetration of zero-emission HDVs will reduce the emission of air pollutants. The HDV standards contribute to reducing air pollutant by 7 to 17% in 2035, by 15% to around 38% in 2040 and by 66 to 80% in 2050, compared to the baseline	
SDG no. 7 **Affordable and clean energy**	**Sustainable energy infrastructure** Investments in publicly accessible recharging and refuelling zero-emission infrastructure, electricity and hydrogen, in order to support the market uptake of ZEV will amount to around (billion EUR per year): 0.16-0.5 over the period 2021-2040. **Energy demand** Under the different TL options, final energy demand decreases further, and such trends become more visible from 2035 as a result of the fleet renewal. By 2040, demand is reduced by between 9%, 14% and 21% for the different TL levels, as compared to the baseline. HDV in general will demand additional 4 – 8; 20 – 51; 69 – 84 GWh of electricity in 2030, 2040 and 2050, compared to the baseline. This represents approximatively (%) 0.4-0.5; 1.4-2.3 and 3.1-3.5 of the total electricity consumption in those years. The CO_2 emission standards alone will increase the demand of hydrogen to nearly 450 – 950; 2 400 – 6 600; 8 300 – 10 100 ktoe by 2030, 2040 and 2050, compared to the baseline. **Benefits from reduction of fossil energy demand** The reduction in the demand of fossil fuels (mostly oil products as diesel) from **lorries, buses and coaches** is expected to provide savings of €150-200 bn at current oil prices (95 EUR / Brent barrel) by 2050. Additionally, EUR 16 bn can be saved by setting energy efficiency standards for **trailers**.	
SDG no.8 **Decent work and economic growth**	**Economic growth** The CO_2 emissions standards alone will contribute to increase by around (%) 0.01-0.02, 0.04-0.07 and 0.06-0.11 the EU-27 GDP in 2030, 2035 and 2040 compared to the baseline. **Net jobs created**	Stringer CO_2 targets delivery positive GDP output and net jobs creation

	The number of additional jobs spurred by the increased economic output from the revised HDV CO_2 Regulation is estimated to be in the ranges of 9-13, 22-41 and 38-83 thousand in 2030, 2035 and 2040, respectively.	
SDG no. 9 **Industry innovation and infrastructure**	**Sustainable industrialization** The HDV CO_2 standards provide a clear regulatory signal and predictability for industry and research in the shift to zero-emission mobility.This will foster research and innovation in related technologies and encourage channelling investments to adapt technological capability to deliver, more resource-efficient vehicles. ZEV shares are expected to raise to around (%): 20-35, 35-57 and 57-100 by 2030, 2035 and 2040 respectively. **Additional investments by manufacturers** The HDV motor vehicles sector is expected to carry out additional investments to meet the stringer targets of around (billion EUR per year): 0.46-0.98 across the period 2021-2030 and 4.36-8.55 for 2021-2040. This represents an increase of around (%) 0.5-1.1 for the period 2021-2030 and 4.0-7.8 for 2021-2040, compared to the annual investments needed to meet the current CO_2 emission standards.	
SDG no. 11 **Sustainable cities and communities**	**Sustainable public transport** In a medium ambition scenario (TL_Med), the share of new urban zero emission share by 2030 is above 80%. Additional measures would increase this ambition to 100%. As most urban buses are operated in urban areas, the access to more sustainable public passenger transport will be increased and additional savings of air pollutants would also appear.	
SDG no. 12 **Responsible consumption and production**	**Responsible procurement** In a medium ambition scenario (TL_Med), the share of zero emissions urban buses is above 80%. Additional measures would increase this ambition to 100%. As most urban buses are publicly procured and managed in the EU, this will promote more sustainable procurement of public services among local authorities.	In the EU, more than 55% of all public transport journeys (or 32.1 billion passenger journeys per year) are currently made by urban and suburban buses.[16]
SDG no. 13 **Climate action**	**CO_2 emissions reduction** Tailpipe CO_2 emissions from motor vehicles are expected to decrease between 2031 and 2050 by 730-996 Mton as	The revised HDV CO_2 Regulation will reduce CO_2 emissions contributing hence directly to the EU climate targets of -55%

[16] ACEA. Buses: what they are and why they are so important.

	compared to the baseline. This represents respectively 35%-48% reduction of the projected emissions in the baseline scenario. On top, energy efficiency standards in trailers and semi-trailers will reduce accumulated CO_2 emissions by more than nearly 45 Mton between 2031 and 2050 compared to medium scenario, equivalent to 1.4% of total HDV CO_2 emissions.	reduction by 2030 and climate neutrality by 2050, in accordance with the Paris Agreement. Potential emissions trade-off because of larger carbon footprint of batteries and fuel cells manufacturing: see comment above.

13. ANNEX 4: ANALYTICAL METHODS

The analytical work underpinning this Impact Assessment uses a series of models: PRIMES, PRIMES-TREMOVE, E3ME, JRC DIONE. They have a successful record of use in the Commission's transport, energy and climate policy impact assessments.

A brief description of each model is provided below.

1.15. 13.1 Common analytical framework

13.1.1 Introduction

Aiming at covering the entire GHG emissions from the EU economy, and combining horizontal and sectoral instruments, the various pieces of legislation under the "Fit for 55" package and the REPowerEU plan strongly interlink, either because they cover common economic sectors (e.g. the transport sector is currently addressed by energy efficiency and renewables policies but it also falls in the scope of ETS) or by the direct and indirect interactions between these sectors (e.g. electricity supply sector and final demand sectors using electricity).

As a consequence, it is crucial to ensure consistency of the analysis across all initiatives. For this purpose, this impact assessment uses models which are part a collection of integrated modelling tools covering the entire GHG emissions of the EU economy and that underpinned the "Fit for 55" policy package as well as the REPowerEU plan[17].

These tools are used to produce a Baseline and a set of scenarios reflecting internally coherent policy packages aligned with the scenario underpinning the REPowerEU plan and building on the Reference Scenario 2020, a projection of the evolution of EU and national energy systems and GHG emissions under the current policy framework[18].

This Annex describes the tools used to produce the and the policy scenarios and the key assumptions underpinning the analysis, as well as the main assumptions and results of the scenario underpinning the REPowerEU SWD.

13.1.2 Modelling tools for assessments of policies

13.1.1.1 Main modelling suite

The main models used to produce the scenarios presented in this impact assessment have a successful record of use in the Commission's energy, transport and climate policy assessments. In particular, they has been recently used for the Commission's proposals for the REPowerEU Plan and for the "Fit for 55".

The models cover:

- **The entire energy system** (energy demand, supply, prices and investments to the future) and **all GHG emissions and removals** from the EU economy.
- **Time horizon:** 1990 to 2070 (5-year time steps).

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[17] Note that the scenario underpinning the REPowerEU plan builds on the scenarios supporting the "Fit for 55" package. For simplicity we will refer simply to the REPowerEU scenario

[18] The "current policy framework" includes EU initiatives adopted as part of the "Fit for 55 package", the REPowerEU plan and the national objectives and policies and measures as set out in the final National Energy and Climate Plans .

- **Geography:** individually all EU Member States, EU candidate countries and, where relevant the United Kingdom, Norway, Switzerland and Bosnia and Herzegovina.
- **Impacts:** energy system (PRIMES and its satellite model on biomass), transport (PRIMES-TREMOVE).

The models have been continuously updated over the past decade. Very recently, technology costs of heavy-duty vehicles and fuel prices have been revised (see sections 6.1.2 and 13.1 respectively).

13.1.1.2 Energy: the PRIMES model

The PRIMES model (Price-Induced Market Equilibrium System)[19] is a large scale applied energy system model that provides detailed projections of energy demand, supply, prices and investment to the future, covering the entire energy system including emissions. The distinctive feature of PRIMES is the combination of behavioural modelling (following a micro-economic foundation) with engineering aspects, covering all energy sectors and markets.

The model has a detailed representation of policy instruments related to energy markets and climate, including market drivers, standards, and targets by sector or overall. It simulates the EU Emissions Trading System. It handles multiple policy objectives, such as GHG emissions reductions, energy efficiency, and renewable energy targets, and provides pan-European simulation of internal markets for electricity and gas.

The model covers the horizon up to 2070 in 5-year interval periods and includes all Member States of the EU individually, as well as neighbouring and candidate countries.

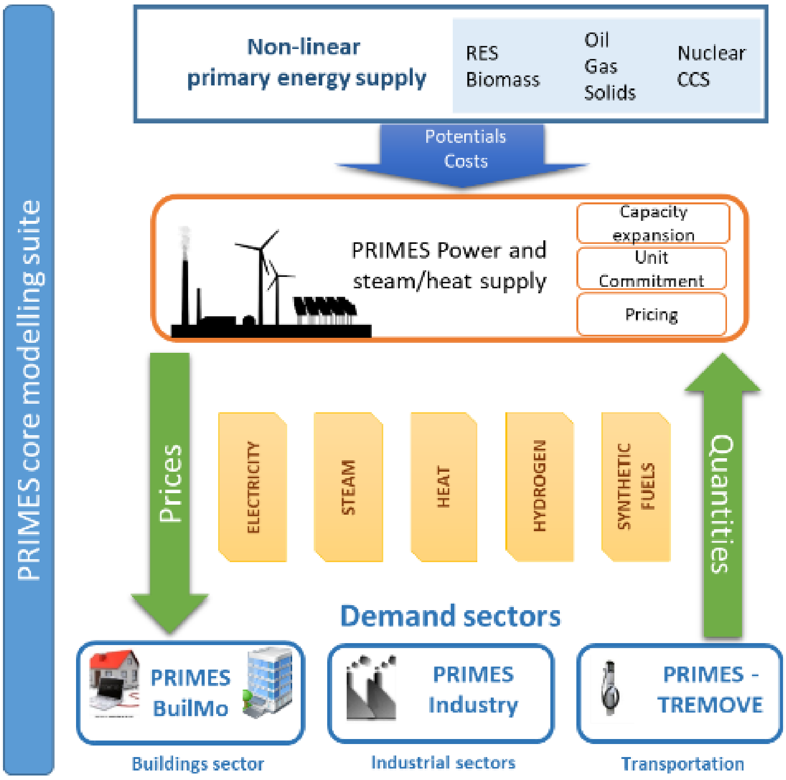
PRIMES offer the possibility of handling market distortions, barriers to rational decisions, behaviours and market coordination issues and it has full accounting of costs (CAPEX and OPEX) and investment on infrastructure needs.

PRIMES is designed to analyse complex interactions within the energy system in a multiple agent – multiple markets framework. Decisions by agents are formulated based on microeconomic foundation (utility maximization, cost minimization and market equilibrium) embedding engineering constraints and explicit representation of technologies and vintages, thus allowing for foresight for the modelling of investment in all sectors.

PRIMES allows simulating long-term transformations/transitions and includes non-linear formulation of potentials by type (resources, sites, acceptability etc.) and technology learning.

[19] More information and model documentation: https://e3modelling.com/modelling-tools/primes/

Figure 3: Schematic representation of the PRIMES model



It includes a detailed numerical model on biomass supply, namely PRIMES-Biomass, which simulates the economics of current and future supply of biomass and waste for energy purposes. The model calculates the inputs in terms of primary feedstock of biomass and waste to satisfy a given demand for bio-energy and provides quantification of the required capacity to transform feedstock into bioenergy commodities. The resulting production costs and prices are quantified. The PRIMES-Biomass model is a key link of communication between the energy system projections obtained by the core PRIMES energy system model and the projections on agriculture, forestry and non-CO_2 emissions provided by other modelling tools participating in the scenario modelling suite (CAPRI, GLOBIOM/G4M, GAINS).

It also includes a simple module which projects industrial process GHG emissions.

PRIMES is a private model maintained by E3Modelling[20], originally developed in the context of a series of research programmes co-financed by the European Commission. The model has been successfully peer-reviewed, last in 2011[21]; team members regularly participate in international conferences and publish in scientific peer-reviewed journals.

Sources for data inputs

A summary of database sources, in the current version of PRIMES, is provided below:

- Eurostat and EEA: Energy Balance sheets, Energy prices (complemented by other sources, such IEA), macroeconomic and sectoral activity data (PRIMES sectors correspond to NACE 3-digit classification), population data and

[20] E3Modelling (https://e3modelling.com/) is a private consulting, established as a spin-off inheriting staff, knowledge and software-modelling innovation of the laboratory E3MLab from the National Technical University of Athens (NTUA).

[21] SEC(2011)1569: https://ec.europa.eu/energy/sites/ener/files/documents/sec_2011_1569_2.pdf

projections, physical activity data (complemented by other sources), CHP surveys, CO_2 emission factors (sectoral and reference approaches) and EU ETS registry for allocating emissions between ETS and non ETS

- Technology databases: ODYSSEE-MURE[22], ICARUS, Eco-design, VGB (power technology costs), TECHPOL – supply sector technologies, NEMS model database[23], IPPC BAT Technologies[24]
- Power Plant Inventory: ESAP SA and PLATTS
- RES capacities, potential and availability: JRC ENSPRESO[25], JRC EMHIRES[26], RES ninja[27], ECN, DLR and Observer, IRENA
- Network infrastructure: ENTSOE, GIE, other operators
- Other databases: EU GHG inventories, district heating surveys (e.g. from COGEN), buildings and houses statistics and surveys (various sources, including ENTRANZE project[28], INSPIRE archive, BPIE[29]), JRC-IDEES[30], update to the EU Building stock Observatory[31]

13.1.1.3 Transport: the PRIMES-TREMOVE model

The PRIMES-TREMOVE transport model projects the evolution of demand for passengers and freight transport, by transport mode, and transport vehicle/technology, following a formulation based on microeconomic foundation of decisions of multiple actors. Operation, investment and emission costs, various policy measures, utility factors and congestion are among the drivers that influence the projections of the model. The projections of activity, equipment (fleet), usage of equipment, energy consumption and emissions (and other externalities) constitute the set of model outputs. The PRIMES-TREMOVE transport model can therefore provide the quantitative analysis for the transport sector in the EU, candidate and neighbouring countries covering activity, equipment, energy and emissions. The model accounts for each country separately which means that the detailed long-term outlooks are available both for each country and in aggregate forms (e.g. EU level).

In the transport field, PRIMES-TREMOVE is suitable for modelling *soft measures* (e.g. eco-driving, labelling); *economic measures* (e.g. subsidies and taxes on fuels, vehicles, emissions; ETS for transport when linked with PRIMES; pricing of congestion and other externalities such as air pollution, accidents and noise; measures supporting R&D); *regulatory measures* (e.g. CO_2 emission performance standards for new light duty vehicles and heavy duty vehicles; Euro standards on pollutant emissions from road transport vehicles; technology standards for non-road transport technologies, deployment of Intelligent Transport Systems) and *infrastructure policies for alternative fuels* (e.g. deployment of refuelling/recharging infrastructure for electricity, hydrogen, LNG, CNG). Used as a module that contributes to the PRIMES model energy system model, PRIMES-TREMOVE can show how policies and trends in the field of transport contribute to

[22] Source: https://www.odyssee-mure.eu
[23] Source: https://www.eia.gov/outlooks/aeo/info_nems_archive.php
[24] Source: https://eippcb.jrc.ec.europa.eu/reference/
[25] Source: https://data.jrc.ec.europa.eu/collection/id-00138
[26] Source: https://data.jrc.ec.europa.eu/dataset/jrc-emhires-wind-generation-time-series
[27] Source: https://www.renewables.ninja/
[28] Source: https://www.entranze.eu/
[29] Source: http://bpie.eu/
[30] Source: https://ec.europa.eu/jrc/en/potencia/jrc-idees
[31] Source: https://ec.europa.eu/energy/en/eubuildings

economy-wide trends in energy use and emissions. Using data disaggregated per Member State, the model can show differentiated trends across Member States.

The PRIMES-TREMOVE model is used, together with PRIMES, to quantitatively describe the baseline scenario, in a fully consistent way with the REPowerEU, Fit for 55 and the Climate target plan analytical scenarios. The model allows for a representation of the market dynamics, projecting demand for freight and passenger transportation services (based on the projected economic activity as in the Reference Scenario 2020) and the projected cost-optimal technology mix (based on the abovementioned technology costs) to produce passenger and freight services which meet such demand. The different categories and powertrain types of HDV are represented in the model and they are an available choice to meet transport demand. In addition, the model formulates the dynamics of vehicle stock turnover.

The PRIMES-TREMOVE has been developed and is maintained by E3Modelling, based on, but extending features of, the open source TREMOVE model developed by the TREMOVE[32] modelling community. Part of the model (e.g. the utility nested tree) was built following the TREMOVE model.[33] Other parts, like the component on fuel consumption and emissions, follow the COPERT model.

While PRIMES-TREMOVE is privately owned, it is documented in several publications in scientific journals and in the model documentation which is publicly available. It has been extensively used both for scientific publication and for policy assessment (including in the IA supporting the current HDV standards, in different proposal of the Fit-for-55 package, including the IA supporting the LDV CO_2 standards, and in the REPowerEU Plan), not only by the European Commission in several IA but also by different stakeholders and Member States.

As a module of the PRIMES energy system model, PRIMES-TREMOVE has been successfully peer reviewed in the past. The model results have been communicated to the scientific audience. Model results have also been reviewed as part of deliverables in Horizon 2020 research projects. Additional information is publicly available on the JRC webpage https://web.jrc.ec.europa.eu/policy-model-inventory/explore/models/model-primes-tremove.

Data inputs

The main data sources for inputs to the PRIMES-TREMOVE model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[34]. Excise taxes are derived from DG TAXUD excise duty tables. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports.

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[32] Source: https://www.tmleuven.be/en/navigation/TREMOVE

[33] Several model enhancements were made compared to the standard TREMOVE model, as for example the technology categories which include vehicle types using electricity from the grid and fuel cells. The model also incorporates additional fuel types, such as biofuels (when they differ from standard fossil fuel technologies), LPG, LNG, hydrogen and e-fuels. In addition, representation of infrastructure for refuelling and recharging are among the model refinements, influencing fuel choices. A major model enhancement concerns the inclusion of heterogeneity in the distance of stylised trips; the model considers that the trip distances follow a distribution function with different distances and frequencies. The inclusion of heterogeneity was found to be of significant influence in the choice of vehicle-fuels especially for vehicles-fuels with range limitations.

[34] Source: https://ec.europa.eu/transport/facts-fundings/statistics_en

In the context of this exercise, the PRIMES-TREMOVE transport model is calibrated to 2005, 2010 and 2015 historical data. Available data on 2020 market shares of different powertrain types have also been taken into account.

13.1.3 Economic assumptions

The modelling work is based on socio-economic assumptions describing the expected evolution of the European society. Long-term projections on population dynamics and economic activity form part of the input to the energy model and are used to estimate final energy demand.

Population projections from Eurostat[35] are used to estimate the evolution of the European population, which is expected to change little in total number in the coming decades. The GDP growth projections are from the Ageing Report 2021[36] by the Directorate General for Economic and Financial Affairs, which are based on the same population growth assumptions.

[35] EUROPOP2019 population projections https://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data

[36] The 2021 Ageing Report : Underlying assumptions and projection methodologies https://ec.europa.eu/info/publications/2021-ageing-report-underlying-assumptions-and-projection-methodologies_en

Table 3: Projected population and GDP growth per MS

	Population			GDP growth	
	2020	2025	2030	2020-'25	2026-'30
EU27	447.7	449.3	449.1	0.9%	1.1%
Austria	8.90	9.03	9.15	0.9%	1.2%
Belgium	11.51	11.66	11.76	0.8%	0.8%
Bulgaria	6.95	6.69	6.45	0.7%	1.3%
Croatia	4.06	3.94	3.83	0.2%	0.6%
Cyprus	0.89	0.93	0.96	0.7%	1.7%
Czechia	10.69	10.79	10.76	1.6%	2.0%
Denmark	5.81	5.88	5.96	2.0%	1.7%
Estonia	1.33	1.32	1.31	2.2%	2.6%
Finland	5.53	5.54	5.52	0.6%	1.2%
France	67.20	68.04	68.75	0.7%	1.0%
Germany	83.14	83.48	83.45	0.8%	0.7%
Greece	10.70	10.51	10.30	0.7%	0.6%
Hungary	9.77	9.70	9.62	1.8%	2.6%
Ireland	4.97	5.27	5.50	2.0%	1.7%
Italy	60.29	60.09	59.94	0.3%	0.3%
Latvia	1.91	1.82	1.71	1.4%	1.9%
Lithuania	2.79	2.71	2.58	1.7%	1.5%
Luxembourg	0.63	0.66	0.69	1.7%	2.0%
Malta	0.51	0.56	0.59	2.7%	4.1%
Netherlands	17.40	17.75	17.97	0.7%	0.7%
Poland	37.94	37.57	37.02	2.1%	2.4%
Portugal	10.29	10.22	10.09	0.8%	0.8%
Romania	19.28	18.51	17.81	2.7%	3.0%
Slovakia	5.46	5.47	5.44	1.1%	1.7%
Slovenia	2.10	2.11	2.11	2.1%	2.4%
Spain	47.32	48.31	48.75	0.9%	1.6%
Sweden	10.32	10.75	11.10	1.4%	2.2%

Beyond the update of the population and growth assumptions, an update of the projections on the sectoral composition of GDP was also carried out using the GEM-E3 computable general equilibrium model. These projections take into account the potential medium- to long-term impacts of the COVID-19 crisis on the structure of the economy, even though there are inherent uncertainties related to its eventual impacts. Overall, conservative assumptions were made regarding the medium-term impacts of the pandemic on the re-localisation of global value chains, teleworking and teleconferencing and global tourism.

13.1.4 Energy prices assumptions

Alongside socio-economic projections, EU energy modelling requires projections of international fuel prices. The projections used for this impact assessment are fully consistent with the assumptions in the REPowerEU analysis[37]: oil and coal prices are based on historical data for 2020-2021, combined with estimates of prices in 2022 and complemented by a linear interpolation to the long-term trajectory assumed in the EU Reference Scenario 2020[38] for the following years. The same approach is used for gas prices, except that these are expected to remain higher than in the Fit-for-55 scenario[39] in the long run.

Table 4 shows the international fuel price assumptions used in this impact assessment.

Table 4: International fuel prices assumptions

in $'15 per boe	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Oil	38.4	65.4	86.7	52.3	39.8	92.1	92.1	92.1	97.4	105.6	117.9
Gas (NCV)	26.5	35.8	45.8	43.7	20.1	80.6	68.9	68.9	68.9	68.9	72.1
Coal	11.2	16.9	23.2	13.1	9.5	18.6	18.9	19.1	20.3	21.3	22.3
in €'15 per boe	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Oil	34.6	58.9	78.2	47.2	35.8	83.0	83.0	83.0	87.8	95.2	106.3
Gas (NCV)	23.4	31.7	40.6	38.7	17.8	71.4	61.0	61.0	61.0	61.0	63.8
Coal	9.9	15.0	20.6	11.6	8.4	16.5	16.7	16.9	18.0	18.9	19.7

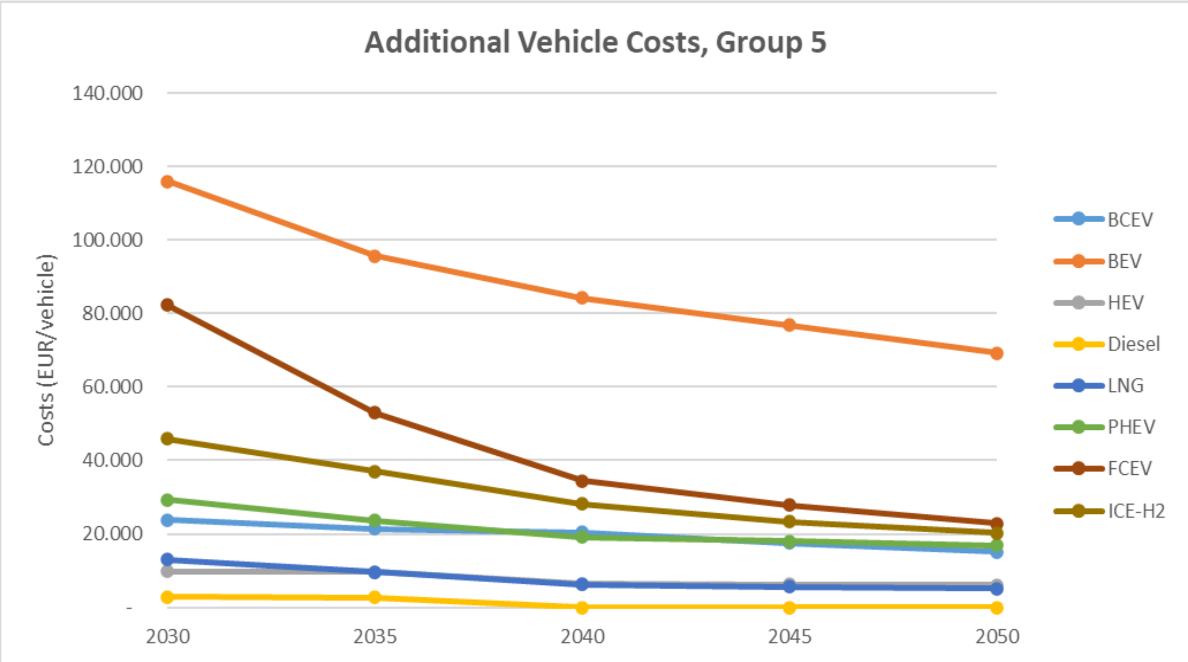
13.1.5 Assumptions

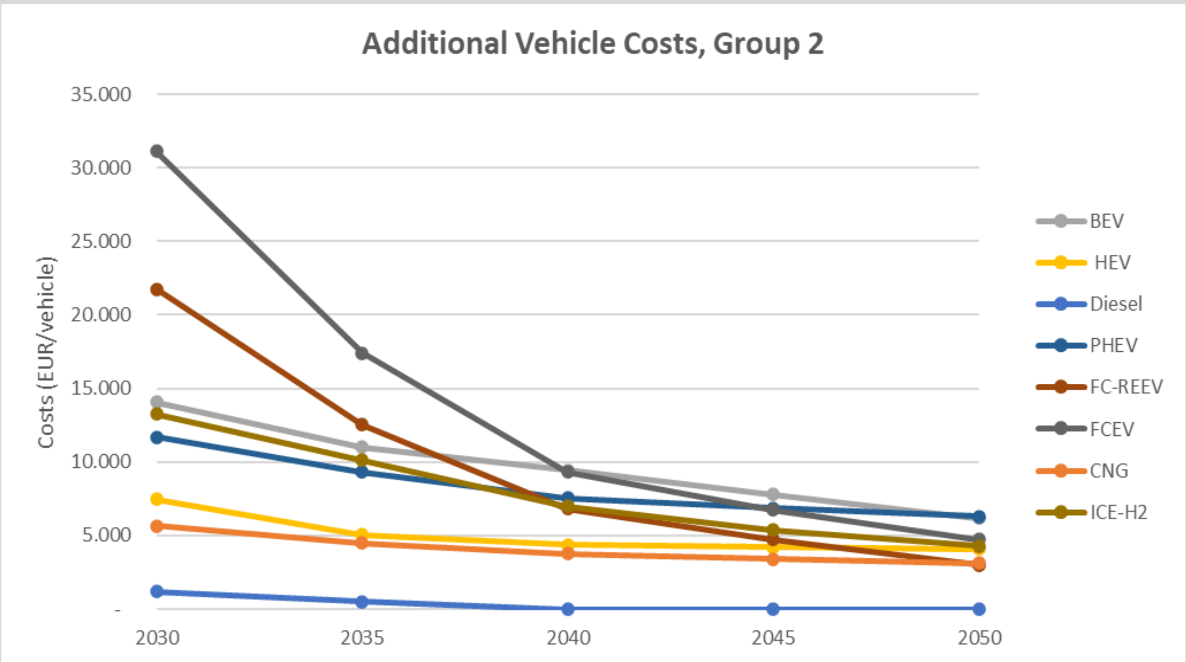
Modelling scenarios on the evolution of the energy system is highly dependent on the assumptions on the development of technologies - both in terms of performance and costs. For the purpose of this impact assessments, these assumptions have been updated based on a rigorous literature review and stakeholder consultation, carried out by external consultants[40].

On the basis of such review and consultation, data have been derived to feed into the analytical procedure which determines the additional vehicle cost. Such procedure has been first described in Ricardo Energy & Environment (2016, https://ec.europa.eu/clima/system/files/2017-11/ldv_co2_technologies_and_costs_to_2030_en.pdf). It has been further developed and implemented in the JRC's DIONE model for Light Duty Vehicles as documented in Krause et al. (2017, https://data.europa.eu/doi/10.2760/87837), and adapted for Heavy Duty Vehicles as in Krause and Donati (2018, https://data.europa.eu/doi/10.2760/555936).

As an example, the figures below show the cost over time for all powertrains, for an articulated lorry above 40t (group 5, which operates predominantly on long-haul and regional delivery cycles and is the group with the highest share of emissions) and of a 12t lorry (group 2). The costs are additional to the costs of a 2019 conventional diesel ICEV of the same group. Similar curves are available for all the relevant groups.

Figure 4: Additional vehicle costs (vs diesel ICE) for different powertrain types





See chapter 13.1.6 and 6.1.2 for additional details.

The baseline

The baseline (and, as a consequence, the policy scenarios) used in this Impact Assessment builds on the EU Reference Scenario 2020 (REF2020) scenario, which has been updated to take into account the European Green Deal policies and the the increased

Renewable and Energy Efficiency target as proposed by the Commission on 18 May 2022 with the REPowerEU plan.

The REF2020 provided projections for energy demand and supply, as well as greenhouse gas emissions in all sectors of the European economy under the then current EU and national policy framework. It served then as the common baseline shared by all the initiatives of the "Fit for 55" policy package to assess options in their impact assessments. It was then updated to take into account the recent increase in fuel prices (see Section 13.1.4) and the increased Renewable and Energy Efficiency target as proposed by the Commission on 18 May 2022 with the REPowerEU plan. The description of the Baseline is available in Section 5.1.

13.1.6 Difference with the scenarios used for the Fit for 55 package

The baseline used in this Impact Assessment embeds some differences compared to the scenarios used for the Fit for 55 package.

- The representation of the HDV sector has been improved, to better represent the differentiation of vehicles according to their vehicle group, as defined in the Commission Regulation (EU) 2017/2400.
- The technology assumptions and the CO_2 reduction potential of the HDV sector have been based on a rigorous literature review and stakeholder consultation[41].
- The fuel prices have been updated, as described in Section 13.1.4.
- The scenarios used in this impact assessment also take into account the revised renewable and energy effieicny targets, proposed by the Commission as part of the REPowerEU plan

13.1.7 Reference scenario process

The scenarios used in the Impact Assessment builds on the REF2020 scenario, which has been prepared by the European Commission services and consultants from E3Modelling, IIASA and EuroCare, in coordination with Member States experts through the Reference Scenario Experts Group.

It benefitted from a stakeholders consultation (on technologies) and is aligned with other outlooks from Commission services, notably DG ECFIN's Ageing Report 2021 (see section 0), as well as, to the extent possible, the 2020 edition of the EU Agricultural Outlook 2020-2030 published by DG AGRI in December 2020[42].

13.1.8 Policies in the baseline

The baseline is based on the REF2020, which took into account existing policies adopted at national and EU level at the beginning of 2020. At national level, the scenario takes into account the policies and specific targets, in particular in relation with renewable energy and energy efficiency, described in the final National Energy and Climate Plans (NECPs) submitted by Member States at the end of 2019/beginning of 2020.

The baseline further includes the policies which are part of the European Green Deal, including those part of the Fit for 55 package, as well as the increased renewable and energy efficiency targets as proposed by the Commission on 18 May 2022 under the

[41] Study conducted by Ricardo AEA for DG Climate Action

[42] https://ec.europa.eu/info/news/eu-agricultural-outlook-2020-30-agri-food-sector-shown-resilience-still-covid-19-recovery-have-long-term-impacts-2020-dec-16_en

REPowerEU plan. EURO 7 is also included. It includes the CO_2 standards for heavy-duty vehicles that are currently in place, as set out in Regulation (EU) 2019/1242. As it serves as a common baseline with forthcoming initatives, it does not include some initiatives related to multimodal mobility, the revision of the Rail Freight Corridors Regulation and the revision of the Combined Transport Directive.

Details on policies and measures represented in the REF2020 can be found in the dedicated "EU Reference Scenario 2020" publication. The scenarios supporting the Fit for 55 package are described in the relevant impact assessments, such as SWD/2021/613. The scenario accompanying the REPowerEU plan is described in the relevant Staff Working Document (SWD/2022/230).

13.1.9 REPowerEU Scenario

The baseline, which the policy scenarios presented in this IA are based on, is built on the scenario underpinning the REPowerEU SWD (COM(2022) 230 final). This section briefly explains the main assumptions and results of the REPowerEU scenario, which was developed with the same models used in this IA (notably PRIMES and PRIMES-TREMOVE).

Assumptions

The REPowerEU Scenario builds on the Fit for 55 proposals and, in line with the core scenarios used to support the IAs of the Fit for 55 package, it assumes more stringent HDV CO_2 standards than those currently in place (as set by Regulation (EU) 2019/1242). Furthermore, compared to these core scenarios, it assumes higher energy prices, as presented in Section 13.1.4. As done for this IA, technology assumptions for HDVs have also been updated.

The REPowerEU SWD

The REPowerEU SWD describes the results and the assumptions of the modelling scenario on how to achieve the objectives of the REPowerEU communication (COM(2022) 108 final) to reduce the dependence of Russian fossil fuels. It will require to reduce faster the EU dependence on fossil fuels while diversifying gas supplies. Both efforts imply investments including to boost energy efficiency gains, increase the share of renewables, address infrastructure bottlenecks, increase LNG imports and pipeline imports from non-Russian suppliers and increase the level of renewable hydrogen and bio-methane.

Implementing the full potential to reduce the dependence to zero would require EUR 300 bn cumulative from now until 2030. These are additional to the Fit for 55 proposals and include the impact of higher fuel costs.

This is an increase of about 5% of the total Fit for 55 investments until 2030 but would lead, together with the measures of the Fit for 55 package, to savings of approximatively €80 bn on gas import expenditures, €12 bn on oil import expenditures and €1.7 bn on coal import expenditures per year.

Achieving the objectives of REPowerEU relies notably on scaling up renewable energies as quickly as possible and develop renewable hydrogen and bio-methane and provide a crucial contribution to the effort of reducing the dependence on Russian gas.

Reducing faster the EU dependence on fossil fuels is done at the level of homes, buildings, transport, industry and the power system by boosting energy efficiency gains, increasing the share of renewables and addressing infrastructure bottlenecks.

Several policy actions are considered both from the supply and demand side, in the short, medium and long term. The most relevant for this IA are the decarbonisation of the power sector, in the short term, as well as the development of renewable hydrogen production and hydrogen infrastructure, which would take place in the long term. Potential measures and investments to reduce dependence on Russian gas are described in Table 1 of the SWD.

The significant reduction on gas consumption would be achieved by both the impact of higher gas and oil prices and by the implementation of the REPowerEU measures.

Three main drivers will change the energy system beyond the Fit-for-55 proposals:

1. The decoupling from Russian gas imports;
2. The REPowerEU plan which further increases the ambition level beyond the Fit for 55 Package for gas alternatives (bio-methane, renewable hydrogen), deployment of renewables, and structural demand measures such as energy efficiency;
    - The renewables reach a 45% share in 2030;
    - Energy efficiency reaches a 13% share in 2030;
    - Bio-methane production reaches 35 bcm in 2030;
    - Renewable hydrogen use reaches 20 Mt by 2030 (of which about 4 Mt as ammonia);
    - Respecting the at least -55% GHG objective of the Fit-for-55 package is achieved.
3. Prices are expected to be persistently higher than the reference (albeit lower than the peak prices observed in 2021 and 2022).

Impact on Energy demand

Compared to the Fit-for-55 proposals, the SWD shows that there is additional scope for decreasing consumption of natural gas in all industrial sectors by 2030. Implementing REPowerEU would, in addition to higher fuel prices, lead to a switch in the industrial sector from natural gas to hydrogen and coal, and to a lesser extent oil.

Higher consumption of hydrogen in hard-to-abate transport sectors, especially in heavy duty trucks and through the production of sustainable fuels for aviation and waterborne sectors provides another opportunity to replace Russian fossil fuels. Consumption of hydrogen in the transport sector is higher by 1.4 Mt of hydrogen in REPowerEU, or about 2.5 times what it would be in Fit for 55, with the share of hydrogen and derived fuels (renewable fuels of non-biological origin) in the transport sector increasing to above 5%.

The SWD also reports on short term and behavioural measures, including the reinforcement of the adoption of electric and more efficient vehicles.

Renewables and Energy Efficiency for REPowerEU

The REPowerEU scenario shows that the increase of the overall RES to 45% in 2030 leads to an increase in all supply and demand renewable sectors – electricity, heating and cooling, industry, buildings and transport. Notably RES-T share in 2030 increases from 28% to 32% and GHG intensity reduction in transport increases from 13% to 16%, compared to the results of the Fit for 55 scenario. With respect to the projections in the EU Reference Scenario 2020, final energy consumption is 13% lower (compared to nearly 9% in the Fit for 55 scenario). Similarly, the share of RFNBOs in 2030 (single counted) increases from 2.6% to 5.7%.

1.16. 13.2 Specific analytical elements for this impact assessment

13.2.1 DIONE model (JRC)

The DIONE model suite is developed, maintained and run by the European Commission's Joint Research Centre (JRC). It has been used for the assessment of net economic savings from different perspectives and of costs for automotive manufacturers presented in Chapter 6 of the Impact Assessment. The suite consists of different modules, such as:

- DIONE Fleet Impact Model
- DIONE Cost Curve Model
- DIONE Cross-Optimization Module
- DIONE Fuel and Energy Cost Module
- DIONE TCO Module

Many of them were developed specifically for the analysis of the total cost of ownership of vehicles in the framework of EC impact assessments[43]. The DIONE model was previously used in support of the analytic work supporting the current regulations setting CO2 standards for light-duty vehicles (Regulation (EU) 2019/631) and heavy-duty vehicles (Regulation (EU) 2019/1242), as well as in support of the impact assessment for strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition (SWD (2021) 613). For the present Impact Assessment, the DIONE Model was extended in several ways, to be able to analyze impacts of possible extensions of regulation scope. Previously, DIONE cost curves covered the presently regulated four vehicle groups, i.e., 4, 5, 9 and 10 (as per (EU) 2017/2400), two powertrains (diesel and liquid natural gas combustion engines), and the two years 2025 and 2030.

Firstly the model was extended to new HDV classes, i.e., large vans and small/medium trucks up to group 3, and additional heavy trucks of groups 11, 12 and 16. Moreover, buses and coaches have been newly included.

Secondly, a major extension of the powertrain/fuel combinations available was undertaken, extending to both additional combustion engine options fuelled by gaseous fuels such as compressed natural gas and hydrogen, and to the development of cost curves for electrified powertrains, covering hybrids, plug-in hybrids (PHEV), battery electric vehicles (BEV), fuel cell electric vehicles (FCEV), fuel cell range extenders (FC-REEV), and battery catenary electric vehicles (BCEV).

Thirdly, the DIONE cost curve model has been extended to trailers and has provided the first ever energy consumption reduction cost curves for a variety of trailers of different types, towed by diverse truck types and classes.

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[43] Krause, J., Donati, A.V., Thiel, C. (2017), Light-Duty Vehicle CO_2 Emission Reduction Cost Curves and Cost Assessment - the DIONE Model, EUR 28821 EN, Publications Office of the European Union, Luxembourg, http://publications.jrc.ec.europa.eu/repository/handle/JRC108725; and Krause, J., Donati, A.V., Heavy-duty vehicle CO_2 emission reduction cost curves and cost assessment – enhancement of the DIONE model (2018), EUR 29284 EN, ISBN 978-92-79-88812-0, doi:10.2760/555936, JRC112013

Forth, all heavy duty vehicle cost curves have been developed out to 2050 (previously 2030).

On the basis of the cost curves, the DIONE Cross-Optimization Module determines the optimal (i.e. cost minimizing) CO_2 and energy consumption reduction for each powertrain and segment, given the relevant targets, fleet compositions and cost curves. Outputs from the Cross-Optimization Module are optimal CO_2 (for combustion engine vehicles using carbon emitting fuels) or energy (for BEV, FCEV, BCEV, FC-REEV, PHEV, and hydrogen combustion engine vehicles) consumption reductions, compared to a baseline vehicle, per vehicle class and powertrain, along with the corresponding additional manufacturing costs.

The DIONE Energy Cost Module is used to calculate fuel and energy costs. For each powertrain and vehicle class, the energy consumption (MJ/km) is derived from the CO_2 emission or energy consumption reduction found in the cross-optimization. The fuel and energy cost is calculated taking into account the specific energy consumption, vehicle mileage and fuel costs per scenario. Costs of conventional fuels, and electricity and hydrogen are aligned with PRIMES outputs for the respective scenarios. They are discounted and weighted by powertrain / class activity over vehicle age.

In the DIONE TCO (total cost of ownership) Module, technology costs, fuel/energy and maintenance costs are aggregated, discounted and weighted where appropriate, to calculate total costs of ownership from the perspectives of end-users and society.

Main assumptions made for the costs assessment by DIONE are presented in **Table 5**.

Table 5: Main assumptions made for HDV cost assessment

	Enduser 1	Enduser 2	Enduser 3	Social Lifetime
Vehicle life years	1-5	6-10	11-15	1-15
Discount rate, applied to fuel/energy, maintenance, and capital costs	9.5% trucks 7.5% buses/coaches	9.5% trucks 7.5% buses/coaches	9.5% trucks 7.5% buses/coaches	3% for all
User period depreciation of technology value	70%	16%	4%	90%
Value added tax on all costs	excluded	excluded	excluded	excluded
Excise duty (on fuels)	included	included	included	excluded
Capital cost mark-up (price-to-cost ration)	1.208	1.208	1.208	1
OEM profit margin on capital costs	5%	5%	5%	5%

13.2.2 *Macroeconomic model E3ME*

E3ME is a computer-based model of Europe’s economies, linked to their energy systems and the environment. The model was originally developed through the European Commission’s research framework programmes in the 1990s and is now widely used in collaboration with a range of European institutions for policy assessment, for forecasting and for research purposes.

The model is run by Cambridge Econometrics, and its detailed manual is available at https://www.e3me.com/wp-content/uploads/2019/09/E3ME-Technical-Manual-v6.1-onlineSML.pdf

The economic structure of E3ME is based on the system of national accounts, as defined by ESA2010. In total there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment and international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

For the analysis presented in Section 6, the E3ME is calibrated to the Primes output for the three scenarios representing different levels of ambition of CO2 emission standards. The PRIMES scenarios consider the effect of different polcies acting on transport.

The labour market is also covered in detail, with estimated sets of equations for labour demand, supply, wages and working hours. For the assessment of employment impacts across the different sectors, labour intensities (number of persons per unit of output) are based on Eurostat Structural Business Statistics (sbs_na_ind_r2). As a starting point, the labour intensity of battery manufacture (which is included in the electrical equipment manufacturing sector) at the EU level is around 3 jobs per €1 million output, compared to a labour intensity of around 5 jobs per €1 million output in the wider electrical equipment manufacturing sector. The labour intensity of the automotive sector (excluding the battery manufacturing) is about 3.5 jobs per €1 million output, reflecting a high labour intensity for manufacture of vehicle parts and engines (5 jobs per €1 million output) but lower labour intensity for the assembly of the vehicle itself (less than 2 jobs per €1 million output). The model also accounts for labour productivity improvements (i.e. the ratio of sectoral employment to gross output over the projection period), based on PRIMES projections for output by sector and CEDEFOP projections for employment by sector.

14. ANNEX 5: REGULATORY CONTEXT

1.17. 14.1 Main elements of Regulation (EU) 2019/1242

14.1.1 CO_2 target levels

EU fleet-wide CO_2 emission targets are set to apply to the average specific CO_2 emissions of the newly registered heavy-duty vehicles[44] of each manufacturer falling within the scope of the Regulation, as from the 2025 to 2029 reporting periods and as from the 2030 reporting period onward, respectively. The vehicles within the scope of the Regulation are the VECTO groups 4, 5, 9 and 10, i.e., lorries with TPMLM over 16t and with 4x2 and 6x2 axle configurations. A reporting period of a certain year 'Y' lasts from the 1 July until 30 June of the following year.

The 2025 and 2030 targets are defined as a percentage reduction with respect to the 2019 reference emissions as shown below:

Table 6. EU fleet-wide CO2 targets

EU fleet-wide CO_2 targets (% reduction from 2019 reference emissions		
	2025	**2030**
Heavy-duty vehicles	15%	30%

The 2019 reference emissions constitute the average specific CO_2 emissions of the vehicles of all manufacturers newly registered in the 2019 reporting period. The regulation also provides some incentives for manufacturers to improve the CO_2 emissions of their vehicles before the 2025 reporting period by allowing them to acquire credits. These credits can be redeemed for compliance in the 2025 reporting period if their CO_2 emissions performance is better than a certain emissions reduction trajectory.

14.1.2 Excess Emission Premiums

If the average specific emissions of a certain manufacturer exceed its specific emission target, an excess emission premium is imposed. The underlying assessment is done for each reporting period separately. Nonetheless, manufacturers have certain possibilities for carrying over debits (if not meeting their targets) and credits (if overachieving their targets by a certain benchmark amount defined through an emissions reduction trajectory) of CO_2 emissions to the following year.

14.1.3 Incentive mechanism for zero- and low-emission vehicles (ZLEV)

A ZEV is a heavy-duty vehicle with no (tailpipe) CO_2 emissions. A LEV is defined as a heavy-duty vehicle which is not a ZEV but has (tailpipe) CO_2 emissions of less than half of the average CO_2 emissions of all new heavy-duty vehicles in a given vehicle group in the reference period 2019.

[44] These values are determined by simulation with the VECTO tool according to the provisions of type-approval Regulation (E° 2017/2400 and reported to the EEA according to the provisions of the HDV Monitoring and Reporting Regulation (EU) 2018/956

In order to incentivise the uptake of ZLEV, a crediting system is introduced. From the 2019 to 2024 reporting periods, each ZEV is counted twice for the conformity assessment of a manufacturer. From 2025 reporting period onwards, each ZEV beyond a ZLEV benchmark of 2% of the manufacturer's new fleet is counted twice. LEV are counted with a multiplier between 1 and 2, depending on their level of CO_2 emissions.

14.1.4 Governance elements

In order to reinforce the effectiveness of the Regulation, it provides for (i) the verification of CO_2 emissions of vehicles in-service and (ii) measures to ensure that the emission test procedure yields results which are representative of real-world emissions.

<u>In-service verification of CO2 emissions</u>

Article 13 requires manufacturers to ensure correspondence between the CO_2 emissions recorded in the certificates of conformity of the vehicles and the CO_2 emissions of in-service vehicles. Type-approval authorities are responsible for verifying this correspondence in selected vehicles and to verify the presence of any strategies artificially improving the vehicle's performance in the type-approval tests. Based on their findings, type-approval authorities shall, where needed, ensure the correction of the certificates of conformity, and may take other necessary measures set out in the Type-Approval Framework Regulation.

The guiding principles and criteria for the procedures for performing the in-service verifications will be set out in a delegated act that will be followed by an implementing act setting out the detailed rules on the procedure itself.

<u>Real-world emissions and the use of on-board fuel and/or energy consumption monitoring devices (OBFCM)</u>

In order to ensure the real-world representativeness of the CO_2 emissions determined using the VECTO certification and to prevent a gap between type approval emissions and real-world emissions, the Commission shall create the necessary technical requirements for monitoring the actual fuel consumption on-board of new heavy-duty vehicles and define procedures for the collection of the related relevant data.

15. ANNEX 6: RESPONSE TO COVID

1.18. 15.1 Effect of the Covid crisis

COVID-19-related measures took their toll on many economic sectors, including the automotive sector. Because of global lockdown measures due to the sanitary crisis, mobility fell by an unprecedented amount in the first half of 2020. Road transport activity in regions with lockdowns in place dropped between 50% and 75%, while global average road transport activity fell to almost 50% of the 2019 level by the end of March 2020. Immediately after the crisis outbreak, public-transit ridership had fallen 70 to 90% in major cities across the world, and operations were significantly impacted by uncertainty and strict hygiene protocols - such as compulsory face masks and health checks for passengers.[45]

Road freight transport was significantly and negatively impacted at global level. The greatest disruption occurred during the first wave of the pandemic, and consequent lockdown, in spring 2020. It brought manufacturers to a standstill for an average of 30 working days while demand of vehicles decreased following uncertainty among drivers and transport operators.[46]

Although the sector recovered from summer 2020 following the lifting of border closures and the return of business activity and household consumption, the activity underwent another slowdown as the virus rode a second contagion wave during Autumn 2020.[47] Many European countries were forced to bring back restrictive measures, partially closing economies. Nonetheless, most factories and plants reopened, and have remained in operation since then, relaunching production after the first lockdown.

The economy recovered gradually along the third quarter of 2020 as containment measures relaxed, allowing businesses and household spending to resume. As a result, EU-27 GDP fell by 5.9% in 2020 in the context of a global GDP contraction of 4.2%. Registration of new lorries and buses over 3.5t decreased by, respectively, -25.7% and -20.3% from 2019 to 2020.

As the EU economy recovered its GDP by 5.1% along 2021, the HDV EU registration figures showed reaction in 2021 compared to 2020 (+16.8% lorries and +2.75% buses).[48] Final 2021 production figures across the factories in the EU (including not only EU registration but also exports) are still below the 2019 watermark: -13.3% for lorries and -12.5% for buses and coaches:[49].

The current situation must be placed in the broader context of the economic crisis worldwide both from the demand- and supply-side perspectives.

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[45] McKinsey. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-impact-of-covid-19-on-future-mobility-solutions

[46] ACEA. https://www.acea.auto/press-release/covid-stakes-are-high-for-european-automotive-recovery-new-facts-and-figures-show/

[47] Impacts of the COVID-19 pandemic on EU industries. European Parliament. https://www.europarl.europa.eu/RegData/etudes/STUD/2021/662903/IPOL_STU(2021)662903_EN.pdf

[48] ACEA. EU Commercial vehicle registrations. https://www.acea.auto/cv-registrations/commercial-vehicle-registrations-19-8-five-months-into-2022-17-7-in-may/

[49] ACEA. EU comercial vehicle production. https://www.acea.auto/figure/eu-commercial-vehicle-production/

Sales of **semiconductors (chips)** to the motor vehicle industry decreased globally during the second quarter of 2020. This shortfall was more than offset by a strong demand for computer and electronic equipment owing to the shift to remote working and distance learning. However, once the global recovery took hold, and though demand for new vehicles picked up again, manufacturers had to deal with shortage of key components including chips among others. The global production of chips was, and still is not, sufficient to meet the global surge in demand from the motor vehicle industry.[50]

The most immediate and obvious consequence of manufacturers not having enough chips to produce electronic products is that there is not enough supply to meet a recovering demand. Vehicles' production has subsequently faced periodic standstills and periodical and irregular production pauses.[51] [52] [53]

In order to respond to both the issue of the chips supply chains and the recovery from the Covid crisis, a number of actions have been taken, as summarized hereinafter.

1.19. 15.2 Responses on the issue of securing supply chains: chips

Recent global semiconductors shortages made more evident the extreme global dependency of the semiconductor value chain on a very limited number of actors in a complex geopolitical context. Chips are strategic assets for vehicles manufacturing and other key industrial value chains. Semiconductors are also at the centre of strong geopolitical interests, conditioning the capacity of countries to act.

Coordinated efforts from Member States resulted in the Joint Declaration on Processors and Semiconductor Technologies signed in December 2020 to working together towards bolstering Europe's electronics and embedded systems value chain.

In July 2021, the European Commission launched the Industrial Alliance on Processors and Semiconductors with the objective to identify current gaps in the production of microchips and the technology developments needed for companies and organisations to thrive. The Alliance will help foster collaboration across existing and future EU initiatives as well as playing an important advisory role and providing a strategic roadmap for the Chips for Europe Initiative, along with other stakeholders.

In February 2022 the Commission proposed the European Chips Act comprising three main components:

- a **Chips for Europe Initiative** to support large-scale technological capacity building and innovation in cutting-edge chips; this includes the ***Chips Joint Undertaking*** resulting from the strategic reorientation of the existing Key Digital Technologies Joint Undertaking making available €11 billion to strengthen existing research, development and innovation on the matter;
- a new framework to attract large-scale investments in production capacities and ensure the security of supply;
- a coordination mechanism between the Member States and the Commission to monitor market developments and anticipate crises.

[50] European Central Bank. Economic Bulletin Issue 4, 2021.

[51]. https://traton.com/en/newsroom/press-releases/press-release-22092021.html

[52] Volvo Says Semiconductor Shortage Impacting Truck Production.

[53] https://www.cnbc.com/2022/06/22/daimler-trucks-says-its-facing-enormous-supply-chain-pressure.html

In the short term, the European Chips Act will allow to understand and anticipate future chips crises, addressing them through close coordination with Member States and equipping the Union with the instruments that some like-minded countries have at their disposal. The Act will strengthen manufacturing activities and support scale-up and innovation across the whole value chain addressing security of supply and a more resilient ecosystem. And, in the mid- to long-term, it will reinforce Europe's technological leadership while preparing the required technological capabilities that would support transfer of knowledge from the lab to the fab and position Europe as a technology leader in innovative downstream markets. This will enable the EU to reach its ambition to double the current chips market share to 20% in 2030 in coherence with the Europe's Digital Decade Targets.

1.20. 15.3 Responses in terms of incentives and recovery packages

Shortly after the breakout of the pandemic and the deployment of the first containment measures adopted by Member States, the EU brought forward an ambitious support package to repair the economic and social damage triggered by the health crisis and set the Union on the path to a sustainable and resilient recovery.[54] Member States and the Commission announced a series of measures to support the economic recovery of the private sector, including the automotive segment. Noticeably, the recession was finally not as deep as expected in 2020[55] despite reintroduction and tightening of containment measures by Member States along Autumn 2020 in response to the 2nd wave. Stimulus packages and recovery measures have also been instrumental for attenuating the recession.

The support package includes the Recovery and Resilience Facility (RRF) as the key instrument at the heart of NextGenerationEU to help the EU emerge stronger and more resilient from the crisis. The RRF is a temporary recovery instrument, fully aligned to the REPowerEU Plan,[56] to mitigate the economic and social impact of the coronavirus pandemic and make European economies better prepared for the challenges and opportunities of the green and digital transitions. Lessons have been learned from the 2008-2009 crisis in this respect[57]: Targeted measures towards stimulating the recovery of the automotive sector from different Member States shortly emerged, including the fleet renovation of heavy-duty vehicles.

For instance, On June 2020, the German government agreed to a €130 billion COVID-19 economic recovery package including about €8 billion to support the automotive industry and accelerate the transition to electric mobility.

1.21. 15.4 Broader impacts on activity patterns

Beside challenges and economic immediate downturn, the COVID-19 has led to an acceleration of the green transition in the automotive sector and to some positive outcome:

- **There is evidence already that the current crisis will not slow down the zero-emission shift**. On the contrary, main manufacturers in the EU have already

[54] Identifying Europe's recovery needs. SWD(2020) 98 final. Staff Working Document accompanying the Communication "Europe's moment: Repair and Prepare for the Next Generation".
[55] See Winter 2021 Economic Forecast: A challenging winter, but light at the end of the tunnel https://ec.europa.eu/commission/presscorner/detail/en/ip_21_504
[56] COM(2022) 231 final.
[57] ICCT – Briefing (May 2020) – Green Vehicle Replacement Programs as a response to the COVID-19 crisis: Lessons learned from past programs and guidelines for the future.

expressed meaningful ZEV objectives for 2025, 2030 and 2040 (see Annex 7 - Announcements by manufacturers and availability on zero-emission vehicles).

- **Powertrain electrification**: Demand and supply were already shifting towards electric and electrified vehicles, driven by CO_2 regulation and technological progress, e.g., improved battery chemistry, increased range, high-performance charging.
- **Last-mile delivery and autonomous cargo transportation.** Companies involved in last-mile delivery, which were quite active prior to the pandemic crisis, are set to gain from the Retail, e-commerce and logistics companies should increase investment in technologies and innovation.

16. ANNEX 7: INTRODUCTION, PROBLEMS AND DRIVERS - COMPLEMENTARY INFORMATION -

1.22. 16.1 Description of the heavy-duty vehicles sector: complementary data.

16.1.1 Introduction

During 2020, 436 000 lorries over 5t were manufactured in the EU across 29 assembly plants concentrated in a few countries, in particular Germany, the Netherlands, Belgium, France, Sweden and Spain. 36.5% of the vehicles were exported worldwide generating a trade surplus of €4.9 billion. Regarding buses, half of the nearly 60 000 units manufactured in the EU were finally exported, representing nearly EUR 1 bn in revenues. In 2021, despite the COVID crisis, the exports generated a trade balance surplus of EUR 4.3 billion, compared to EUR 5.2 billion registered during 2019.[58]

16.1.2 Heavy-duty vehicle manufacturers

The market distribution of the different heavy-duty vehicles segments varies in nature across the several types, sizes, and powertrains of vehicles.[59]

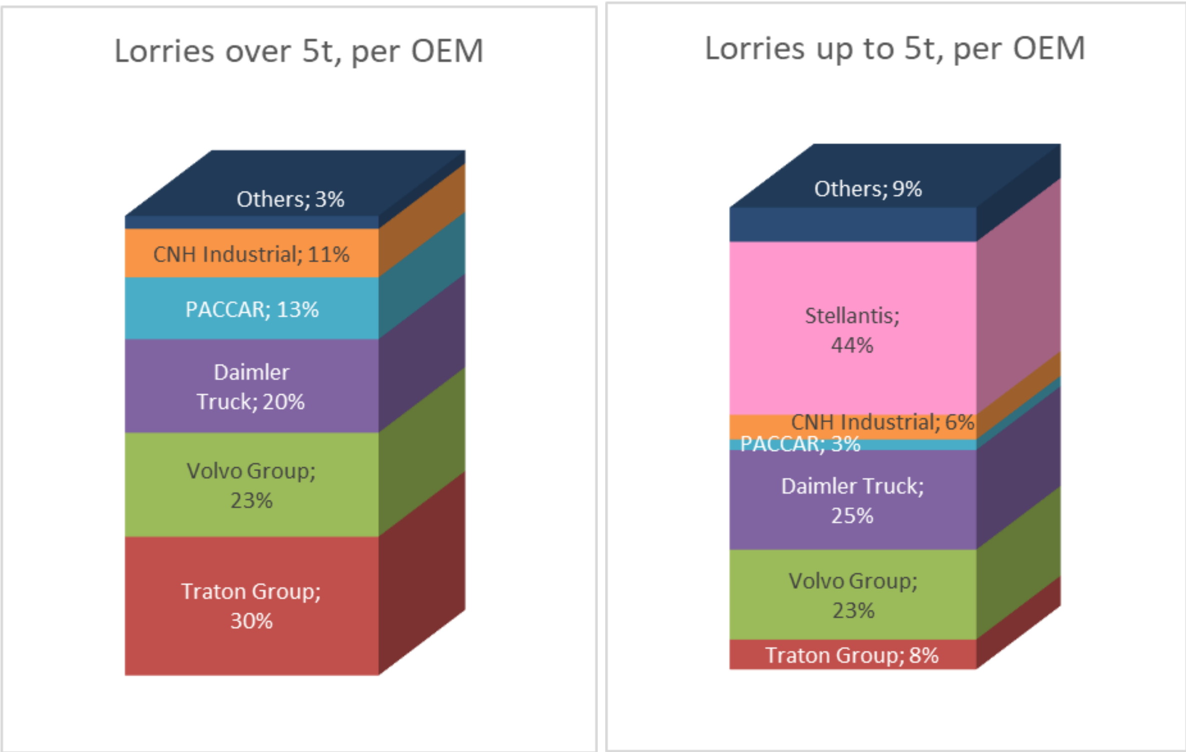
Lorries

On lorries covered by SCOPE 1 with TPMLM over 5t., five major manufacturers dominate the EU lorry market summing up to a combined share of over 97%. The picture gets more diverse for unregulated lorries with TPMLM up to 5t, as shown below in **Figure 5**.

[58] Data source: ACEA.

[59] Data source: EEA, based on MS reported registration statistics. Second half of 2021 not available when drafting this report.

Figure 5. EU Market share per manufacturer (OEM) - newly registered lorries along 2020 and first half of 2021



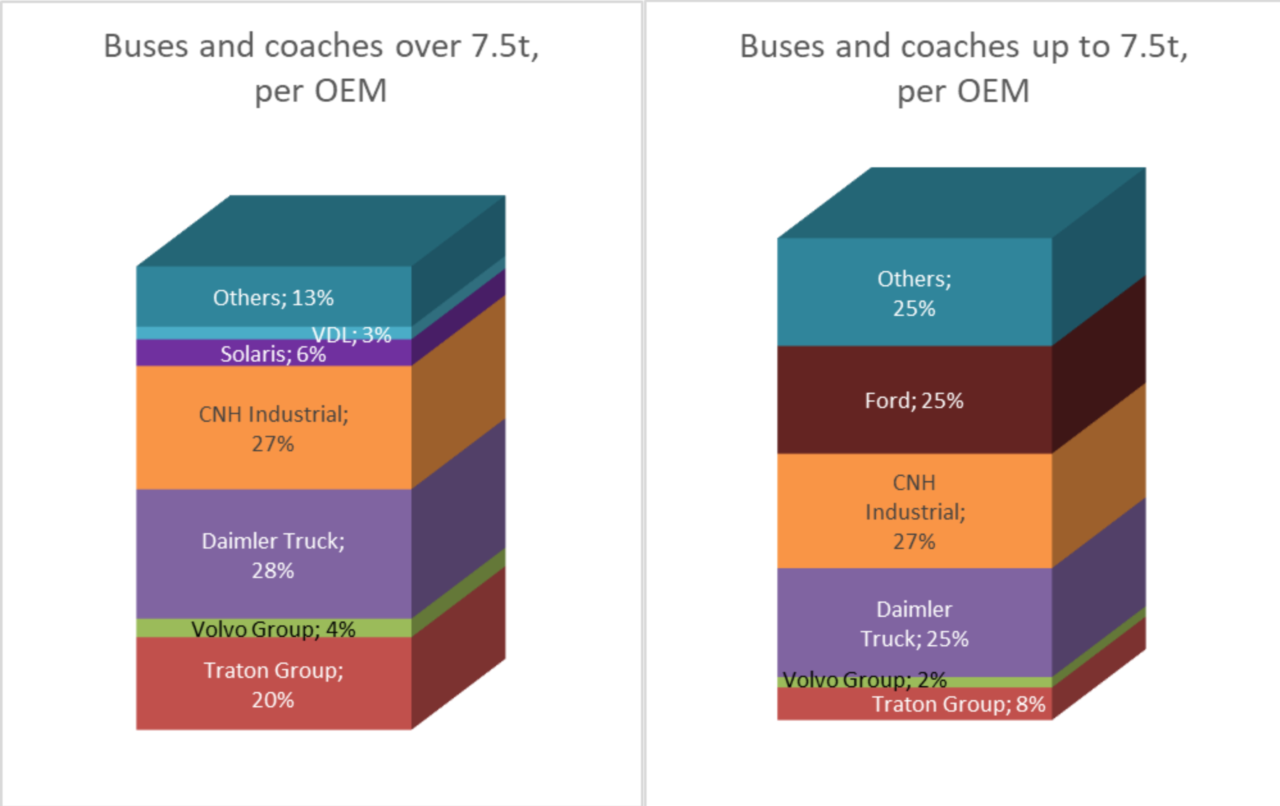
Main lorries' manufacturers registering vehicles in the EU and common trademarks are:

- Traton Group: Scania, MAN, Volkswagen
- Volvo Group: Volvo, Renault
- Daimler Truck: Daimler, Mercedes-Benz, Fuso
- PACCAR: DAF
- CHN Industrial: IVECO
- Stellantis: FCA, Fiat

Buses and coaches

This trend is also present for the buses and coaches market, where five manufacturers produce up to 85% of primary vehicles registered in the EU, while there is more diversity in unregulated vehicles below 7.5t. 1 out of 4 lorries under 5t are registered by a variety of manufacturers, as illustrated in **Figure 6** below.

Figure 6. EU Market share per manufacturer (OEM) - newly registered buses and coaches along 2020 and first half of 2021



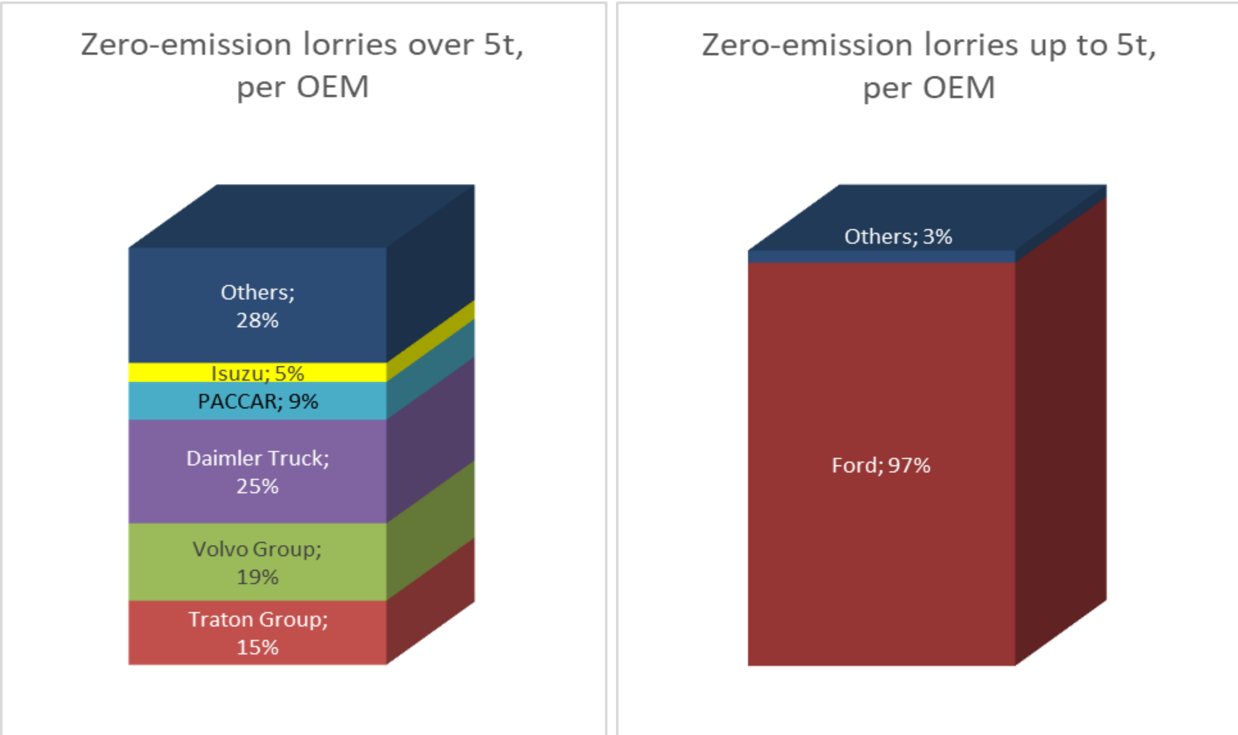
16.1.3 Zero-emission heavy-duty vehicles market

Compared to the general vehicles market dominated by ICE-based models, the zero-emission HDV market in Europe encompass a more varied group of manufacturers with a significant presence in these early market phases.

Indeed, the five largest manufacturers hold 72% of the zero-emission lorries market share (compared to 97% when all powertrains are accounted, see previous section) as shown in **Figure 7.** EU Market share per manufacturer (OEM) - newly registered zero-emission lorries along 2020 and first half of 2021. On smaller lorries up to 5t, Ford holds a significant presence due to a specific ZEV procurement initiative by Deutsche Post in Germany.[60]

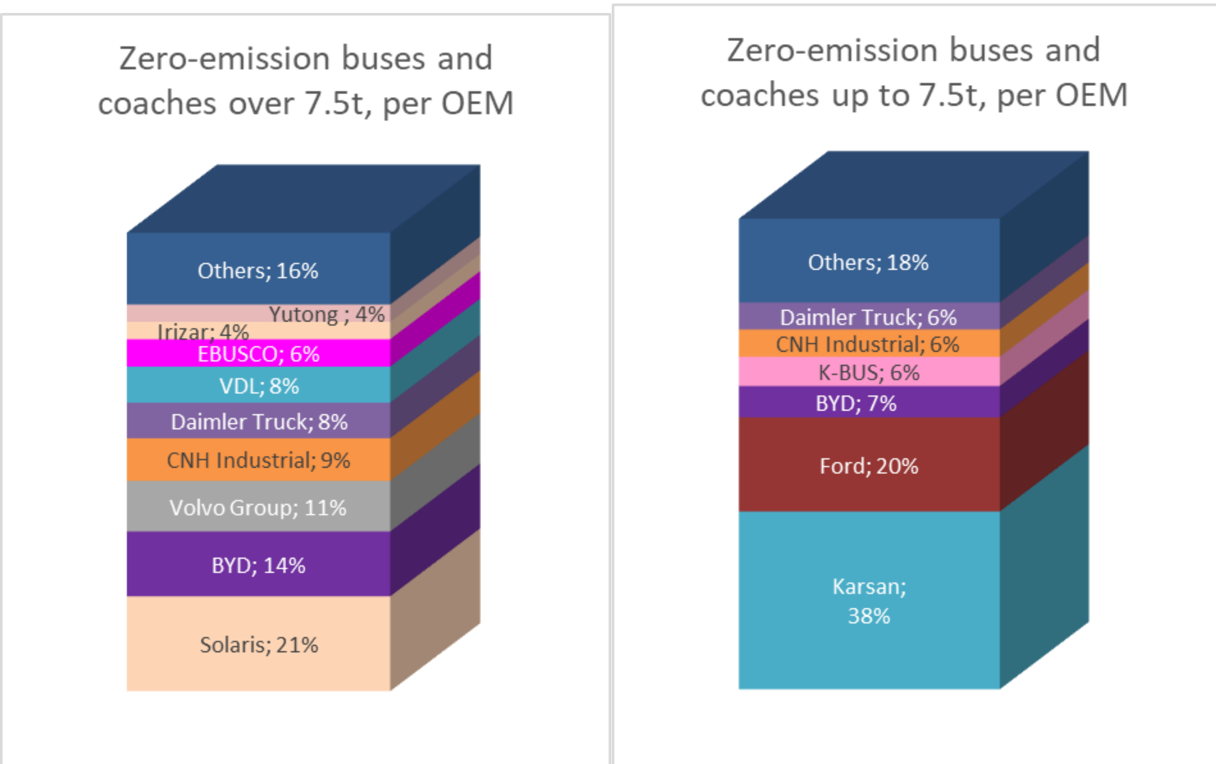
[60] https://www.dw.com/en/ford-deutsche-post-kick-off-streetscooter-xl-production/a-45810020

Figure 7. EU Market share per manufacturer (OEM) - newly registered zero-emission lorries along 2020 and first half of 2021.



The zero-emission buses and coaches market is particularly varied. Along 2020 and first half of 2021, the key players in zero-emission buses and coaches over 7.5t sales were Solaris (21% share), BYD (14%) and Volvo Group (11%). The complete breakdown is presented in **Figure 8**. It is noteworthy that, unlike in the general market of buses, non-European manufacturers have a significant market stake - around one fifth.

Figure 8. EU Market share per manufacturer (OEM) - newly registered zero-emission buses and coaches along 2020 and first half of 2021.



16.1.4 Heavy-duty vehicles registrations per EU-27 country

Figures below represent the market share per Member State for both lorries and buses. The breakdowns are particularised also for those vehicles within SCOPE 1: lorries with TPMLM above 5t and buses and coaches over 7.5t.

Figure 9. New lorries over 5t - registration percentage per Member State along 2020 and first half of 2021

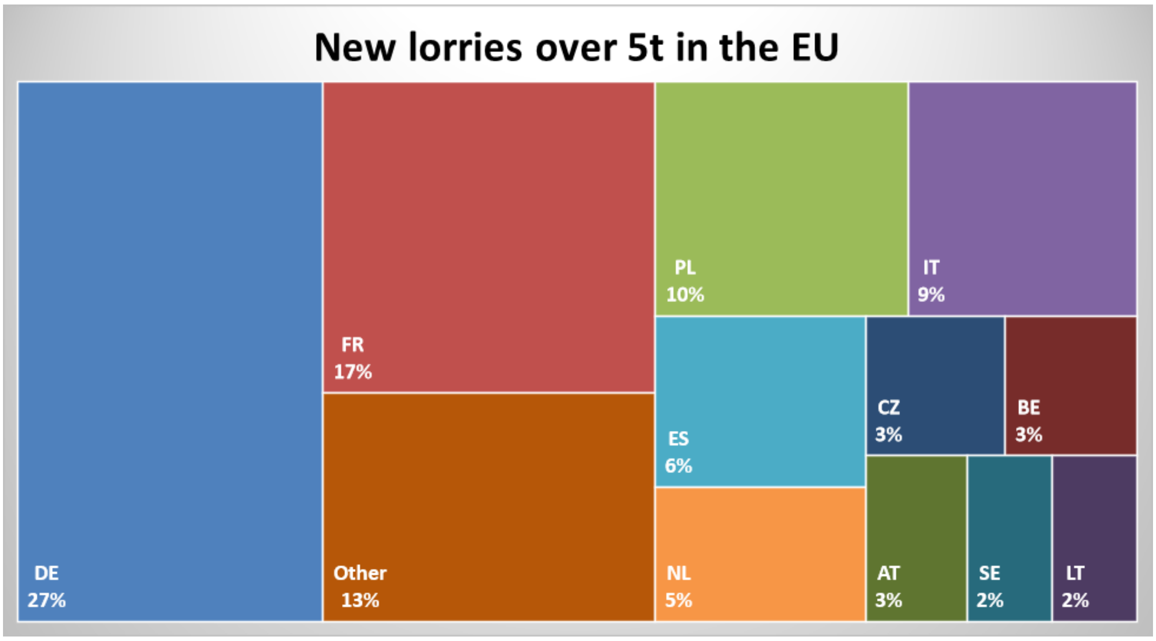


Figure 10. New lorries (over 3.5t) - registration percentage per Member State along 2020 and first half of 2021

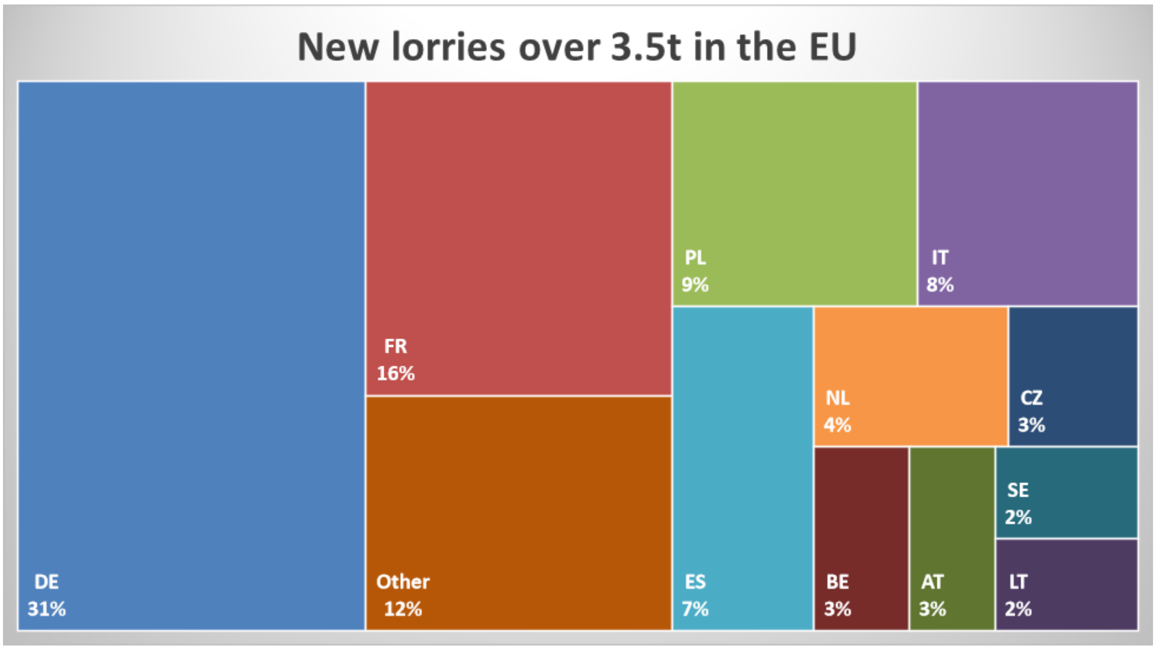


Figure 11. New buses and coaches over 7.5t - registration percentage per Member State along 2020 and first half of 2021

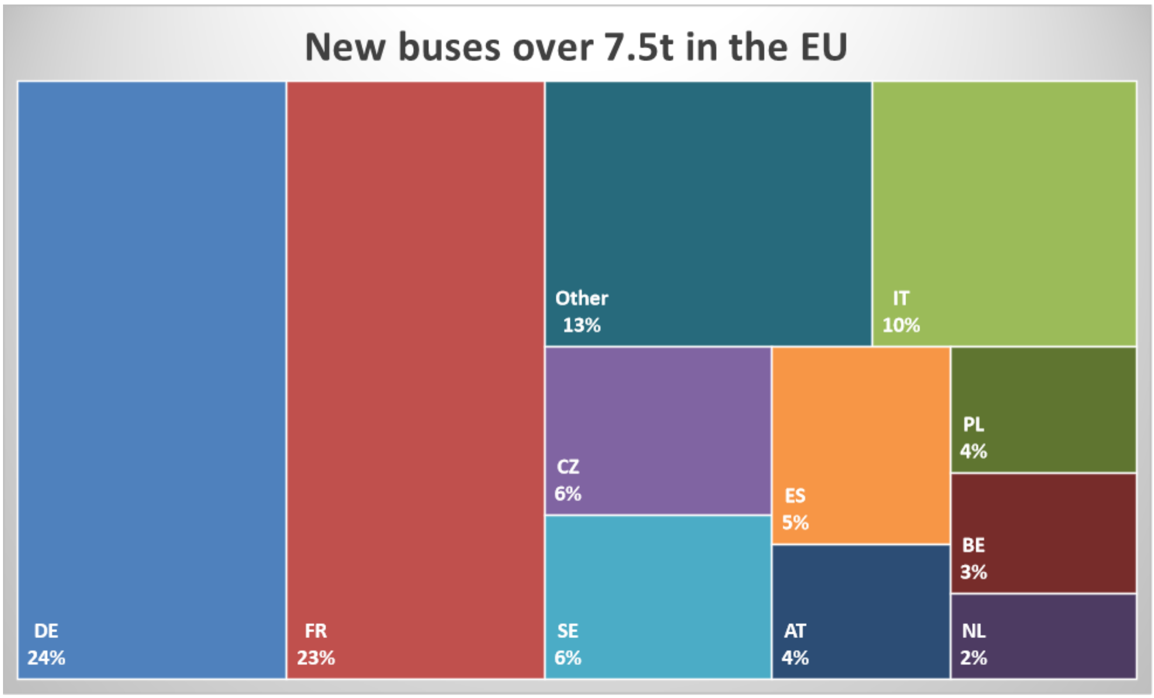
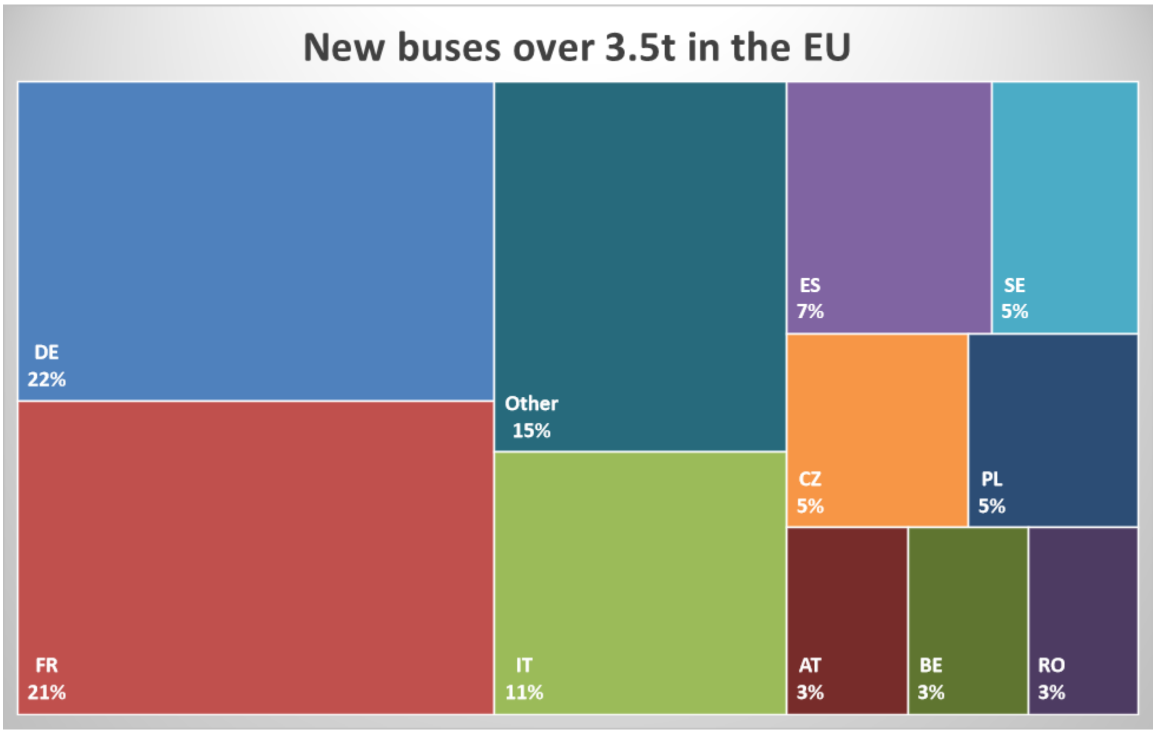


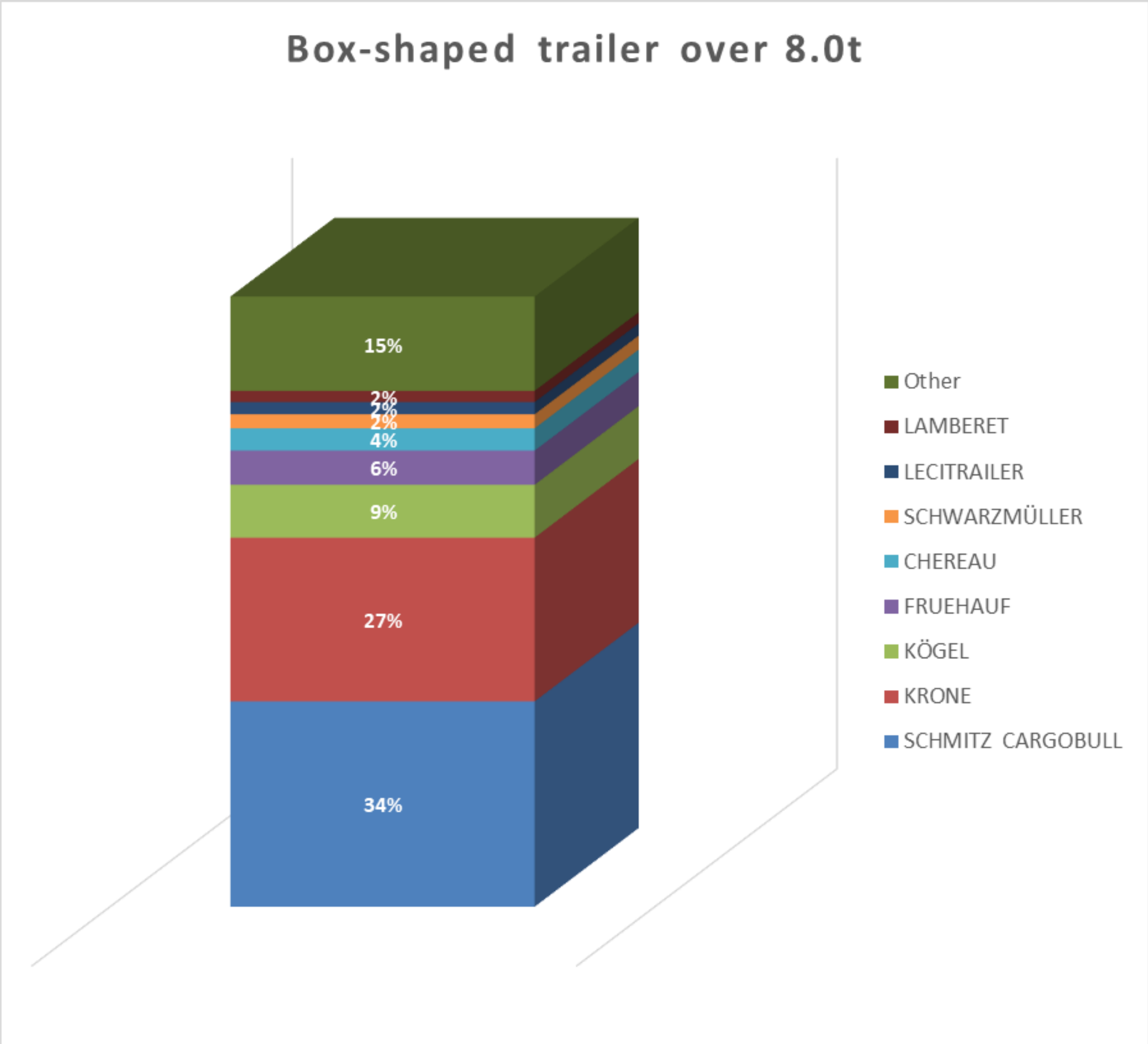
Figure 12. New buses and coaches (over 3.5t) - registration percentage per Member State along 2020 and first half of 2021



16.1.5 Trailers

The largest manufacturers offer a range of standardized vehicles (box-shaped bodywork) produced in large quantities, leaving specialized trailers to smaller companies who build highly customized products. There is also a high number of very small companies building only a few trailers per year for their customers. Actually, as explained in Annex 8, over 90% of companies manufacture only 5% of trailers. The following **Figure 13**Error! Reference source not found. illustrates however, how eight manufacturers only, 2% of total, cope with 85% of the market.

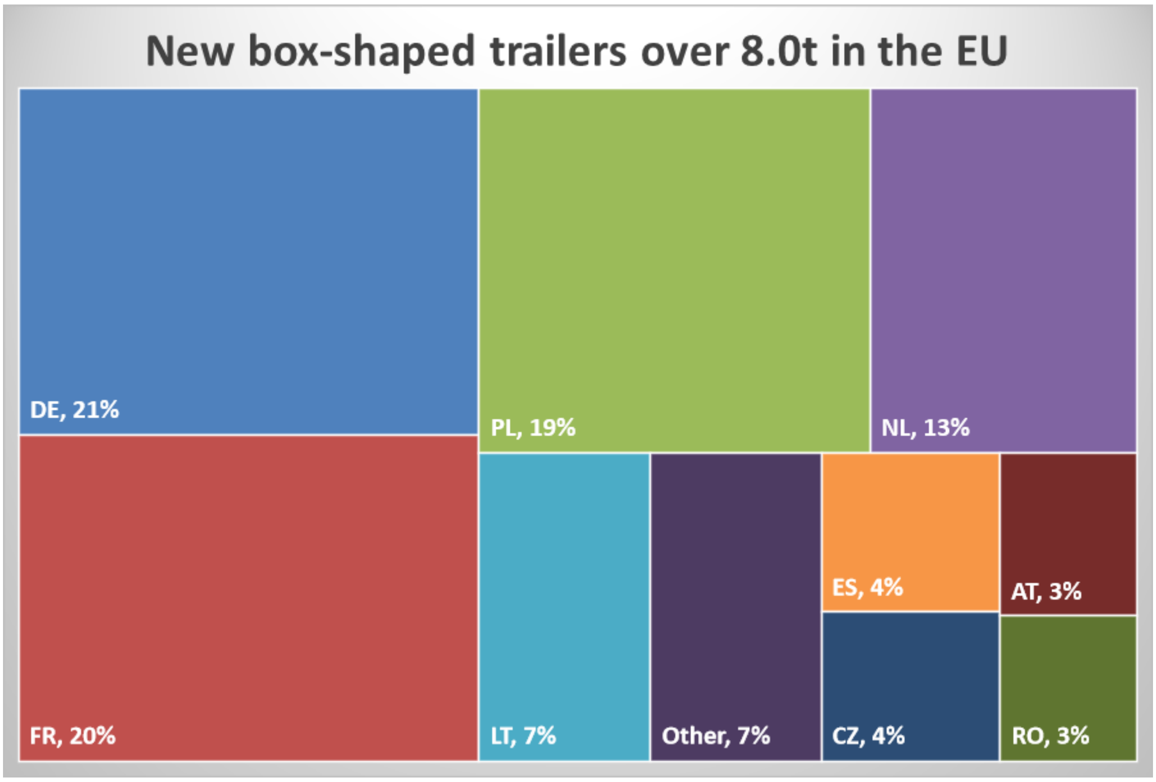
Figure 13. EU Market share per manufacturer (OEM) - newly registered box-shaped trailers along 2020 and first half of 2021.



The **Figure 14** below shows the market share of box-shaped trailers above 8.0t per Member States for which data are available[61].

[61] Data missing or incomplete from the following Member States: BE, CY, DK, HR, HU, IE, IT and MT.

Figure 14. New box-shaped trailer (over 8.0t) - registration percentage per Member State along 2020 and first half of 2021



16.1.6 Transport operators

The road freight and passenger transport sector in the EU broadly consists of one million companies from which 80% are SMEs.[62] Only the road freight service sector employees 2.85 million people working in more than 550,000 enterprises across the EU.[63] Small transport companies holding no more than five HDV in their fleet are quite abundant.[64] 30% of commercial road transport companies hold no more than 25 vehicles in their fleet (source: IRU)

[62] IRU, December 2021. Position paper on the European Commission proposal on the deployment of AFIR
[63] The figure includes road haulage together with waste management and removals, but exclude post and courier services, manufacturing or retail. Source: Eurostat.
[64] IRU, December 2021. Position paper on the European Commission proposal on the deployment of AFIR.

1.23. 16.2 Description of the heavy-duty vehicles sector: Announcements by manufacturers and availability on zero-emission vehicles.

The below **Table 7** presents information on recent announcements by main European manufacturers of heavy-duty vehicles, based on publicly available information and sources. The announcements are very diverse, sometimes published on the official websites, sometimes only referred to in specialised press. They are not always very clear and specific on the type of vehicles (e.g., fossil-free vehicles would well refer either to ZEV or conventional ICE burning only zero-carbon fuels), but they illustrate their technology readiness paving the intention to make zero-emission mobility the backbone of the heavy-duty fleets.

Table 7. Summary of manufacturers announcements.

Manufacturer	Announcements	Type of vehicles	Year
Daimler Trucks	60% 100% buses 100%	ZEV* (BEV**+FC***) ZEV CO_2-neutral in driving operation ("from tank to wheel" in Europe, North America and Japan).	2030 2030 2039
Volvo Group ***Volvo trucks*** ***Renault trucks***	35% 50% 100% 35% 50% 10% 35%	100% electric (presumably BEV) ZEV* (BEV + FC) Net-zero GHG emissions BEV ZEV (BEV+FC) ZEV ZEV	2030 2030 2040 2030 2030 2025 2030
Traton Group ***Scania*** ***MAN***	50% 10% 50% 90%-100% 50% buses 90% buses 60% delivery trucks 40% long-haul trucks	BEV BEV BEV BEV BEV BEV BEV BEV	2030 2025 2030 2040 2025 2030 2030 2030
CNH Industrial	none		
PACCAR	none		

** zero-emission vehicle (100% electric by any means or hydrogen-powered).*
*** battery-electric vehicle.*
**** fuel-cell hydrogen powered.*

The transition to zero-emission HDVs is currently led by BEV since battery-electric powertrains have achieved pilot- or commercialization-stage technological readiness across multiple uses, though limited to certain ranges application (ca. 250-300 km maximum). BEV urban buses, medium-duty delivery lorries and refuse trucks are now being commercialized. Short-range BEV delivery lorries and yard trucks (lorries that move trailers and containers in freight terminals, port facilities, etc. for short distances) have reached the mid- to late-pilot stage and are being commercialized at small scales. In fact, there is increasing consensus among truck manufacturers that BEVs will play a dominant role in the decarbonisation of the road freight sector. Around 50 BEV models have already been announced for series production until 2023.[65]

Some manufacturers as Daimler, MAN, Scania and Volvo, expect starting production by 2024 of fully electric long-haul lorries able to perform up to 500 km.[66]

For heavier lorries, however, the availability of models varies by vehicle application and powertrain. Although hydrogen claims its future stake as range needs increase, especially over 500 km, some manufacturers are confident in that future battery technology developments will enable even 1,000 km range for BEV as a feasible option in the coming years. Fuel cell hydrogen lorries are, at the best, at the early pilot stage and slowly moving to commercial-scale deployment in Europe as from 2025-2026. Indeed, the Volvo Group and Daimler Trucks expect covering some long-range needs based on joint venture fuel cell development, while the Traton Group focuses on full electric models and CNH Industrial aims at bringing BEV vehicles to the market by 2022 and hydrogen Fuel Cell by 2023, based on its alliance with US manufacturer Nikola.

Tesla claims that the fully electric 800-km range Tesla Semi would be firstly delivered in the USA by end 2022.[67]

16.2.1 Manufacturers' announcements

DAIMLER TRUCK

- Daimler Truck -the world's largest truck maker- is outspoken on relying zero-emission mobility to cover most of uses in the future and this way reaching the ultimate goal of having CO_2-neutral transport on the road by 2050. As it takes about ten years to completely renew a fleet until 2050, Daimler Truck's ambition is to offer only new vehicles that are "CO_2-neutral in driving operation, from tank to wheel" in Europe, North America and Japan by 2039.[68]
- According to some corporate sources, the term "CO_2-neutral" seems to include only battery electric and hydrogen-based vehicles, i.e., zero-emission vehicles.[69] Other

[65] IEA. Global EV Outlook 2022. Securing supplies for an electric future.
[66] See Mercedes eActros long-haul 500km range https://www.arenaev.com/mercedesbenz_eactros_longhaul__electric_truck_with_500_km_range-news-736.php and
[67] https://topelectricsuv.com/news/tesla/tesla-semi-all-we-know-feb-2022/#Production_Release_Date
[68] Daimler Truck. On the road to CO_2-neutral transport. Consulted 17 June 2022.
[69] *Truly CO2-neutral transport only works with battery electric or hydrogen-based drive. That's why Daimler Truck is consistently focusing on battery electric and hydrogen-powered commercial vehicles that can drive locally CO2-neutral.* We focus on these locally CO2-neutral technologies. Consulted 17 June 2022.

statements claim that fully CO_2-neutral transport can be accomplished through zero-emission vehicles.[70]

- Daimler Truck has a dual zero-emission strategy: Both BEV and FC (liquid hydrogen) technologies would be needed and are complementary, depending on specific use cases. Daimler is quite confident in the rapid development of battery and fuel cell technologies, for what overhead electrified lines (catenaries) are considered, in principle, as "impossible to implement as a practical matter"[71] or "as a realistic and timely solution".[72] As well, it seems it abandoned the development of gas-powered trucks.[73] [74]
- Ramp-down of fossil by significantly reducing ICE spending: vast majority of R&D spending to be ZEV-focused by 2025. Full ZE product line-up set by 2027.

VOLVO GROUP (VOLVO TRUCKS, RENAULT TRUCKS)

- Volvo group commit to reach 35% BEV and 50% ZEV sales in the EU by 2030.
- As Daimler, Volvo has a dual zero-emission based on both BEV and FC vehicles depending on the application needs. The company is committed to offer by 2023 a 100% electric option for each market segment.
- Volvo expects to start reach FC vehicles customer tests by 2024, entering volume sales in the second half of the decade both for Volvo and Renault.

TRATON GROUP (SCANIA, MAN, VOLKSWAGEN TRUCK & BUS)

- Traton prefers BEV for achieving zero-emission mobility. Though the company recognizes that hydrogen may play a role in some niches needed of longer ranges as some difficult long-haul applications and coaches, the company is clear about

[70] *Fully CO_2-neutral transport can be accomplished through electric drive trains with energy coming either from batteries or by converting hydrogen on board into electricity.* Daimler Truck. On the road to CO_2-neutral transport. Consulted 17 June 2022.

[71] *[…] overhead electric lines would require a comprehensive, Europe-wide infrastructure over thousands and thousands of kilometres. The associated planning processes would be highly complex, lengthy and fraught with great uncertainty. This technology is therefore impossible to implement as a practical matter. Rigid overhead lines would also deprive freight forwarders of what is so important to them in their daily transport jobs: Flexibility. Political decision-makers should therefore not invest any additional funds in expensive pilot programs. Time and money are precious and urgently needed elsewhere.* Daimler Truck. The right way to emission-free transport.

[72] *Due to the high infrastructure costs involved, and also considering of the rapid development of battery and fuel cell technology, the company we do not see potential in catenary trucks at present. Daimler Truck is not against catenary trucks, but for realistic and timely solutions. We are convinced that with the battery electric truck we have a flexible and already available concept for the respective field of application - without expensive, time-consuming and lengthy planning measures.* We focus on these locally CO2-neutral technologies. Consulted 17 June 2022.

[73] *However, natural gas drives also emit CO_2 and would only be an expensive transition technology on the road to CO_2-neutral transport. Therefore it's not worth pursuing natural gas further.* Martin Daum, Chairman of the Board of Management Daimler Truck AG & Member of the Board of Management Daimler AG. The road to CO_2-neutral transport | Daimler Truck AG, consulted 17 June 2022. Also: *Natural gas is a fossil fuel - and therefore it is at most a transitional technology on our way to CO2-neutral transport.* We focus on these locally CO2-neutral technologies. Consulted 17 June 2022.

[74] *We can't allow ourselves to get bogged down and continue to pursue all possible development paths. Natural gas drives, for example, are not CO_2-free and are therefore just an expensive bridge technology.* The right way to emission-free transport.

considering the superiority of electricity as the better alternative from a technical and economic perspective. This is clearly reflected in its investment roadmap.[75]

- Scania, likewise, ditches FC trucks to focus on full electric. The company plans to bring out at least one new electric product application in the bus and truck segment every year. Electric vehicles would make up around 10% of Scania's European unit sales in 2025. By 2030, 50% of all vehicles sold by Scania will be electric while the 2040 goal oscillates between the 90% as endorsed in the Global Memorandum of Understanding for ZEVs and the 100% claimed by the company CEO.
- MAN presented its Zero-Emission Roadmap in October 2019 being BEV the main choice while hydrogen would play the complementary role for some long-haul transport needs. 500 km-range BEV long-haul lorries are claimed to be produced as soon as in 2024 and just one year later, by 2025, half of MAN's new buses will be electric. At least 60% of MAN's delivery trucks, 40% of long-haul trucks and 90% of buses (BEV) will be zero-emission by 2030. MAN considers possible that 1.000 km-range BEV, able to recharge in just one hour, will be available "in a few years" thanks to expected big leaps in battery technology.
- Traton is scaling back investments in conventional drives for these to make up less than one-fifth of its product development in 2025 involving that, by then, the share of product development dedicated to electric mobility will have doubled.

PACCAR (DAF)

- No written commitments found on ZEV sales share.
- PACCAR develops some BEV options while explores hydrogen options for medium-long term together with Toyota and Shell.
- DAF does not see a role for CNG/LNG trucks due to technological practical challenges and non-advantageous WTW overall CO_2 emissions.

CNH INDUSTRIAL (IVECO)

- No commitments found on ZEV or ICE phasing-out.
- CNH Industrial has an exclusive alliance with US zero-emission manufacturer Nikola for developing and distributing both hydrogen-powered and BEV lorries.

16.2.2 Alliances among manufacturers

- **ELECTRIFICATION**

Traton, Volvo and Daimler: Binding agreement to implement and operate a high-performance public charging network for electric long-haul HDV throughout Europe as from 2022. €500 million investment to operate by 2027 at least 1,700 high performance 'green energy' points close to highways, ports and logistic centres. Joint Venture, equally owned by the three parties, pending of competence regulator's approval.

- **FUEL CELL HYDROGEN**

Cellcentric: Volvo and Daimler on hydrogen fuel cells. A 50/50 joint venture will have activities all along the value chain for fuel cell systems, from research and

[75] The future of trucks is electric | TRATON. https://traton.com/en/newsroom/current-topics/furture-transport-electric-truck.html

development through production to marketing of fuel cells, aiming at making Cellcentric a leading global manufacturer in hydrogen-powered HDV.

H2Accelerate: Mass-market alliance for the roll-out of fuel-cell hydrogen HDV among CNH Industrial, Volvo, Daimler, Shell and OMV.

- **ZERO-EMISSION TECHNOLOGIES**

CNH Industrial and Nikola: joint ventures both on electric and hydrogen fuel-cell technologies. Collaboration agreements to accelerate industry transformation towards zero emissions,

16.2.3 Vehicles' market

DAIMLER TRUCK

- Daimler Truck discloses abundant information about its many current and upcoming zero-emissions models according to a *Technology Strategy for the Electrification* for its vehicles.
- The company claims to be the first manufacturer in the world to present an e-truck, the Fuso eCanter, in short-series production since 2017 with 120 km range and up to 9.1t.
- The Mercedes-Benz eActros truck, with a range of up to 200 km, is in use in the EU since 2018 while medium-duty Freightliner eM2 and the heavy-duty Freightliner eCascadia are present in North America.
- Daimler Truck plans to start series-produced BEV trucks and buses in the main sales regions: Europe, USA and Japan, to be followed by the BEV eActros long-haul truck in 2024 (2 & 3-axes, 40t. 500 km range).
- The eEconic low-floor refuse truck, based on the e-Actros, is already being tested by some EU municipalities. Series production to start along 2022.
- On the hydrogen side, the aim is to hand over the first fuel-cell liquid-hydrogen trucks to customers by 2025. The fuel cell-powered GenH2, able to operate 40t up to a 1,000-km range will benefit from the Cellcentric joint venture with Volvo.

VOLVO GROUP

- Already in volume production: short to medium range trucks. Volvo FL Electric (urban and refuse truck, 317 kWh, 300 km, up to 16.7t)) and Volvo FE Electric (urban and vocational, up to 27t, 3-axle, 200 km) since 2019 in Europe. North America: Volvo VNR by late 2020.
- Start of production plans: long-haul trucks. Sales of the European BEV heavy-duty models, Volvo FM, FMX and FH (up to 44t) 300 km range trucks to begin by 2021, volume production by 2022.
- Renault truck D, urban delivery manufactured since March 2020: 395 kWh, 300 km range, up to 9.4t. Renault truck D 'Wide' enlarges capacity to 16t (26t if refuse truck). Preparations to market a tractor for regional and inter-regional transport from 2023 hydrogen fuel cells in long-haul transport after 2025.

TRATON GROUP

- Scania offers at the moment a single BEV truck equipped with 300 kWh battery capacity and able to move up to 29t. Based on this, a PHEV with reduced 90 kWh is also available.
- The company plans to deliver trucks capable of running for 4 hours with 40t or 3 hours with 60t, intended for regional transport, by 2023. By 2024 long-distance

electric trucks, adapted for fast charging during drivers' 45-minute rest breaks, would be capable of running 4-4.5h, depending on whether the vehicle weighs 40 or 60t.[76]

- MAN plans to start series production of electric trucks at its main plant in Munich from 2024. Currently, only the urban delivery eTGM is available (2020), in low-volume production.

PACCAR

- DAF CF, BEV for urban, refuse, local applications. Tractor 315 kWh, 220 km (4x2, 37t) and rigid 250 km (6x2, 29t), expected delivery by 2021. Based on this, plans to deliver PHEV 85 kWh, 50 km range.
- DAF LF, BEV for urban applications, 254 kWh battery capacity, range up to 280 km (4x2 rigid, 19t).

CNH INDUSTRIAL

- Aimed at bringing BEV vehicles to the market by 2022 and hydrogen FC by 2023 based on the alliance with Nikola.
- BEV Nikola TRE to be assembled in Ulm, Germany. 4x2 and 6x2 articulated lorry with modular and scalable batteries, capacity of up to 720 kWh. Production expected to start along 2022.

1.24. 16.3 Interaction between CO_2 emission standards for heavy-duty vehicles and other policies to deliver increased climate ambition in the road transport sector - complementary data on other policies.

This paragraph complements the analysis on the interactions among policies presented in paragraph 1.3 of the Impact Assessment, focusing on other transport related policies.

16.3.1 Complementary policies

The European Green Deal commits the Commission to a revision of ambient air quality legislation, notably to align air quality standards more closely with the World Health Organization recommendations. Furthermore, while the CO_2 emission standards incentivise the market deployment of zero-emission technologies, the emission standards on air pollutants (Euro VI and Euro 7) will aim at further reducing the pollutant emissions from internal combustion engine vehicles, which will still be used as long as there will be non-zero-emission HDV on the road.

The proposed **Batteries Regulation**[77] addresses the sustainability of batteries and sets requirements for the collection, treatment and recycling of waste batteries. It will also help addressing the issue of availability of critical raw materials, such as lithium, cobalt, and natural graphite.

The **Clean Vehicles Directive**[78] promotes clean mobility solutions and supports the demand for zero- and low-emission vehicles through public procurement.

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[76] https://www.scania.com/group/en/home/newsroom/news/2021/Scanias_commitment_to_electrification_our_initiatives_so_far.html

[77] COM(2020) 798

[78] Directive (EU) 2019/1161

The **Urban Mobility Package**[79] helps urban mobility become more sustainable. Its revision will provide urban nodes on the TEN-T of a strengthened role as enablers of sustainable, efficient and multi-modal transport.

Tyres sold in the EU are subject to energy labelling requirements.[80] Tyre labels aims at supporting operators and consumers in the purchasing decisions for more fuel-efficient tyres.

The **Eurovignette Directive**[81] and the **Energy Taxation Directive**[82] support the decarbonisation of road transport by contributing to the internalisation of the climate externality. The revised Eurovignette Directive includes the obligation for Member States to apply an external-cost charge based on the environmental performance and to vary road charges based on the CO_2 emissions of heavy-duty vehicles. The proposal for the **revision of the Energy Taxation Directive**[83] increases the current minima and does not allow the rate diesel used as motor fuels be lower than petrol used for the same purpose, in energy terms. The possibility for a preferential treatment for commercial vehicles would also disappear.

The **Directive on maximum authorized weights and dimensions**[84] rules the maximum dimensions of HDV for national and international use and the maximum weight of for international traffic. It is undergoing a review process which will look, among others, at the maximum dimensions permitted for ZEV (by longer lengths and higher weights).

16.3.2 Budgetary framework:

The EU's long-term budget - **Multiannual Financial Framework and the Next Generation EU** are specifically tailored to supporting the green transition and to enabling a framework for clean vehicles and technologies. 30% of Multiannual Financial Framework are dedicated to support climate action, including funding instruments for infrastructure investments (**Connecting Europe Facility, Cohesion and Structural Funds, InvestEU, blending with EIB instruments**), for the demonstration of innovative low-carbon technologies (**Innovation Fund**) and for research and development (**Horizon Europe** with 35% target in green investment R&D**, Battery Alliance**). The **Strategy for Financing the Transition to a Sustainable Economy**[85] will also help unlock the private investment needed, in addition to the available public funding.

1.25. 16.4 Problem 2 - Life-cycle analysis (LCA) considerations.

ZEV are, in general, intrinsically cleaner than conventional ICE vehicles as they do not produce tailpipe pollutant emissions. In addition, from the energy efficiency side, electric motors (and hydrogen fuel cells to a slightly smaller degree) are more efficient.

According to a study led by Ricardo on behalf of DG Climate Action "**Determining the environmental impacts of conventional and alternatively fuelled vehicles through**

[79] https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/urban-mobility/urban-mobility-package_en
[80] Regulation (EC) No 1222/2009
[81] Directive 1999/62/EC
[82] Directive (EU) 2021/0213
[83] https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3662
[84] Directive 2015/719/EU.
[85] COM/2021/390 final

LCA"[86] **(Life-Cycle Assessment),** considering all the processes involved , not only less energy is needed to drive a ZEV, but also their GHG impacts are lower.

The aim of this study was to improve the understanding of the environmental impacts of road vehicles over their entire lifecycle and the methodologies to assess them. The study has two main objectives:

- To develop an LCA approach for road vehicles including the fuels or electricity which power them, both for light and heavy-duty vehicles.
- To apply this approach to understand the impacts of methodological choices and data sources on the LCA results for selected vehicles with different types of powertrains and using different types of energy, which are expected to be in use over the period 2020 to 2050.

The assessment of impacts included a broad range of different impact categories (up to 14), ranging from impacts associated with airborne emissions (e.g. the mid-point indicator Global Warming Potential – GWP, for greenhouse gas emissions) to impacts from resource use. The impacts are studied across 14 different sensitivities exploring the significance and impacts of key assumptions and uncertainties for the comparative analysis of different vehicles/powertrain and fuel types including not only manufacturing process but also the end-of-life phase of vehicles.

The methodological choices made were generally in accordance with the norms set out for performing a LCA (ISO-14040 and ISO-14044).

The outputs from the study provide robust and internally consistent indications on the relative life-cycle performance of the different options considered, particularly for vehicle powertrain comparisons, electricity chains, and conventional fuels. The study also provides good evidence on how temporal and spatial considerations influence lifecycle performance and how potential future developments (in technology or electricity supply) are likely to affect these powertrain comparisons.

However, the methodology developed is not immediately suited for calculating the individual lifecycle emissions of individual vehicles, which would require an even more detailed and disaggregated approach.

In broad terms, the analysis shows that **ZEV powertrains have significantly lower environmental impacts, including the lifecycle GWP impact, across all vehicle types and most impact categories**. The analysis also demonstrates that these benefits in terms of lower environmental impacts vary depending on regional and operational circumstances.

Whilst there were differences in the relative performance of powertrains, predominantly due to differences in duty cycle, similar trends were confirmed: **heavy-duty ZEV, either lorries or urban buses, present notable environmental benefits, including a significant reduction of lifecycle GWP impacts, versus conventional liquid and gaseous fuels powertrains,** which increased in the medium to long term (2030 and 2050).

The dataset allows for the further investigation of individual impacts, as well as for comparing across different impact categories.

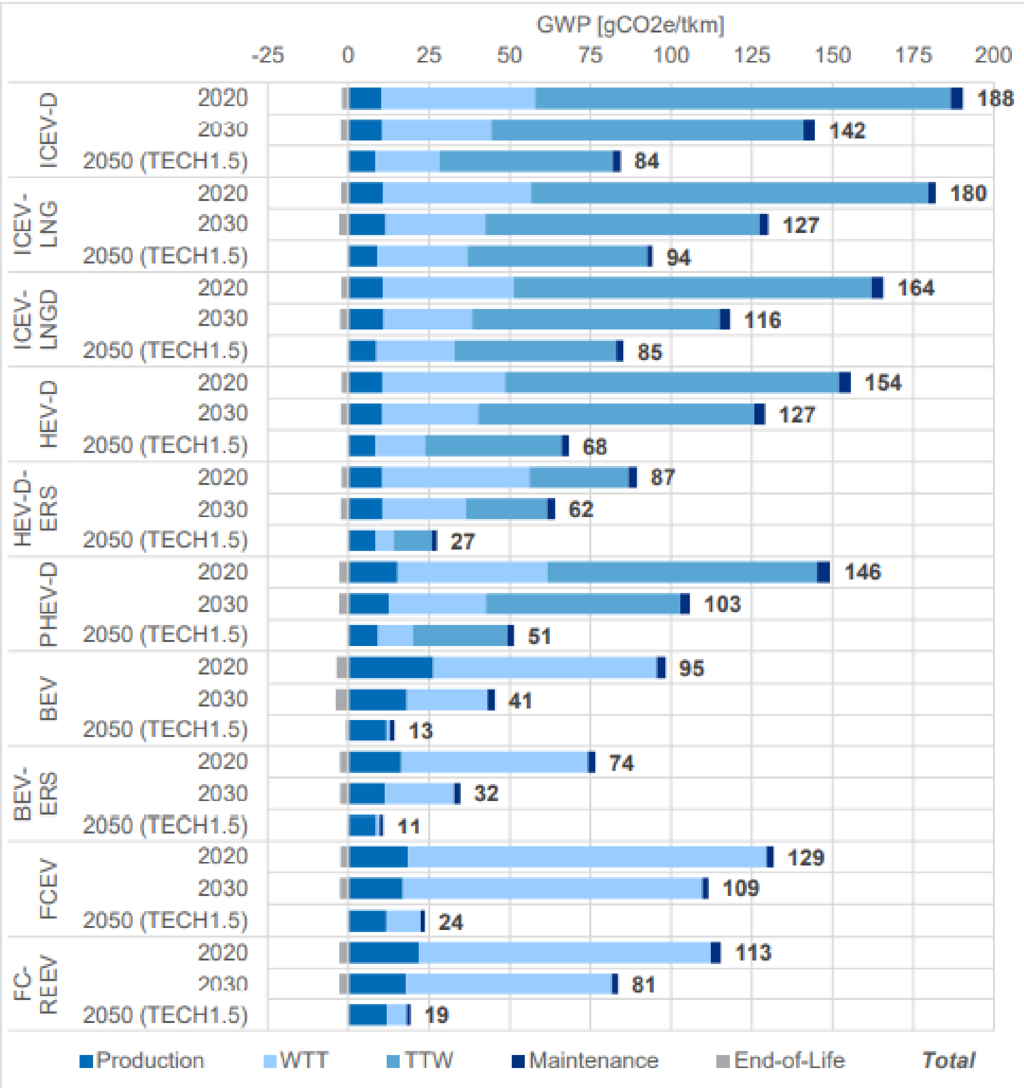
[86] Find all documents and datasets at DG CLIMA website: https://ec.europa.eu/clima/policies/transport/vehicles_en#tab-0-1

For illustration purposes, the lifecycle impacts of articulated lorries of 40t are shown below. Smaller lorries and urban buses cases are also available in the study.

LORRIES UP TO 40 T

Regarding the GHG emissions reduction potential, **Figure 15** illustrates the lifecycle GWP impact for articulated lorries up to 40t comparing several powertrains. The average EU lifecycle GWP impact of ZEV lorries up to 40t, either BEV or FCEV, is much better than for any ICEV by 2030. In 2050, the difference is even bigger as the electricity mix becomes more decarbonised[87]. For instance, conventional diesel-powered lorries would emit 132 gCO_2e/tkm by 2030 (84 in 2050), while fuel cell vehicles would emit 109 gCO_2e/tkm (24 in 2050) and battery electric vehicles would emit 32 gCO_2e/tkm (11 in 2050). Results for smaller lorries and urban buses cases are also available in the study and provide similar overall conclusions.

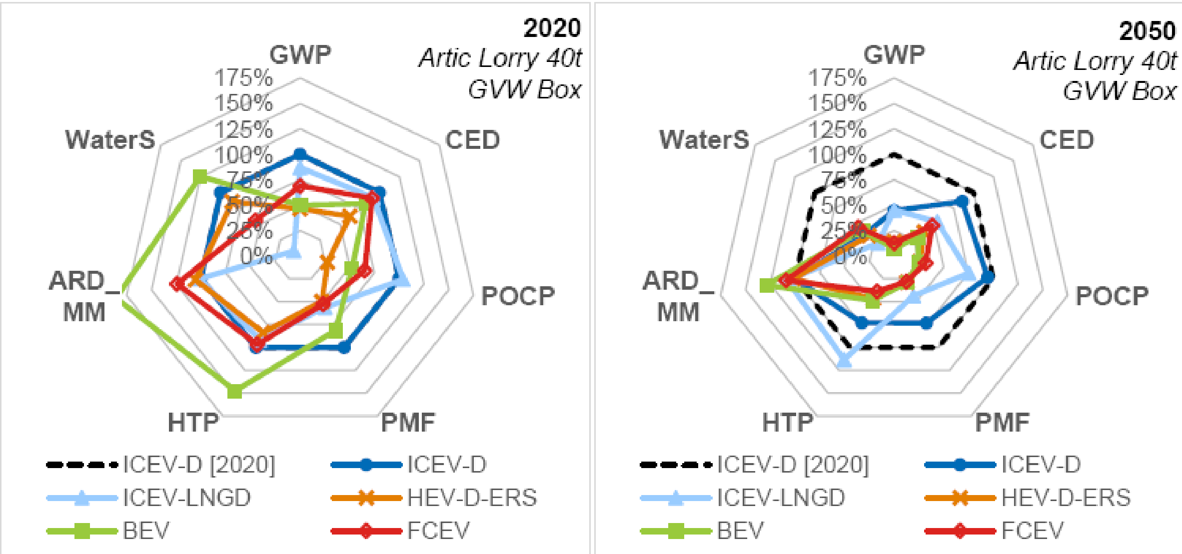
Figure 15. Summary of breakdown of overall lifecycle GWP impacts for articulated lorries (40t Gross Vehicle Weight, box body) for different powertrain types (Baseline scenario for 2020 and 2030, Tech1.5 scenario for 2050)



[87] The power sector is fully decarbonised in the "Policy scenarios for delivering the European Green Deal".

With regards to other environmental impacts, the below **Figure 16** provides a summary of the relative performance of a number of different powertrain types compared to the baseline case (100%) of a conventional diesel 2020 ICE vehicle. The results show that the comparable 2020 impacts by ZEV all progressively reduce in the years after 2020 compared to conventional vehicles. In particular, and apart from GWP, the particle matter formation, ozone creation potential, human toxicity potential, water scarcity and cumulative energy demand are far more reduced in 2050 for ZEV than for conventional lorries.

Figure 16. Summary of the relative impacts for articulated lorries (40t Gross Vehicle Weight, Box Body) for the most significant environmental impacts for road transport, by powertrain for 2020 and 2050, including GWP.



Notes: GWP = Global Warming Potential, CED = Cumulative Energy Demand, POCP = Photochemical Ozone Creation Potential, PMF = Particulate Matter Formation, HTP = Human Toxicity Potential, ARD_MM = Abiotic Resource Depletion, minerals and metals, WaterS = Water Scarcity. LNGD = LNG HPDI engine, using ~5% diesel (estimated at only 3% energy efficiency penalty vs conventional diesel); HEV-D-ERS = Hybrid with pantograph enabling electric operation on roads equipped with an overhead catenary electric road system (ERS).

1.26. 16.5 Problem 3 – Overview of regulatory status of zero-emission vehicles in other countries.

Several governments have already initiated the discussion on setting mandatory zero-emission targets on heavy-duty vehicles as the debate of if, and when, all new vehicles would need to be (tailpipe) zero emission is getting more important.[88] California was the first government that introduced obligations to put in the market zero-emission HDV, including setting a date for a 100% ZEV mandate.

[88] ICCT, August 2021. Global overview of government targets for phasing out internal combustion engine medium and heavy trucks.

16.5.1 *Legally binding zero-emission targets on HDV*

- **California** was the first government in the world that legally obliged to increase the sales share of zero-emission HDV. The Advanced Clean Trucks Regulation sets a minimum of 30% ZEV sales for certain vehicles by 2030, followed by 75% by 2035 and 100% by 2045 (2035 for drayage trucks). The latter means, therefore, that California has effectively legislated that **all new heavy-duty vehicles will be (tailpipe) zero-emission by 2045**.
- The Californian example has been followed by other several US States as Oregon, Washington, New York, New Jersey and Massachusetts by requiring ZEV mandates starting in 2025, from 30% to 50% by 2030, and from 40% to 75% by 2035.

16.5.2 *Non-legally binding zero-emission targets and commitments on HDV*

Several governments are publicly considering or have already announced the intention to reduce tailpipe CO_2 emissions from new heavy-duty vehicles, most frequently by setting progressively stricter zero-emission sales obligations. Some countries have introduced aspirational targets within their respective energy and transport planning policies driven by targeted accompanying policies, as green taxation (e.g. Norway):

- A Memorandum of Understanding committing on enabling zero-emission sales targets for medium- and heavy-duty vehicles of 30% by 2030 and 100% by 2040, was launched by the Netherlands and signed by 15 countries during the COP26 in Glasgow and. At COP27 in Sharm El-Sheikh 10 more countries signed it, thus increasing the total number of State signatories to 26. In the **EU: Austria, Belgium, Croatia, Denmark, Finland, Ireland, Lithuania, Luxembourg, the Netherlands and Portugal**; together with Aruba, Canada, Chile, Curaçao, the Dominican Republic, Liechtenstein, New Zealand, Norway, Scotland, Switzerland, Turkey, Ukraine, United Kingdom, United States, Uruguay and Wales. Some transport companies and manufacturers have also signed.
- **Austria** is considering setting a 100% zero-emission target for buses by 2032 and for trucks up to 18t and over 18t by 2030 and 2035 respectively, according to the 2030 Mobility Master Plan. The measures are planned in the frame of aiming at carbon neutrality in the transport sector by 2040.
- The **United Kingdom** closed a public consultation in September 2021 on *when to phase out the sale of new, non-zero emission heavy good vehicles*, providing indicative goals of **2035 for lorries up to 26t and 2040 for the rest.** The government confirmed during COP26 in November 2021 these phasing out dates to become mandatory soon.
- **Ireland**, further to the pledges made at COP27, adopted the Climate Action Plan 2021, according to which bus fleets in major cities (Dublin, Cork, Waterford, Limerick and Galway) are to become fully electric by 2035.
- **Norway** set zero-emission targets for new HDV on its National Transport Plan: 100% urban buses should be zero-emission (or alternatively powered by biogas) by 2025, 75% for long-distance buses (coaches) and 50% for lorries.

- Regarding the **USA**, a Medium- and Heavy-Duty Zero Emission Vehicle MoU signed in July 2020 by the governors of **15 US states**[89] and the District of Columbia commit themselves to pursue all sales of new medium- and heavy-duty vehicles to be zero-emission by no later than 2050, phased in from at least 30% by no later than 2030.
- Also, **12 US states**[90] sent a letter to the President of the USA requesting to set standards ensuring that new sales of medium- and heavy-duty vehicles nationwide be zero-emission by 2045 and other accompanying measures, as support for infrastructure recharging and taxes rebates.
- In January 2023 the US released the National Blueprint for Transportation Decarbonization aiming at removing all emissions from the transportation sector by 2050. Concrete milestones are 30% zero-emission medium- and heavy-duty vehicle sales by 2030 and 100% by 2040, fuelled by an obligation for the federal fleet to acquire only zero-emission vehicles by 2035.**Canada** aims to achieve 30% ZEV sales for medium- and heavy-duty vehicles by 2030 in its 2030 Emissions Reduction Plan. As well, the country plans a 100% ZEV mandate for 2040 for a subset of vehicles, helped by 2030 requirements and perhaps also interim targets for the mid-2020s.
- **Cape Verde** aspires, in its Electric Mobility Policy Charter, to purchase only zero-emission vehicles, including HDV, by 2035, with intermediate objectives by 2030 of 25% for buses and heavy trucks and 35% for medium trucks.
- **Japan** unveiled a target in June 2021 for all trucks with a capacity of up to 80,000 pounds (36t) go electric by 2040. A policy for larger trucks will be set by 2030.
- **Chile** unveiled its National Electromobility Strategy in late 2021 whereby new sales of urban buses would be zero-emission by 2035, followed freight transport and intercity buses (coaches) in 2045.
- **China**, quite active on clean air local regulations and incentives to "new energy vehicles" that led the country to dominate the global ZEV bus market, is in the process of developing ZEV targets for heavy-duty vehicles.
- **Pakistan**, as part of its National Electric Vehicle Policy, aspires to reach 30% of zero-emission HDV sales by 2030 (50% for buses) and 90% by 2040.

16.5.3 100% zero-emission targets on urban buses

The following **Table 8** summarizes the countries and regions that specifically committed to procure or set a mandate to sell, only zero-emission buses by a certain date. Commitments may refer to only urban buses, public transport buses and even all buses, as the case may be.[91]

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[89] California, Colorado, Connecticut, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont and Washington.

[90] California, Connecticut, Hawaii, Maine, Massachusetts, New Jersey, New York, New Mexico, North Carolina, Oregon, Rhode Island and Washington.

[91] Based on ICCT, 2021. https://theicct.org/decarbonizing-bus-fleets-global-overview-of-targets-for-phasing-out-combustion-engine-vehicles/

Table 8. Governments setting or planning zero-emission mandates on urban buses by a certain date

Country / region	100% ZE buses date
Denmark	2025
Netherlands	2025
New Zealand	2025
California (USA)	2029
Austria	2032
Ireland	2035
Cape Verde	2035
Chile	2035

17. ANNEX 8: DESCRIPTION OF THE POLICY OPTIONS – COMPLEMENTARY INFORMATION

1.27. 17.1 Policy option categories

The options considered in the Impact Assessment can be grouped into the following categories:

- Extension of the scope;
- CO_2 emission targets and their timing;
- Incentives for zero-emission vehicles;
- Contribution of renewable and low-carbon fuels to the standards;
- Governance.

The following **Table 9** summarizes the relations within these categories and the problems described in section 2.1 of the Impact Assessment.

Table 9. Relations among problems and policy options

Policy options	Problem 1: Insufficient contribution to GHG emissions EU energy dependency reduction	Problem 2: Transport operators and consumers missing out on fuel savings	Problem 3: Risk of losing technological and innovation leadership in the HDV value chain
Extension of the scope	✓	✓	✓
CO_2 emission targets and their timing	✓	✓	✓
Incentives for ZEVs	✓	✓	✓
Contribution of renewable and low-carbon fuels	✓	✓	
Governance	✓		✓

1.28. 17.2 Extension of the scope - complementary information on Scope 1

The HDV CO_2 standards are currently based in the following stepwise approach, applicable to regulated new vehicles:

- The manufacturer simulates the new vehicle using the VECTO tool to calculate their fuel consumption and CO_2 emissions. The rules are defined by the Emissions Determination Regulation as part of the vehicle type-approval process.

- The manufacturer reports to the European Commission, among others, the certified CO_2 emissions values. Data are publicly available according to the Monitoring and Reporting Regulation.
    - Therefore, the **certification of CO_2 emissions under type-approval**, based on the availability of VECTO simulations, **is a prerequisite for regulating heavy-duty vehicles under the HDV standards**.

17.2.1 Option SCOPE 0

The currently regulated vehicles are responsible for more than 73% of all HDV CO_2 emissions from newly registered vehicles[92] including both regional and long-haul transport of goods as shown in **Table 10** below.

Table 10. Share of CO2 emissions (newly registered vehicles) from currently regulated HDV groups - SCOPE 0

Vehicle' groups*	CO_2 emissions contribution over HDV total (%)
4	8.05
5	48.93
9	10.76
10	5.68
TOTAL SCOPE 0	**73.42%**

** Vocational vehicles not included*

17.2.2 Option SCOPE 1

Option SCOPE 1 ensures covering a wide range of currently unregulated vehicles on the condition that their CO_2 emissions can be determined in the Emissions Determination procedure and then made available to the Commission. In principle, all vehicles expected to be covered by the Determination of CO_2 emissions when the HDV Regulation enters into force can be included in this option. The vehicles that can be potentially added can be grouped as follows[93]:

- Heavy lorries belonging to VECTO groups 1, 1s, 2, 3, 11, 12 and 16. Determination of CO_2 emissions applicable since 2020;
- Lorries with TPLMP above 5t and up to 7.5t belonging to VECTO groups 53, 54, (medium lorries). Determination of CO_2 emissions applicable as from 2024.
- Buses and coaches with TPLMP above 7.5t belonging to VECTO groups P31, P32, P33, P34, P35 P36, P37, P38, P39 and P40 (heavy buses and coaches). Determination of CO_2 emissions applicable as from 2024.

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[92] Source of CO_2 emissions from new vehicles across this annex: *Technical support for analysis of some elements of the CO_2 emission standards for heavy duty vehicles (HDV).* Ongoing study, to be published by Q1 2023.
[93] The groups are described in Table 1 of Annex I of Regulation (EU) 2017/2400.

The vehicle groups and respective attributed CO_2 emissions are listed in **Table 11**.

Table 11. Share of CO2 emissions from currently unregulated HDV groups (newly registered vehicles) expected to be ready for certification

Vehicle category	Attributed CO_2 emissions weight over HDV total (%)		Vehicle type
1 and 1s	0.29	13.94	Heavy lorry
2	1.51		
3	2.63		
11	3.07		
12	0.83		
16	5.21		
Vocational vehicles	0.40		
53	1.24	1.83	Medium lorry
54	0.59		
P31	3.44	4.80	Heavy bus (low floor)
P33	0.37		
P35	0.99		
P32	3.04	4.14	Heavy bus (high floor)
P34	1.10		
P37 and P39*	0.19	0.19	Heavy bus (low floor)
P36, P38 and P40*	0		Heavy bus (high floor)
TOTAL EMISSIONS SCOPE 1	**24.90%**		

** Given the low registration number of these vehicles and their special features (number of axles, size and weight), setting a representative baseline CO_2-level against which the future reduction targets can be implemented for these bus groups P36, P37, P38, P39 and P40 can be statistically complicated.*

Adopting option SCOPE 1 on top of SCOPE 0 would suppose regulating in total around 98.32% of the total HDV CO_2 emissions. The vehicles producing the remaining 1.68% (other vehicles) are described in next section 17.3.

1.29. 17.3 Extension of the scope - complementary information on 'other vehicles'

Some heavy-duty vehicles, for a variety of reasons, cannot have their CO_2 emissions certified in the foreseeable future through VECTO:

- Several heavy lorry groups not ready to be certified with VECTO;
- All lorries with TPMLM up to 5t (small lorries);
- All buses and coaches with TPMLM up to 7.5t (medium and small buses and coaches);
- Very specific vehicles, including special purpose vehicles, e.g. auto-cranes, firefighting lorries, etc., which are exempt from the scope of VECTO certification and partially not even covered by type-approval legislation.

The following **Table 12** summarizes the groups of these ‘other vehicles’, their CO_2 certification status together with their estimated CO_2 emissions production.

Table 12. ‘Other vehicles’ groups certification status and contribution to CO2 emissions

Group	Vehicle groups	Certification status	Contribution to the overall HDV fleet CO_2 emissions
A	Heavy lorries from groups 6, 7, 8, 13, 14, 15, 17, 18 and 19: Lorries with particular axle configurations and use cases (e.g. forestry, agriculture);	No certified CO_2 emissions available since they are not required by the Emissions Determination Regulation	0.96%
B	Small lorries with TPMLM up to 5 t	No certified CO_2 emissions available since they are not required by the Emissions Determination Regulation.	0.42%
C	Small buses and coaches with TPMLM up to 7.5 t	No certified CO_2 emissions available since they are not required by the Emissions Determination Regulation.	0.3%
D	Very specific vehicles including special purpose vehicles	No certified CO_2 emissions available because exempt from the scope of the Emissions Determination Regulations. Some vehicles, as off-road vehicles, are even not registered.	No data available. Contribution expected to be very small due to typically low mileage and speed.

1.30. 17.4 Extension of the scope – exemption to Small Volume Manufacturers (SVM)

Meeting compliance requirements of the HDV Regulation implies a certain burden for the manufacturers. The corresponding costs are made of two components:

- Fixed entry costs related to development and investment;
- Variable costs evolving proportionally along the number of manufactured vehicles.

Since fixed costs apply from the first vehicle produced, the smaller the manufacturer, the higher the relative economic effort per vehicle to meet the regulatory requirements. Extending the scope to regulate more vehicles would imply, given the dependence on economies of scale, for smaller manufacturers putting on the market a very limited number of vehicles, a relatively high economic impact whilst a marginal resulting benefit in terms of CO_2 emissions reduction would be delivered in exchange.

The cost analysis indicates that variable technology costs are largely similar across the various groups of lorries. Some 'cross-fertilisation' effect of technologies is also likely to take place with other vehicles groups such as buses and lorries. As the relative share of the fixed technology costs for an individual vehicle decreases with the number of vehicles for which the technology is installed, economies of scale would make option SCOPE 1 and SCOPE 2 more cost-efficient from the societal point of view for achieving a given CO_2 emissions reduction target when compared to option SCOPE 0. Therefore, exempting Small Volume Manufacturers (SVM) from meeting the targets needs to be considered to avoid a major burden on smaller companies

The criteria to determine what a SVM should meet a compromise solution between two factors:

- The relative total compliance costs (both fixed and variable) supported by the manufacturer;
- The resulting CO_2 emissions that would be waived from the regulatory scope from the vehicles put in the market by manufacturers meeting the criteria

Therefore, the upper the threshold criteria to determine what a SVM is, the higher also the amount of benefitted smaller manufacturers, but the less efficient the regulation will control CO_2 emissions from new vehicles.

The key parameter to decide what a SVM may be the **number of vehicles registered every year in the Union**. Despite other metrics associated to the condition of SMEs could be taken instead (number of employees, balance sheet assets, annual turnover or revenues, etc.), they may not provide clear information whether corporative actions happen, as mergers, acquisitions, or spin-offs. In addition, the HDV business structure show a quite linear distribution directly linked to the sales figures. In addition, the compliance legal costs can be shared by different companies of a same group, the number of registered vehicles should apply to the whole business perimeter defined by connected undertakings and entities. Some stakeholders supporting the SVM exemption during the public consultation defined this metric as the most appropriate, while alternative metrics have not been proposed.

Given the peculiarities of the structure of the HDV market (and an extreme segmentation in some niche cases) as a starting point setting differentiated SMV thresholds according to the different vehicle groups seems reasonable and is also supported by stakeholders. Possible SVM thresholds will therefore be investigated separately for the following vehicle groups falling within the scope options proposed

- Lorries with TPMLM over 5t (SCOPE 1);
- Buses and coaches with TPMLM over 7.5t (SCOPE 1);
- Trailers and semi-trailers of category O4 and O3 and a TPMLM over 8t (heavy trailers, falling under SCOPE 2).

17.4.1 SVM determination methodology

The information reported by the Member States to the EEA identifies manufacturers of primary and completed vehicles and trailers. As sales from years 2020 and 2021 were severely affected by the COVID-19 crisis, it seems reasonable to consider a wider database set to ensure a more representative analysis. Therefore, considered reporting periods taken are years 2019, 2020 and first half of 2021[94].

17.1.1.1 Lorries in SCOPE 1

67 manufacturers registered in the different Member States of the EU over 600,000 N2 and N3 lorries exceeding TPMLM 5t (over 250,000 during a normalized average year). Main large and consolidated OEM, together with their confirmed subsidiaries, registered nearly 99.60% of vehicles total:

- Daimler Truck (Daimler, Mercedes-Benz, Fuso)
- Traton Group (Scania, MAN, Volkswagen)
- Volvo Group (Volvo Truck, Renault)
- PACCAR (DAF)
- CNH Industrial (IVECO)
- Isuzu

The remaining 56 manufacturers registered during an average reporting year nearly 1,000 lorries split into: 13 manufacturers delivering around 850 special purpose vehicles only (e.g., refuse collection vehicles, fire engines, etc. all vehicles out of both options SCOPE 1 and SCOPE 2) and remaining 43 small manufacturers registering less than 150 lorries. None of these small manufacturers was found to register more than 25 vehicles during a normalized year. The below **Table 13** summarizes the situation on an average year:

Table 13. Lorries in SCOPE 1 registered along an average normalised year classified by manufacturers

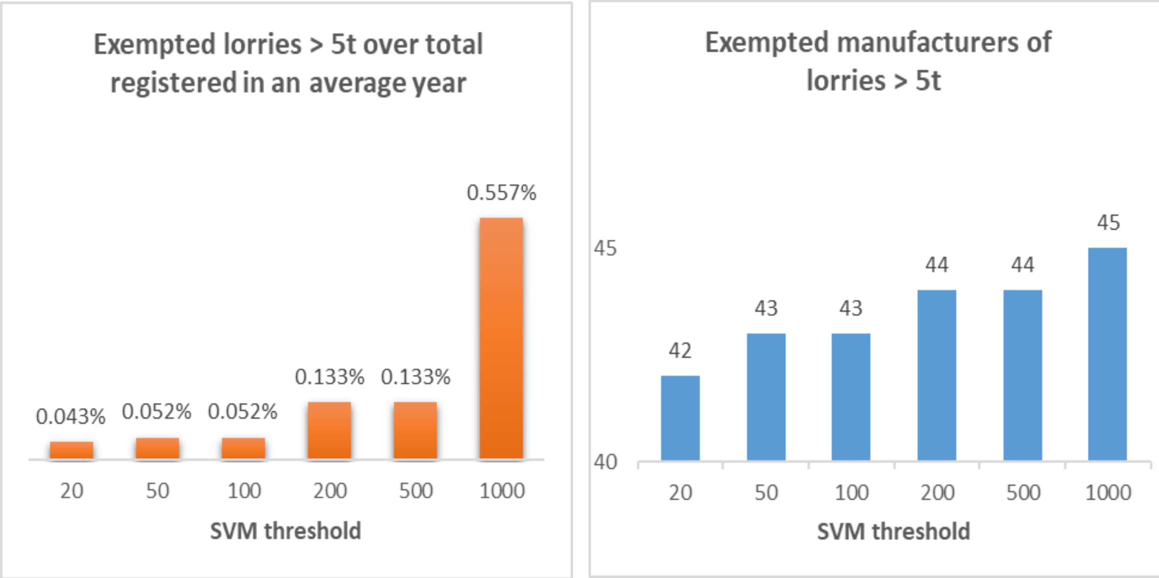
	Main OEM and subsidiaries	Special purpose manufacturers	Smaller manufacturers*
Registered vehicles on a normalized year	Over 250,000	Around 850	Less than 150
Identified manufacturers	11	13	**43**
Average yearly normalised production	ca. 23,000	Ca. 65	~ 3

* < 100 registered vehicles per year

After excluding special purpose vehicles and their related manufacturers not covered by SCOPE 1, **Figure 17** below summarizes in histograms the vehicle production share and the number of manufacturers exempted against several possible SVM thresholds.

[94] Second half of 2021 was not available yet when drafting this report.

Figure 17. Exempted lorries in SCOPE 1 and corresponding manufacturers across different threshold values.



Setting the SVM threshold for lorries at **100 vehicles** registered during a certain reporting year would exempt 43 manufacturers manufacturing on average a very reduced number of vehicles (over 3 out 4 of manufacturers falling under SCOPE 1), while only 0.052% of lorries[95] would get exempted from the Regulation. As lorries falling under SCOPE 1 produce in total over 88% of CO_2 emissions of newly registered HDV (see section 17.2: Extension of the scope - complementary information on Scope 1), this exemption for lorries would concern, after taking several conservative assumptions[96], about **0.05% of total HDV CO_2 emissions**.

Therefore, setting this threshold would keep all important manufacturers regulated and, at the same time, small manufacturers out of any regulatory burden, whilst ensuring that just a very negligible amount of the addressed CO_2 emissions would keep unregulated.

17.1.1.2 Buses and coaches in SCOPE 1

Similarly to lorries, a wider registration data representativeness beyond a single year has been taken to determine a valid threshold for SVM exemption in buses: during 2019, 2020 and first half of 2021, nearly over 55,000 primary buses exceeding TPMLM 7.5t were registered in the EU by a total of 53 manufacturers.

Primary vehicle manufacturers that registered more than 100 buses and coaches over 7.5t along an averaged normalized year are identified below:

Daimler Truck	7 407
Iveco (CNH Industrial)	6 154
MAN (Traton Group)	3 587
Scania (Traton Group)	1 488
Solaris	1 434

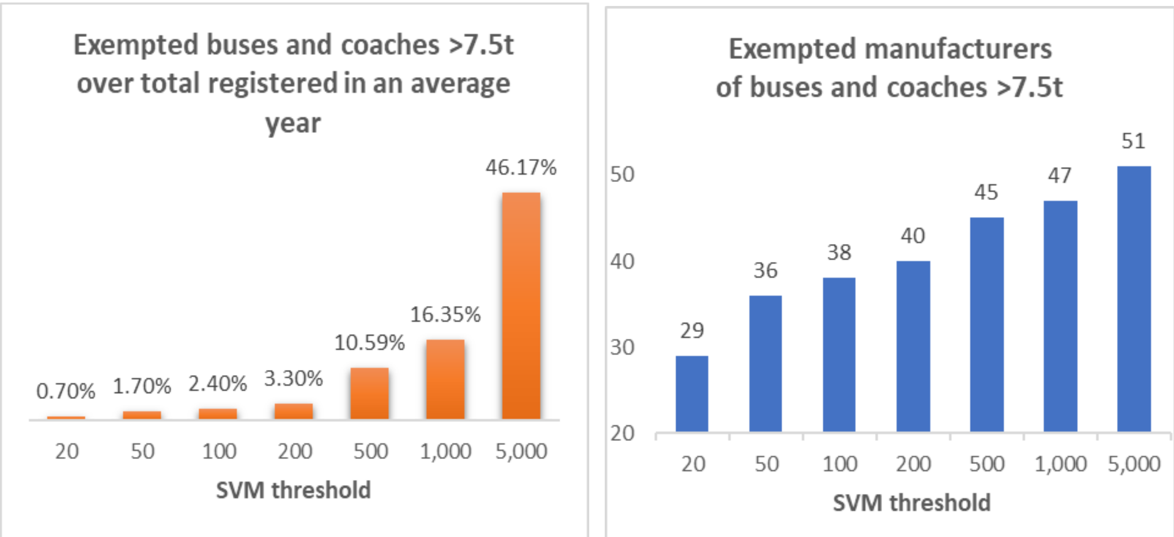
[95] Lorries with TPMLM over 5t from regulated groups 4, 5, 9, 10 and from currently unregulated groups 1, 2, 3, 6 and 11, 12, 16.

[96] For instance, it has been assumed a simple linear relation among number of vehicles and corresponding emissions. However, the smaller the lorry typically the lower their emissions due to lower weight and typical mileage.

Volvo (Volvo Group)	1 002
VDL	872
Otocar	581
Sor Libchavy	498
TEMSA	406
ISUZU	439
Van Hool	247
BYD	244
EBUSCO	114
Autosan	114
Other 38 manufacturers registering less than 100 vehicles	603

The following histograms in below **Figure 18** show the vehicles production share and the number of manufacturers exempted across possible manufacturing thresholds for buses and coaches.

Figure 18. Exempted buses and coaches in SCOPE 1 and corresponding manufacturers across different threshold values.



Small buses manufacturers are especially active in the zero-emission segment. In fact, more than half of all buses and coaches delivered by small manufacturers registering up to 100 vehicles were zero-emission, hence out of the regulatory scope. Taking this into account and that buses and coaches produce roughly 10% of total HDV CO_2 emissions (see section 17.2: Extension of the scope - complementary information on Scope 1), setting the SVM threshold for buses and coaches to **100 vehicles** registered during a certain reporting year would exempt 38 small manufacturers and, at the same time and considering several conservative assumptions[97], only **0.12% of total HDV CO_2 emissions** would waive the regulatory targets.

[97] For instance, similarly to lorries, it has been assumed a simple linear relation among the number of vehicles and their corresponding emissions. However, the smaller the bus the lower their emissions due to lower weight and typical mileage.

17.1.1.3 Trailers over 8.0t (heavy trailers)

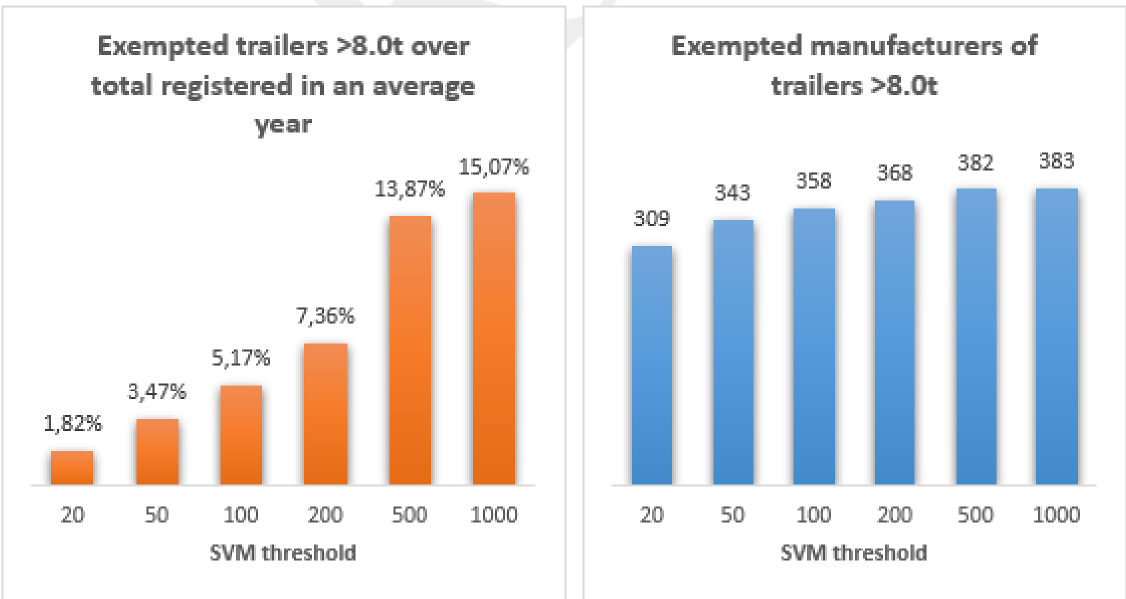
The analysis of the heavy trailer sector is limited to trailers above 8.0t with a box-shaped bodywork, which correspond to the scope of trailers to be included in option SCOPE 2. In a given year, a total of almost 65,000 heavy trailers were registered in the 19[98] EU Member States from which registration data are available (normalised figures for an average year).

There are a significant number of small manufacturers in the heavy trailer sector. The total number of manufacturers is around 390 but the majority of trailers are produced by only a few manufacturers. During the last monitoring and reporting period, one manufacturer only was responsible for one third of the registrations. Manufacturers with an annual production of more than 100 units accounted for 95% of the registered fleet while manufacturers with more than 50 units produced 96.5% of the registered vehicles. The number of manufacturers concerned was 33 and 48 respectively. The situation is illustrated in **Table 14** and **Figure 12** for 8t box-shaped trailers.

Table 14. Exempted trailers (absolute and percentage) and corresponding manufacturers across different threshold values.

	Number of		Share of trailers
	Trailers	**Manufacturers**	
All	64.894	390	100%
>50	62.645	48	96.5%
>100	61.539	33	95%
>200	60.118	23	92.5%

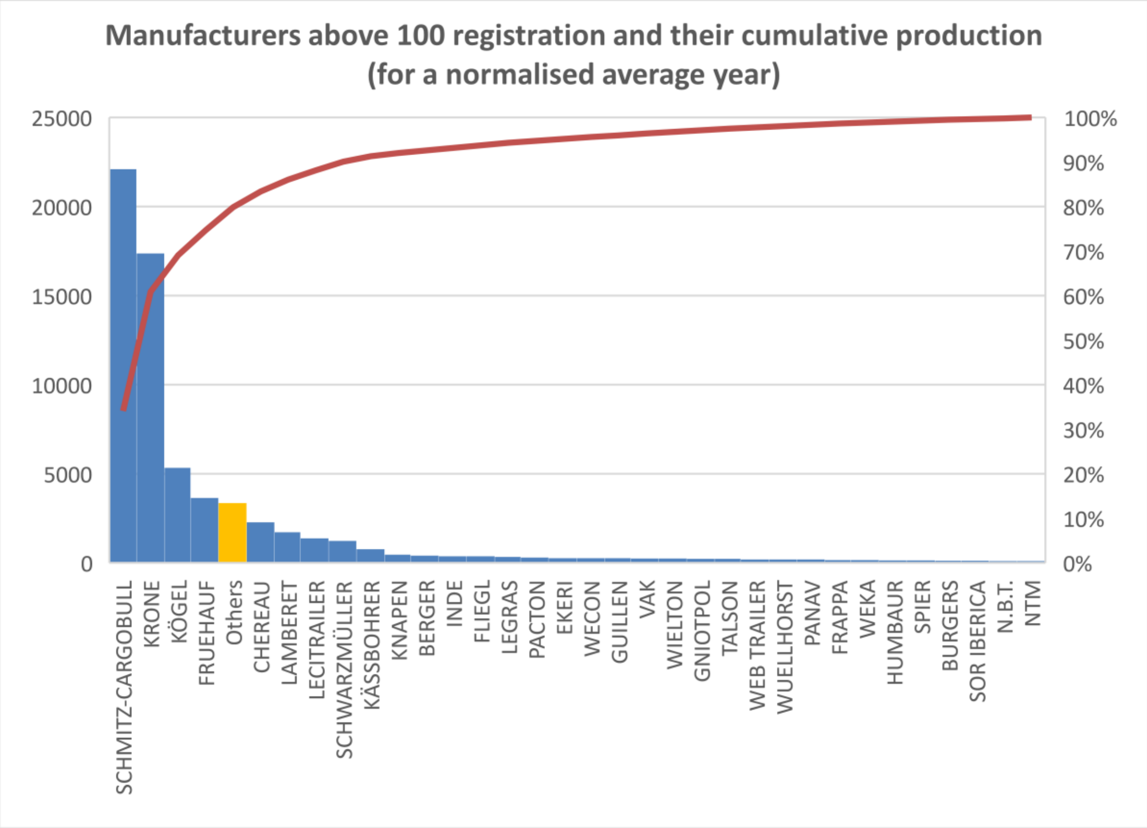
Figure 19. Exempted trailers and corresponding manufacturers across different threshold values.



[98] Data missing or incomplete from the Member States BE, CY, DK, HR, HU, IE, IT and MT.

If the threshold is set at 100 registered trailers per year, most manufacturers would be exempted (357 out of 390), while most trailers concerned, around95%, would still fall within the scope of the standard. This is due to the fact that there are only a few manufacturers producing large quantities per year, while the smaller manufacturers produce only on order. There are 33 manufacturers who have registrations of more than 100 trailers per year and only nine of them sell more than 500 trailers per year, as illustrated in **Figure 20** below.

Figure 20. Trailer manufacturers and their cumulative production over a normalised average year.



18. ANNEX 9: ADDITIONAL INFORMATION CONCERNING THE ASSESSMENT OF THE ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS OF THE DIFFERENT POLICY OPTIONS

1.31. 18.1 Economic impacts of options regarding CO2 target levels (TL)

18.1.1 Methodology

As explained in Section 6.1 of the Impact Assessment, for the analysis of the economic impacts of the different options regarding the CO_2 target levels (TL), the following indicators have been used:

(i) Net economic savings from a societal and end-user perspective
These savings are calculated as the difference, between the policy options and the baseline, of the total costs, averaged over the EU-wide new vehicle fleet of Heavy Duty vehicles registered in 2030, 2035 or 2040. The total costs include the capital costs, the fuel or electricity costs, and the operation and maintenance (O&M) costs of the vehicles.
The savings from a societal perspective is the change in average costs over the lifetime (15 years) of a new vehicle without considering taxes and using a discount rate of 3%. In this case, the costs considered also include the external cost of CO_2 emissions.
The savings from an end-user perspective are presented for the first user (first five years after first registration), the second user (years 6-10) and the third user (years 11-15). In these cases, taxes are included and a discount rate of 9.5% (lorries) and 7.5% (buses and coaches). The calculation also takes account of the residual value of the vehicle (and the technology added) with depreciation.
These calculations assume one replacement of the battery and of the fuel cell stack over the lifetime of the relevant vehicles.

(ii) Costs for automotive manufacturers
These costs are calculated as the difference, between the policy options and the baseline, of the manufacturing costs, averaged over the EU-wide new vehicle fleet of heavy duty vehicles registered in 2030, 2035, 2040. They include both direct manufacturing costs, including materials and labour, as well as indirect manufacturing costs, including R&D, warranty costs, depreciation and amortisation, maintenance and repair, general other overhead costs.

(iii) Energy system impacts
In view of the links between the CO_2 standards for heavy duty vehicles and the energy system, impacts of the TL options on the final energy demand, electricity consumption and on the hydrogen demand have been analysed, also considering the links with the revision of the EU ETS as well as the Energy Efficiency and Renewable Energy Directives, incuding the revised target as proposed under the REPowerEU Plan.

(iv) Investment in alternative fuels infrastructure
The investments needed for recharging and refuelling infrastructure have been analysed, to ensure consistency with the revision of the Alternative Fuels Infrastructure Regulation.

(v) Macro-economic impacts, including employment

18.1.2 Total cost of ownership (TCO) for the second and third users

The economic impacts of stricter CO_2 targets under the different TL options on buyers of second and third hand vehicles were also looked at. The results of the analysis are similar as for the first-user (see Section 6). The net savings increase with the stringency of the targets for the second-hand user perspective, as shown below in **Figure 21**, and for the third-hand user perspective, as shown below in **Figure 22**.

Figure 21. Average net economic savings from a TCO-second use perspective (EUR/vehicle)

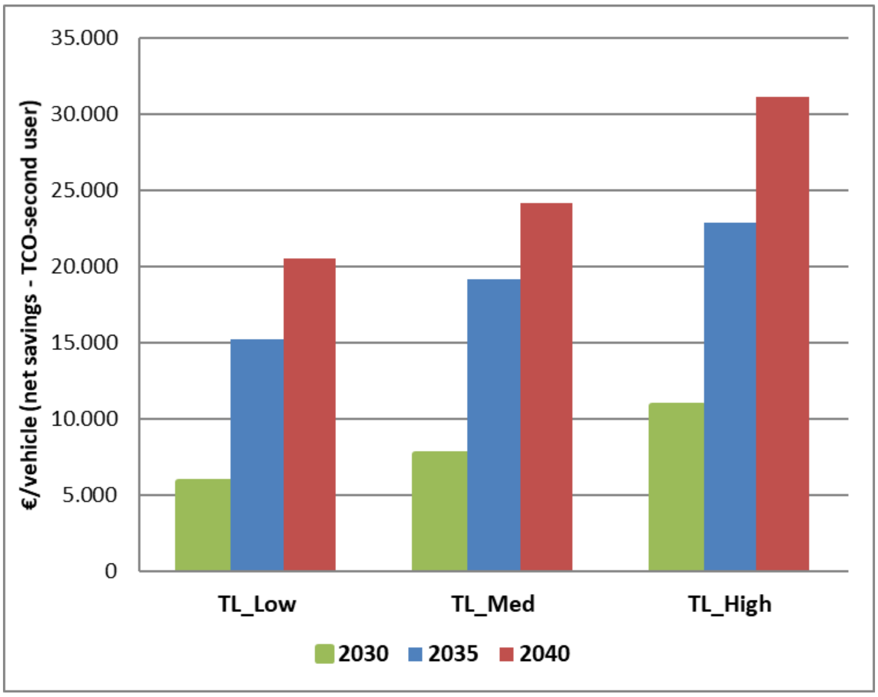
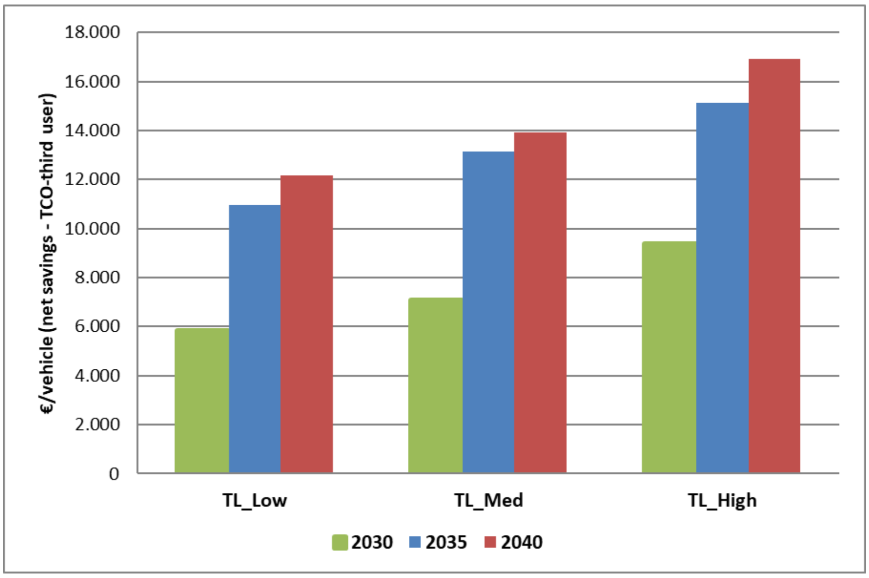


Figure 22. Average net economic savings from a TCO-third use perspective (EUR/vehicle)



18.1.3 Eurovignette

The Eurovignette Directive[99] provides for infrastructure road charges, which depend on the CO_2 emissions class of the vehicle (each class defined by a range of specific CO_2 emissions as compared to an average vehicle). Most importantly, Member States shall provide a discount of road charges between 50 and 75% for ZEVs. In order to preserve their potential revenues from road charges that are constrained by road infrastructure costs, Member States may (but do not have to) increase the road charges on ICE vehicles to compensate losses from ZEV discounts.

It has been performed on the assumptions that Member States apply a discount of 75% to ZEV road charges, strictly implement the revenue neutrality principle for granting discounts to ZEV and on the basis of an average annual road charge of 3500 € for a HDV first registered in 2030 (according to the Impact Assessment of the Eurovignette Directive).

If Member States are ready to accept certain revenue losses from road charges to incentivise ZEV deployment or if the average road charges of HDVs would be higher, the average lifetime savings of a HDV in the policy scenarios would be higher as well. Therefore the estimates below can be considered as conservative. The savings from road charges have to be added to the TCO savings for the end users as they have not been included in the TCO analysis due to the wide range of assumptions that had to be made.

One should also be aware that the figures for 2040 have to be considered with some care as the Eurovignette provisions are likely to be amended at the background of a high uptake of ZEV. The savings from road charges for new HDVs after 2040 will gradually shrink and converge to 0 when ZEV shares in the entire fleet will eventually reach saturation.

Figure 23 below shows the average lifetime savings of a HDV (ICE and ZEV combined) from road charges for different years of first registration and the different policy scenarios[100]. These savings increase with time and with the stringency of the targets. These savings are additional to the ones shown in the previous sections.

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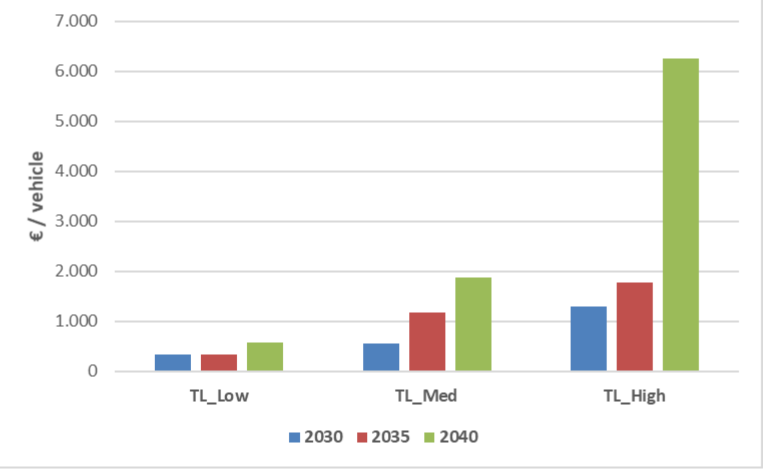
[99] Directive 1999/62/EC, as amended by Directive (EU) 2022/362.

[100] The analysis has been performed under the assumptions that Member States apply a discount of 75% to ZEV road charges, implement the revenue neutrality principle by increasing the ICEV road charges, and on the basis of an average annual road charge of 3,500 € for a HDV first registered in 2030, in line with the estimation done in the Impact Assessment of the Eurovignette Directive.

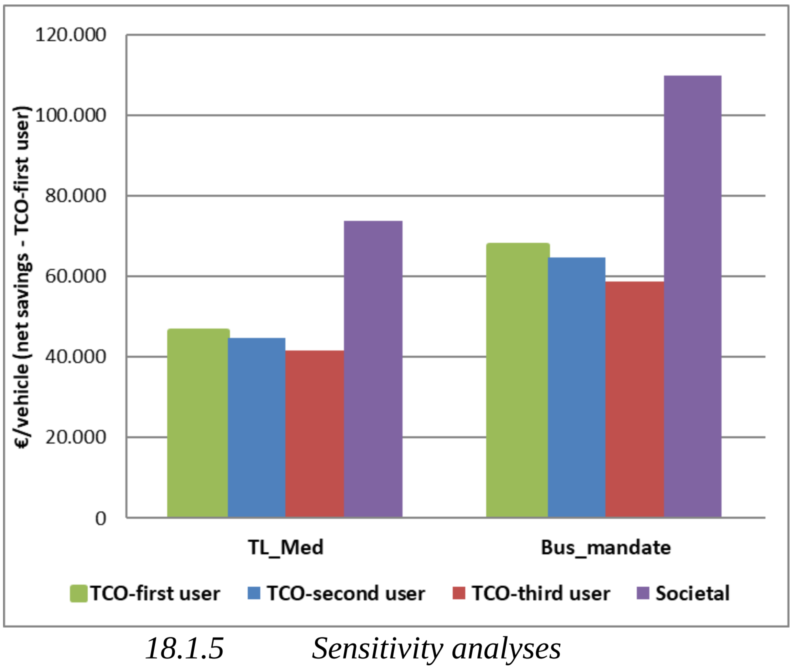
Figure 23. Vehicle lifetime discounted average road charge savings compared to the baseline (EUR/vehicle).



18.1.4 Total cost of ownership (TCO) under the option BUS ZEV2

Figure 24 shows the net savings of a new regulated bus registered in 2030, compared to the baseline. Results are shown for the 1st, 2nd and 3rd owners and for the society, as presented in Section 6.

Figure 24. Total savings of a new regulated bus registered in 2030 under different perspectives (EUR/vehicle) under TL_Med and BUS ZEV2.



18.1.5 Sensitivity analyses

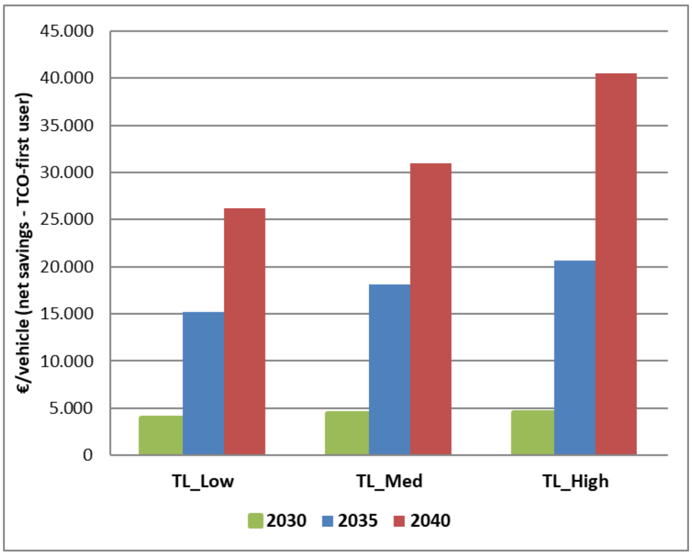
The net economic savings from different perspectives have also been subject to two sensitivity analyses.

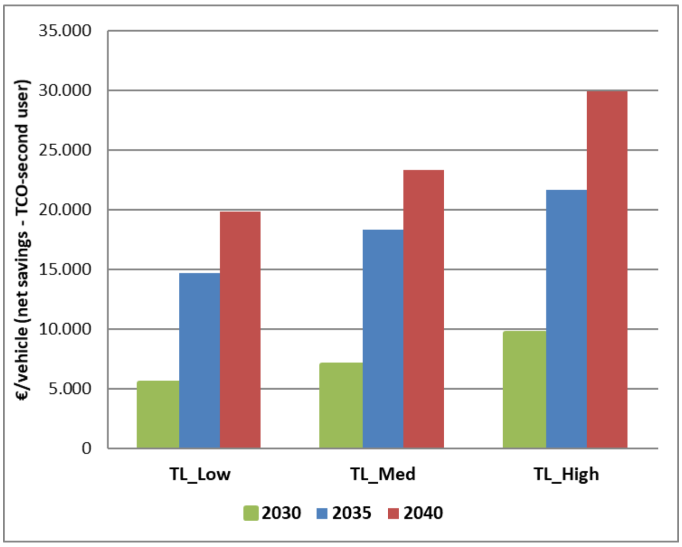
The first captures the uncertainty related to the projected evolution of zero-emission technologies (and PHEV) in case their costs decrease at a lower rate than assumed[101] and

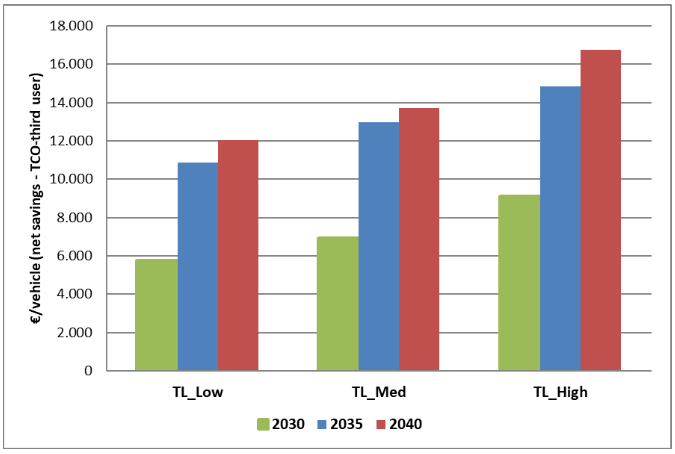
[101] This corresponds to the "high cost" in Ricardo's study

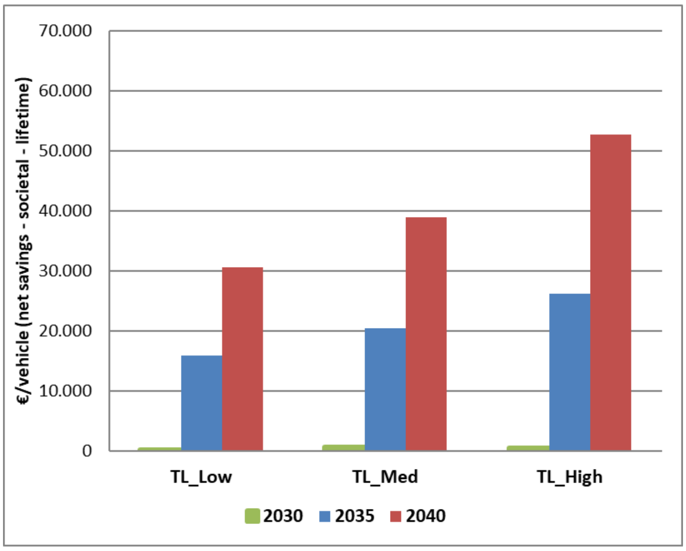
shows that, even when the capital cost of such vehicles increases compared to the main scenario runs, savings would still occur for all users and for the society.

Figure 25. Average net savings over the vehicle lifetime from different perspectives for a new average heavy-duty vehicle registered in 2030, 2035 or 2040, assuming higher ZEV costs.



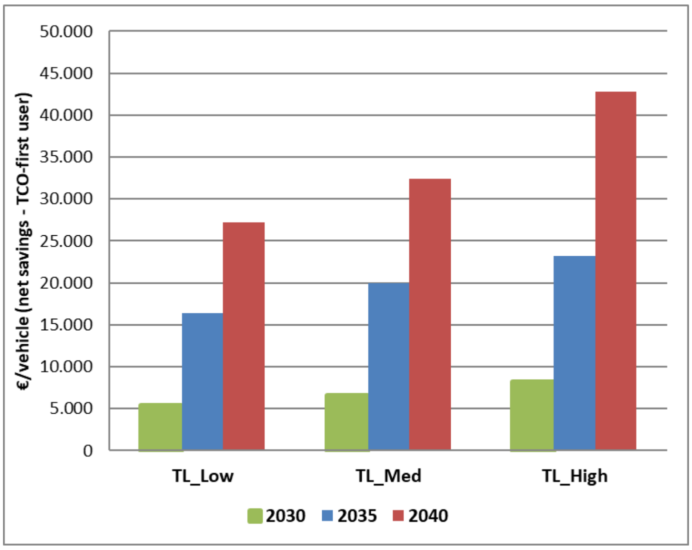


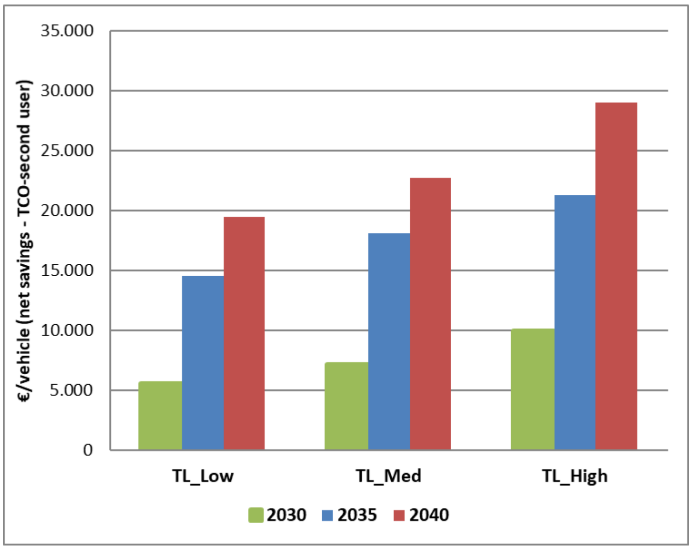


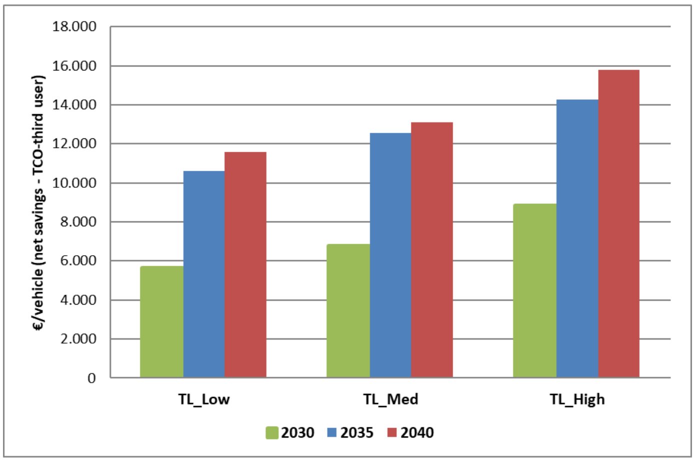


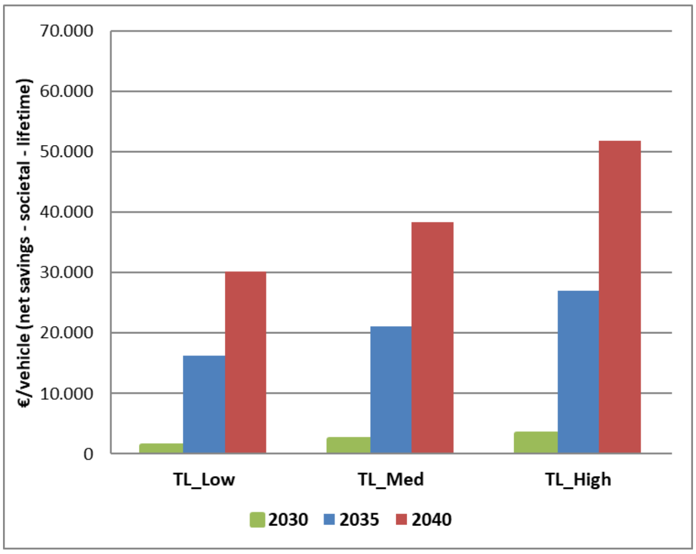
The second assumes electricity and hydrogen prices which are 10% higher than those presented in Section 13.1.4. As for the sensitivity on technology costs, it shows that, even when the price of such fuel increases compared to the main scenario runs, savings would still occur for all users and for the society.

Figure 26. Average net savings over the vehicle lifetime from different perspectives for a new average heavy-duty vehicle registered in 2030, 2035 or 2040, assuming higher electricity and hydrogen costs.









1.32. 18.2 Impact on GDP and jobs of options regarding CO2 target levels (TL)

18.2.1 Introduction

The E3ME model is used to assess macro-economic and sectoral economic impacts. In particular, it quantifies the impacts of the different CO_2 targets for light-duty vehicles on the wider economy, i.e. GDP, sectoral output and employment.

An analysis of the macro-economic impacts, including on employment, of meeting the different targets with respect to Heavy Duty Vehicles (HDV). HDVs are defined here as public transport vehicles (buses and coaches) and lorries. The targets reflect policies, including different CO_2 emissions standards for these types of vehicles. In total, three policy scenarios were run: Low, Medium and High ambition. All policies scenarios were compared to the baseline, in order to capture only the specific impacts of the policies affecting HDVs .

18.2.2 E3ME modelling results

The E3ME model is used to assess macro-economic and sectoral economic impacts (see Annex 4 for a detailed description of the model and the main assumptions used for the analysis), in particular, to quantify the impacts of the different CO_2 targets for heavy-duty vehicles on the wider economy, i.e. GDP, sectoral output and employment.

Table 15 shows the options for the target levels which were considered in the scenarios modelled by E3ME.

Table 15: Scenarios modelled with E3ME for assessing the macro-economic impacts of the TL options

• **E3ME scenarios**	• **CO_2 target levels option (HDVs)**
• Baseline	• As in current regulation (EU) 2019/1242
• Low	• TL_Low
• Medium	• TL_Med
• High	• TL_High

All the modelled scenarios estimate changes due to the new CO_2 target levels in order to isolate the macroeconomic effects of this specific policy. In all scenarios, government revenue neutrality from the associate reduction in fuel duty is imposed. The implementation of the new CO_2 targets reduces petrol and diesel consumption, which are commodities upon which taxes are levied in all Member States. The loss of fuel duty revenue due to lower petrol and diesel consumption is compensated, in all scenarios, by a proportional increase of VAT rates[102][103].

<u>GDP and sectoral output</u>

Table 16 shows the projected GDP impact for the EU-27 for the three scenarios compared against the baseline.

Table 16: GDP impacts in the baseline (million EUR in 2015 price) and percentage change from the baseline under the policy scenarios (E3ME results)

[102] As an example, in the scenario Low ambition scenario modelled through E3ME, it is projected that fuel duty revenues in the EU-27 decrease by around 730 million euros in 2030, corresponding to a 0.6% decrease with respect to the baseline. The fuel duty revenue loss represents around 0.004% of the EU-27 GDP. To ensure revenue neutrality, VAT total revenues increase by around 0.008% in 2030. The loss in fuel duty revenues in 2035 and 2040 amounts to up to 0.02% and 0.03% of the EU-27 GDP.

[103] The choice of VAT compensation is functional in the model to ensure government revenue neutrality, and it does not imply specific policy choices. Alternative options in reality are possible and they would depend on specific Member States choices.

Scenario	2030	2040	2050
Baseline (M€2015)	14,609,759	16,763,096	19,368,708
Low	+0.01%	0.06%	0.09%
Medium	+0.02%	0.08%	0.10%
High	+0.02%	0.11%	0.10%

The results show a positive impact, compared to the baseline, of the three policy scenarios on EU-27 GDP from 2030 onwards. It is projected that with stricter CO_2 targets for HDVs increased consumer expenditure as well as increased infrastructure and vehicle technology investment would be triggered.

In these scenarios, policies affecting HDV lead to lower transport costs for households and thus higher purchasing power with a net positive effect in the economy[104]. Despite VAT increases to offset the loss in fuel duty revenues (assumption), consumers overall benefit from higher disposable income. Together with a reduction in imports of petroleum products with its obvious benefit to trade balance, the lower investment in fossil fuels would result in an overall small positive impact on GDP, including through indirect effects, related to the increase of demand of goods and services in the EU.

At the sectoral level, there would be an expansion of electric and hydrogen vehicles supply chain, with a production increase in sectors such electronics and electrical equipment and electricity supply. This reflects the impact of increased demand for batteries, electricity infrastructure, electric motors as well as hydrogen feul manufacture and fuel cells.

The automotive sector would see a limited decrease in turnover due to the decreasing shares of internal combustion engines vehicles, while the electronic and electrical equipment sector would see an increase due to the additional demand for batteries.

This shows that the automotive value chain and its employment composition (see employment section below) are expected to change over time, with a shift from the production of components for internal combustion engines to the manufacturing and management of equipment for zero-emission powertrains.

While outside of the scope of the analysis of the impacts of different CO_2 emission standards levels, it should be noted that other trends, including connectivity and automation, and new business models, are likely to affect the automotive value chain, and its employment characteristics. While vehicle production is likely to remain the core competence of the automotive manufacturers, they have started to participate in new business models and to expand their suppliers pool to integrate new hardware, software and services.

Furthermore, the modelling results show that power and hydrogen supply sectors would increase production reflecting increased demand for electricity and hydrogen to power EVs, while the petroleum refining sector and petrol stations would see losses. Indirect effects are observed for the recreation and services sectors, which would benefit from higher demand from consumers. With stricter target levels, these effects would become slightly more pronounced.

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[104] Also considering the recharging and refuelling infrastructure costs

Table 17 shows the main impacts on the output within the most affected sectors for the different scenarios.

Table 17: Impacts on the output within the most affected sectors (million EUR in 2015 price) and percentage change from the baseline

	Baseline	Low	Medium	High
2030				
Petroleum refining	333 268	-0.21%	-0.32%	-0.51%
Automotive	867 506	0.01%	-0.01%	-0.01%
Electronics	412 685	0.01%	0.02%	0.02%
Metals	1 014 944	0.01%	0.01%	0.01%
Electrical equipment	310 232	0.06%	0.08%	0.13%
Electricity, gas, water, etc	1 186 861	0.08%	0.11%	0.17%
2040				
Petroleum refining	224 365	-2.21%	-2.79%	-3.67%
Automotive	937 985	0.05%	-0.05%	-0.08%
Electronics	476 499	0.07%	0.09%	0.15%
Metals	1 100 704	0.05%	0.08%	0.12%
Electrical equipment	356 527	0.14%	0.22%	0.37%
Electricity, gas, water, etc	1 289 883	0.43%	0.66%	1.11%
2050				
Petroleum refining	165,852	-2.37%	-2.38%	-2.39%
Automotive	1,034,706	0.00%	-0.08%	-0.09%
Electronics	552,025	0.10%	0.16%	0.15%
Metals	1,205,507	0.04%	0.12%	0.14%
Electrical equipment	411,582	0.23%	0.23%	0.21%
Electricity, gas, water, etc	1,373,390	1.63%	1.86%	2.02%

Consumer expenditure

The lower fuel and transport costs lead to increased purchasing power for consumers, since their real disposable incomes is higher than in the baseline. Households would pay less in real terms for transport and fuels, which would then allow them to spend money on other goods and services.

Table 18: Total impacts on Consumer expenditures the baseline (Million EUR) and changes to the baseline (% difference) under the three policy scenarios

Consumer expenditure EU27			
Scenario	**2030**	**2040**	**2050**
Baseline (M€2015)	8 179 661	9 210 465	10 572 667
Low	+0.02%	+0.06%	+0.13%
Medium	+0.02%	+0.09%	+0.16%
High	+0.02%	+0.12%	+0.17%

Employment

As shown in **Table 19**, stricter HDV CO_2 target levels resulting in an increase in economic output,there is also an increase in the number of jobs across the EU-27 compared to the baseline, be it overall limited. The number of additional jobs also increases over time. The main drivers behind the GDP impacts also explain the employment impacts.

Table 19: Total employment impacts in terms of number of jobs in the baseline (000s) and changes to the baseline (000s jobs) under the three policy scenarios

	2030	2040	2050
Baseline	200 613	194 601	187 796
Low	+9	+38	+81
Medium	+11	+54	+110
High	+13	+83	+121

At sectoral level, similar conclusions and considerations as for the impacts on the output can be drawn. The overall impacts are small. Positive impacts are mainly seen in the sectors supplying to the automotive sector as well as in the power sector. Other sectors experience some positive second order effects, e.g. as a result of overall increased consumer expenditure.

In the different options assessed, the market uptake of battery and plug-in hybrid electric vehicles increases with respect to the baseline, while the conventional powertrains remain the majority of the fleet in 2030, but decrease thereafter, as shown in **Section 18.3.1**. This impacts the employment situation in the automotive sector.

In particular, as shown in

Table 20, while the Low scenario results in net 9 000 additional jobs economy-wide in 2030, it also results in around 150 jobs losses in the automotive sector corresponding to 0.01% reduction compared to the baseline. Employment impacts are more pronounced in the long term. In 2040 there are net 38 000 additional jobs economy-wide, with job losses in the automotive sectors increase by around 400 jobs corresponding to 0.02% reduction compared to the baseline. In 2050 there are net 81 000 additional jobs economy-wide, with job losses in the automotive sectors increase by around 1600 jobs corresponding to 0.07% reduction compared to the baseline.

Job losses in the automotive sector reflect mainly the reduction in demand for internal combustion engine vehicles. However, as the automotive sector covers a variety of vehicles production activities, which would continue to operate for electric and hydrogen-powered vehicles production, the losses are limited.

Jobs in electronics and electrical equipment increase as a result of the additional demand for batteries, hydrogen fuel cells and components for the electric engines. To fully reap the job opportunities offered by the transition towards zero-emission mobility, it is essential to stimulate investments in these areas and sub-sectors with growth potential.

The change in the automotive value chain described above is reflected in these changes in the employment distribution at sectoral level. Transitions of employment can occur at different levels: intra-company, within the automotive sector and also outside of the automotive sector. In this context, it remains key to ensure that adequate policies and programs are set-up for the reskilling of workers to facilitate the transitions.

At the EU level, beside the Just Transition Fund, the European Social Fund Plus (ESF+) is the main EU instrument to address this concern, with the aim to support Member States to achieve a skilled workforce ready for the green and digital transition[105].

With a total budget of 88 billion euros, the ESF+ contributes to financing the implementation of the principles from the European Pillar for Social Rights through actions in the area of employment, education and skills and social inclusion. It aims to, inter alia, achieve high employment levels, ensure social inclusion, contribute to poverty reduction, and grow a skilled and resilient workforce ready for the transition to a green and digital economy.

The ESF+ will in particular make a strong contribution to the green and digital transitions by driving investment in skilling opportunities so that workers can thrive in a climate-neutral, more digital and inclusive society.

The Industrial Strategy for Europe[106] also highlights the importance of increasing investment in skills and life-long learning with collective action of industry, Member States, social partners and other stakeholders through a new **'Pact for Skills'**[107]. The Pact helps to mobilise the private sector and other stakeholders to upskill and reskill Europe's workforce.

The Pact also supports large-scale skills partnerships per ecosystem, some of which already put forward skilling commitments. The **Skills Roundtable** organized with the automotive sector provided a number of suggestions and principles for the automotive partnership, including:

[105] https://ec.europa.eu/esf/main.jsp?catId=62&langId=en

[106] COM(2021) 350 final and COM(2020) 102 final

[107] https://ec.europa.eu/social/main.jsp?catId=1517&langId=en

- The need to address the fragmentation of skills initiatives in the EU and encourage closer co-operation between companies and educational institutes.
- A key first step is to map those initiatives and identify ways for cooperation between initiatives building on the DRIVES project.
- The Pact for skills must be inclusive to take account of the whole value chain (including SMEs) and workforce with the different levels of skills required
- Local and regional training centres and clusters can play an important role in identifying skill needs (especially for SMEs) and help in the delivering of training.
- The Pact should build on the work of DRIVES and related blueprints such as the ALBATTS[108] project.

It is needed to ensure that educational programmes provide future employees with a set of skills matching future demands, while creating an ecosystem where industry, education, and national and regional authorities are working together in targeting key areas and implementing relevant training, reskilling and upskilling in the automotive sector. It is crucial to ensure the transformation of the labour force in a particular area and in a way that reflects the possibilities of the region. National and local-level initiatives, such as cooperation between employers, trade unions and schools, collective bargaining frameworks, social security reforms and increased incentives for workers to relocate (to address missing skill-needs) can be important in tackling this challenge.

The further expansion of the value chain driven by other trends than the transition to zero-emission mobility is also likely to create new job opportunities in sectors traditionally not part of the automotive value chain, such as electronics, software and services.

[108] See www.project-albatts.eu

Table 20 also shows that jobs are also projected to decrease in the petroleum refining sector, by about 200 in 2030 and just over 1 300 in 2050 as a consequence of the shift away from fossil fuels. However the electrification of road transport, increase employment in electricity sector.

Table 20: Employment impacts, broken down by sector

	Low	Medium	High	Low	Medium	High
	Number of jobs (thousands) change from baseline			**% change from baseline**		
2030						
Petroleum refining	-0.2	-0.4	-0.6	-0.18%	-0.29%	-0.46%
Automotive	-0.1	-0.2	-0.3	-0.01%	-0.01%	-0.01%
Electronics	0.0	0.0	0.0	0.00%	0.00%	0.00%
Metals	0.0	0.0	0.0	0.00%	0.00%	0.00%
Electrical equipment	0.6	0.8	1.2	0.04%	0.05%	0.07%
Electricity, gas, water	1.6	2.1	3.1	0.06%	0.08%	0.12%
Economy-wide Total	**9.2**	**10.7**	**13.5**	**0.00%**	**0.01%**	**0.01%**
2040						
Petroleum refining	-1.7	-2.2	-2.9	-1.93%	-2.44%	-3.20%
Automotive	-0.4	-0.8	-1.4	-0.02%	-0.03%	-0.06%
Electronics	0.2	0.2	0.3	0.02%	0.02%	0.03%
Metals	0.7	1.0	1.8	0.02%	0.03%	0.05%
Electrical equipment	1.7	2.7	4.4	0.09%	0.14%	0.24%
Electricity, gas, water, etc	7.0	10.6	17.5	0.30%	0.46%	0.76%
Economy-wide Total	**37.9**	**53.8**	**82.6**	**0.02%**	**0.03%**	**0.04%**
2050						
Petroleum refining	-1.3	-1.3	-1.3	-2.08%	-2.09%	-2.10%
Automotive	-1.6	-1.4	-1.4	-0.07%	-0.06%	-0.06%
Electronics	0.2	0.2	0.1	0.02%	0.02%	0.02%
Metals	0.7	1.4	1.9	0.02%	0.04%	0.05%
Electrical equipment	3.0	3.1	2.8	0.14%	0.01%	0.13%
Electricity, gas, water, etc	22.3	28.3	33.5	1.07%	1.36%	1.60%
Economy-wide Total	**81.0**	**110.3**	**121.3**	**0.04%**	**0.06%**	**0.06%**

1.33. 18.3 Additional PRIMES-TREMOVE results

18.3.1 Fleet composition

To complement the composition of the average fleet of new regulated heavy-duty vehicles presented in section 6.3.1, the **Table 21** below provides the same indicators broken down by vehicle type and, for lorries, vehicle size.

Table 21 **Share of powertrain in the new stock, in specific years, for buses, coaches and lorries**

Buses above 7,5 tonnes	Diesel (including hybrid)	Gas-powered vehicles	PHEV	BEV	Hydrogen-powered vehicles
2030					
Baseline	56%	6%	2%	34%	2%
TL_Low	21%	3%	3%	70%	3%
TL_Med	15%	2%	3%	77%	3%
TL_High	7%	1%	3%	85%	4%
2035					
Baseline	45%	7%	2%	40%	6%
TL_Low	16%	3%	4%	68%	8%
TL_Med	9%	2%	4%	76%	9%
TL_High	4%	1%	3%	83%	9%
2040					
Baseline	27%	10%	3%	45%	16%
TL_Low	7%	2%	3%	70%	18%
TL_Med	3%	1%	3%	73%	20%
TL_High	0%	0%	0%	71%	29%

Coaches above 7,5 tonnes	Diesel (including hybrid)	Gas-powered vehicles	PHEV	BEV	Hydrogen-powered vehicles
2030					
Baseline	87%	2%	0%	4%	8%
TL_Low	70%	2%	0%	8%	19%
TL_Med	61%	2%	0%	11%	26%
TL_High	43%	2%	0%	17%	38%
2035					
Baseline	77%	2%	0%	7%	13%
TL_Low	50%	2%	0%	17%	31%
TL_Med	35%	2%	0%	22%	41%

TL_High	21%	1%	0%	28%	50%
2040					
Baseline	63%	3%	0%	10%	24%
TL_Low	25%	2%	0%	23%	50%
TL_Med	14%	1%	0%	26%	58%
TL_High	0%	0%	0%	30%	70%

Lorries between 5 and 7,5 tonnes (as in scope 1)	**Diesel (including hybrid)**	**Gas-powered vehicles**	**PHEV**	**BEV**	**Hydrogen-powered vehicles**
2030					
Baseline	76%	14%	6%	4%	1%
TL_Low	66%	13%	12%	7%	1%
TL_Med	61%	12%	15%	10%	1%
TL_High	48%	10%	24%	16%	2%
2035					
Baseline	65%	20%	7%	7%	1%
TL_Low	50%	16%	19%	13%	2%
TL_Med	40%	13%	25%	19%	4%
TL_High	28%	9%	29%	29%	5%
2040					
Baseline	53%	25%	7%	12%	3%
TL_Low	32%	11%	23%	28%	6%
TL_Med	21%	8%	22%	40%	9%
TL_High	0%	0%	0%	80%	19%

Lorries between 7,5 and 16 tonnes (as in scope 1)	**Diesel (including hybrid)**	**Gas-powered vehicles**	**PHEV**	**BEV**	**Hydrogen-powered vehicles**
2030					
Baseline	69%	14%	6%	9%	2%
TL_Low	57%	12%	10%	18%	3%
TL_Med	52%	11%	12%	22%	3%
TL_High	39%	8%	15%	33%	5%
2035					
Baseline	57%	19%	5%	15%	4%
TL_Low	40%	13%	11%	30%	6%
TL_Med	31%	11%	12%	39%	8%
TL_High	21%	7%	11%	50%	10%

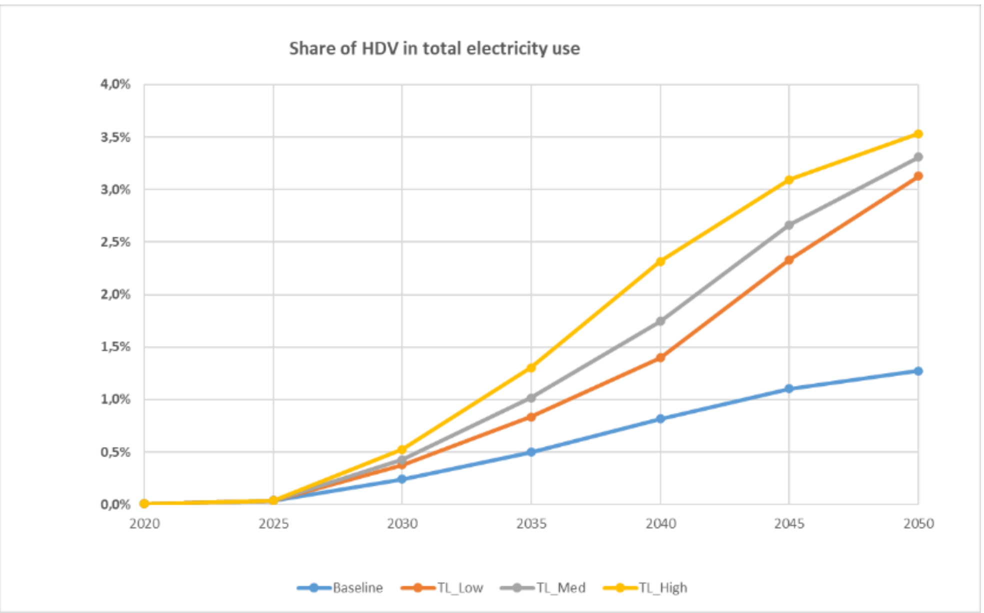
2040					
Baseline	44%	23%	4%	22%	7%
TL_Low	24%	9%	10%	46%	12%
TL_Med	16%	6%	8%	57%	14%
TL_High	0%	0%	0%	78%	22%

Lorries above 16 t (as in scope 1)	**Diesel (including hybrid)**	**Gas-powered vehicles**	**PHEV**	**BEV**	**Hydrogen-powered vehicles**
2030					
Baseline	66%	20%	0%	7%	7%
TL_Low	64%	16%	0%	9%	11%
TL_Med	63%	13%	1%	10%	13%
TL_High	58%	9%	0%	14%	18%
2035					
Baseline	52%	26%	0%	10%	13%
TL_Low	45%	18%	0%	15%	21%
TL_Med	39%	14%	0%	19%	28%
TL_High	32%	8%	0%	24%	35%
2040					
Baseline	35%	30%	0%	13%	21%
TL_Low	27%	12%	0%	21%	40%
TL_Med	19%	7%	0%	25%	48%
TL_High	0%	0%	0%	31%	69%

18.3.2 Electricity demand

Figure 27 shows the share of the total EU-27 electricity consumption used by HDV for the considered three TL options. HDV in general (and long-haul road transport in particular) will demand about 14, 78 and 130 GWh in 2030, 2040 and 2050 in the most ambitious scenario TL_High. This represents approximatively 0.5%, 2.3% and 3.5% of the total electricity consumption in those years.

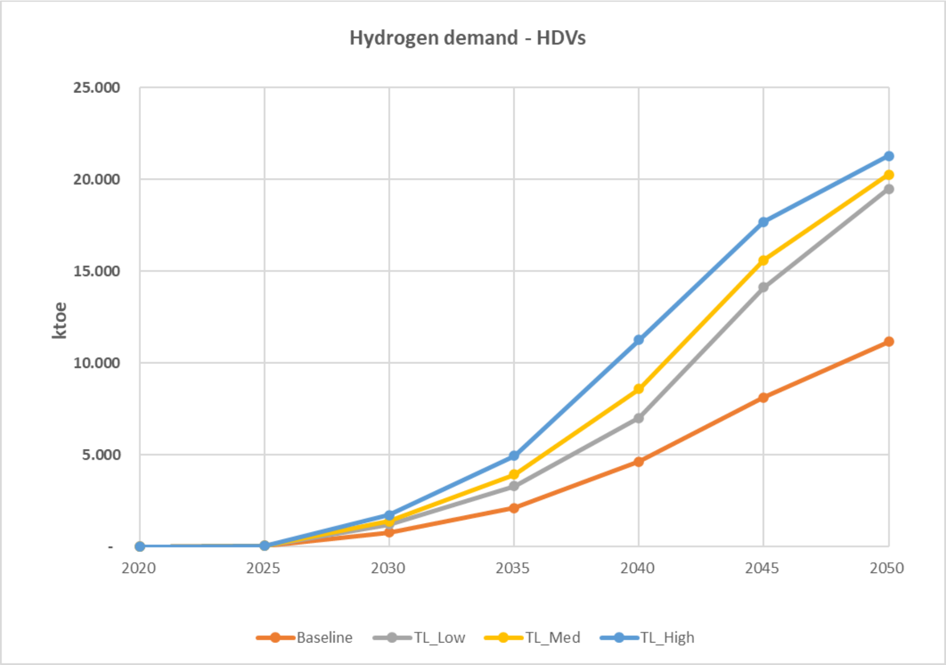
Figure 27: Electricity consumption by HDVs as a percentage of total electricity consumption (EU-27) under different TL options



18.3.3 Hydrogen consumption

Hydrogen has also an important role to play in reducing emissions in HDV, as illustrated in the Figure 28. below that shows its expected consumption by lorries, buses and coaches in 2030, 2035, 2040 and 2050 for the considered TL options.

Figure 28. Hydrogen demand by HDVs (EU-27) under different TL options.



18.3.4 WTW CO2 emissions

Well-To-Wheel (WTW) CO_2 emissions trend progress across the different TL options very similar as for the tailpipe CO_2 emissions. Nonetheless, the regression trend is softer in reason of the upstream emissions (WTT, Well-To-Tank).

The cumulative savings of WTW CO_2 emissions between 2031 and 2050 amount to 719, 841, 1023 Mtons in TL_Low, TL_Medium and TL_High respectively. These represent respectively 31, 36 and 44 % of the projected emissions in the baseline scenario over the same 20 years.

18.3.5 Air pollutant emissions

Many climate change mitigation strategies in the transport sector would have several co-benefits, including air quality improvements and health benefits.[109] The HDV standards contribute to reducing air pollutant emissions through the reduction of fuel consumption by both the adoption of energy efficiency technologies and shift to ZEV (which do not produce tailpipe emissions). The benefits of changes in fuel consumption and mix as a result of stricter standards have been assessed. Effects of stricter air pollutant emission standards for internal combustion engine vehicles, as estimated in Euro 7, are taken into account (also in the baseline) as they should further reduce the pollutant emissions from these vehicles. Cumulative discounted health benefits would sum up to EUR 7 to 14 billion between 2031 and 2050. The most ambitions targets deliver the better results in terms of higher air quality co-benefits, with the ZEV mandate for buses having a positive effect. On the other hand, keeping the current scope and accounting for renewable and low-carbon fuels would reduce such savings. Additional details are provided in Table 22 and

[109] IPCC Sixth Assessment Report. Mitigation of Climate Change. Summary for Policymakers

Table 23 (source: PRIMES-TREMOVE)

Table 22 Reductions in air pollutants compared to the baseline under different TL options.

		Savings vs Baseline				
		2030	**2035**	**2040**	**2045**	**2050**
TL_Low, SCOPE1	CO	-2%	-6%	-13%	-38%	-66%
	NOx	-2%	-6%	-13%	-37%	-67%
	PM2.5	-3%	-7%	-13%	-37%	-66%
	SO2	-3%	-8%	-14%	-34%	-61%
TL_Med, SCOPE1	CO	-3%	-9%	-22%	-48%	-72%
	NOx	-3%	-9%	-22%	-47%	-74%
	PM2.5	-4%	-10%	-21%	-46%	-72%
	SO2	-4%	-12%	-24%	-45%	-68%
TL_High, SCOPE1	CO	-4%	-14%	-36%	-61%	-80%
	NOx	-5%	-14%	-37%	-62%	-83%
	PM2.5	-5%	-15%	-35%	-60%	-81%
	SO2	-5%	-18%	-40%	-61%	-79%

Table 23 Reductions in air pollutants compared to the TL_Low, TL_Med and TL_High under different options

		Difference vs TL_Low				
		2030	**2035**	**2040**	**2045**	**2050**
TL_Low, SCOPE1, ZEV BUS2	CO	-1%	-2%	-2%	-1%	-1%
	NOx	-1%	-1%	-1%	-1%	0%
	PM2.5	-1%	-1%	-1%	-1%	0%
	SO2	-1%	-1%	-1%	-1%	0%

		Difference vs TL_Med				
		2030	**2035**	**2040**	**2045**	**2050**
TL_Med, SCOPE0	CO	5%	9%	17%	35%	52%
	NOx	2%	4%	9%	22%	37%
	PM2.5	4%	7%	14%	30%	46%
	SO2	4%	8%	16%	31%	51%
TL_Med, SCOPE1, LCF_factor	CO	1%	4%	7%	6%	3%
	NOx	2%	5%	8%	6%	3%
	PM2.5	2%	4%	7%	6%	3%
	SO2	2%	5%	8%	7%	4%
TL_Med, SCOPE1, LCF Credits	CO	1%	2%	2%	1%	0%
	NOx	1%	2%	2%	1%	0%
	PM2.5	1%	2%	2%	1%	0%
	SO2	1%	3%	2%	1%	0%
TL_Med, SCOPE1, ZEV BUS2	CO	-1%	-1%	-1%	-1%	0%
	NOx	0%	-1%	-1%	-1%	0%
	PM2.5	0%	-1%	-1%	-1%	0%
	SO2	0%	-1%	-1%	-1%	0%

		Difference vs TL_High				
		2030	**2035**	**2040**	**2045**	**2050**
TL_High, SCOPE0	CO	6%	12%	24%	42%	56%
	NOx	2%	4%	13%	27%	40%
	PM2.5	5%	9%	20%	37%	50%
	SO2	4%	10%	21%	37%	55%
TL_High, SCOPE1, ZEV BUS2	CO	0%	-1%	-1%	-1%	-1%
	NOx	0%	0%	-1%	-1%	0%
	PM2.5	0%	0%	-1%	-1%	-1%
	SO2	0%	0%	-1%	-1%	0%

1.34. 18.4 Complementary information on trailer modelling

1.35. 18.4.1 Methodology for energy efficient trailer modelling

1.36. 18.4.1.1 Introduction

A total cost of ownership (TCO) and fleet-wide greenhouse gas (GHG) emission analysis was carried out for the potential introduction of energy-efficient (semi-)trailer targets from 2030 to 2050. The whole analysis was performed by Ricardo, with data from DG Joint Research Centre (JRC) and TU Graz (Graz University of Technology) for the European Commission

1.37. 18.4.1.2 Key inputs and assumptions

The analysis performed by Ricardo consists of two elements:

(i) HDV (semi-)trailer EU fleet impacts analysis, and

(ii) Marginal total cost of ownership (TCO) of new (semi-)trailers analysis.

1.38. 18.4.1.2.1 Data sources used

The energy efficient trailer modelling utilised a number of key datasets:

- Cost/energy consumption cost-curves for energy efficient trailer technologies provided by the JRC using the Dione model, based on trailer technology simulation results undertaken by TU Graz and cost data developed by Ricardo;
- PRIMES-TREMOVE modelling outputs for baseline, low ambition, medium ambition and high ambition vehicle CO_2 target scenarios; including number of vehicles per group and powertrain, total vehicle activity, total GHG emissions, fuel prices and fuel emission factors;
- Total trailer stock, new trailer stock per year based on a European trailer database from 2005 to 2025 (provided by CLEAR International).

1.39. 18.4.1.2.2 (Semi-)trailer EU fleet impact

In order to calculate the potential fleet-level impacts (on capital costs, fuel costs and CO_2 emissions), Ricardo developed a simple trailer stock model based on trailer stock dataset, and future projections beyond 2025 based on the EC modelling scenario outputs. The analysis disaggregates by trailer type (Semi/Drawbar, as described in Table 24) and trailer group (Box/Curtain, Reefer, others, as described in Table 25), and calculates impacts based on different scenarios for trailer efficiency targets, and for different ambition levels for the main vehicle modelling.

The main inputs for the (semi-)trailer EU fleet impact analysis included:

- The CLEAR international trailer dataset, containing total stock of trailers by trailer type and new trailers by trailer type projected to 2025;
- The (semi-)trailer efficiency cost-curves developed (by JRC using their Dione model) from the outputs from Task 4 (of the CO2 regulations support project) at a powertrain group level (See Table 26 for more details) and by HDV segment (Table 24);

- Trailer activity and utilisation rates (per trailer type and vehicle group), derived from PRIMES-TREMOVE modelling outputs of vehicle activity and stock along with the CLEAR trailer dataset;
- Inputs for different scenarios from PRIMES-TREMOVE for the baseline and different ambition levels (low, medium and high) for CO_2 targets for HDVs, including:
  - **(a)** Vehicle stock and average efficiency (energy consumption per km) for relevant HDV segments and powertrain types to 2050.
  - **(b)** Total vehicle fleet GHG emissions (ktCO2e) for relevant HDV segments and powertrain types to 2050.
  - **(c)** Fuel price projections and emission factors for the different fuel types to 2050.

Fleet modelling assumptions

For the purposes of the energy-efficient trailer modelling, 5 vehicle segments (Table 24) were included as they operate potentially regulated trailers.

Table 24: Potentially regulated trailers and motor vehicles towing them

Vehicle segment	Trailer type	Vehicle type
Group 4	Drawbar	Rigid Lorry
Group 5	Semi-trailer	Articulated Lorry
Group 9	Drawbar	Rigid Lorry
Group 10	Semi-trailer	Articulated Lorry
Group 12	Semi-trailer	Articulated Lorry

The trailers were categorised into three groups: BoxCurtain (Dry Box, Curtain), Reefer (refrigerated trailers) and Others (tipper, chassis, tankbulk, etc). The BoxCurtain and Reefer trailer categories will have potential energy efficient targets explored, whereas the Other trailer types are not proposed/deemed suitable to be regulated at this stage. The trailer cost curve outputs were potentially different for the Reefer trailer types (as there are additional reefer-specific measures available – such as improved insulation and cooling systems) [110], and therefore they are kept separate from the BoxCurtain trailer group in the modelling.

Table 25: Trailer grouping considered in the modelling

Trailer group	Trailers covered	Regulated/Unregulated
BoxCurtain	Dry Box, Curtain	Regulated (proposed)
Reefer	Reefer	Regulated (proposed)
Others	Tipper, Chassis, TankBulk, etc.	Unregulated

[110] There are currently not established mechanisms for inclusion of such Reefer-specific technologies in the modelling/certification approach developed for trailers, so these were not in the end included in the cost-curves. However, they may be added at a future time, once suitable certification approaches are put in place.

Future projections of the different vehicle powertrains for the 5 vehicle segments were included. Although trailers can be attached to any vehicle and powertrain type, there are different cost curve associated with different trailer and powertrain combinations. For the purposes of the modelling, the cost curves were grouped into 4 powertrain groups, where the trailer cost-curves for the vehicle powertrains within these groups were minimally different, namely: ICEs (internal combustion engines), xEVs (mono-fuel electric powertrains), PHEVs (plug-in hybrid electric vehicles), and REEVs (range-extended electric vehicles). The mapping of powertrains to each powertrain group is shown in Table 26 below.

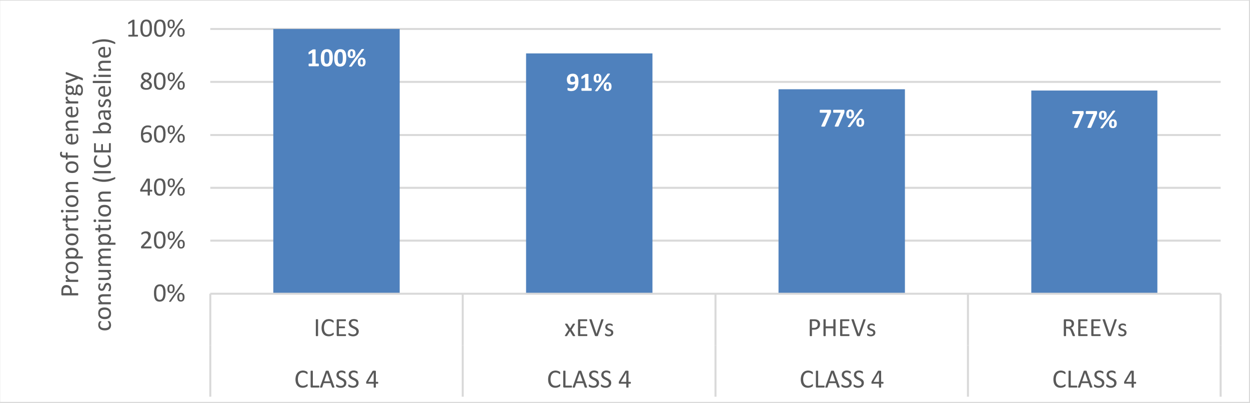
Table 26: Vehicle powertrains mapping to trailer cost curve group

Powertrains included	Powertrain trailer cost curve group
CI ICE	ICE/HEVs
CI HEV	ICE/HEVs
SI ICE-CNG	ICE/HEVs
SI ICE-LNG	ICE/HEVs
CI ICE-LNG	ICE/HEVs
SI ICE-H2	ICE/HEVs
CI PHEV	PHEVs
BEV	xEVs
BCEV	xEVs
FCEV	xEVs
FC-REEV	REEVs

Energy scaling

Energy efficient trailer targets are proposed to be implemented based on (i.e. with energy savings potential defined relative to) the current diesel vehicle standard; however, a trailer could be pulled by any type of powertrain in actual applications. The developed trailer cost curves are different for each powertrain group, and therefore will have different effects on real-world operational energy consumption for the fleet impacts analysis, despite having the same energy-efficient trailer target. This scaling for effects of standards on vehicles with different powertrains was calculated using the end points of the powertrain group cost curves, as some powertrain groups will have a higher energy-saving potential compared to diesel (e.g. presented for a group 4 rigid lorry in Figure 29 below).

Figure 29: Proportion of energy consumption for different powertrain groups against a diesel ICE baseline (Group 4, BoxCurtain, 2020)



1.40. 18.4.1.2.3 TCO of new (semi)trailers

The estimated marginal impacts (compared to the baseline of no efficiency standards) on TCO for the whole vehicle in combination with the trailer (i.e. rigid lorry+drawbar trailer, or tractor+semi-trailer) were calculated. The impacts of possible cost elements from policy scenarios on TCO were considered, i.e. effects of improved efficiencies but also new elements such as road tolls as function of the vehicle+trailer efficiency levels.

The main inputs for the TCO of new (semi-) trailers included:

- The (semi-)trailer efficiency cost-curves.
- The emission/energy savings at a vehicle/trailer level.
- Data on trailers, including:
  - Annual trailer mileage
  - Trailer lifetime (for societal cost) and payback period (for end-user cost)[111]
  - Fuel cost (with and without taxes), taken from PRIMES-TREMOVE
  - External cost of GHG emissions[112]
  - Discount rates (to society and end-user, taken from PRIMES-TREMOVE

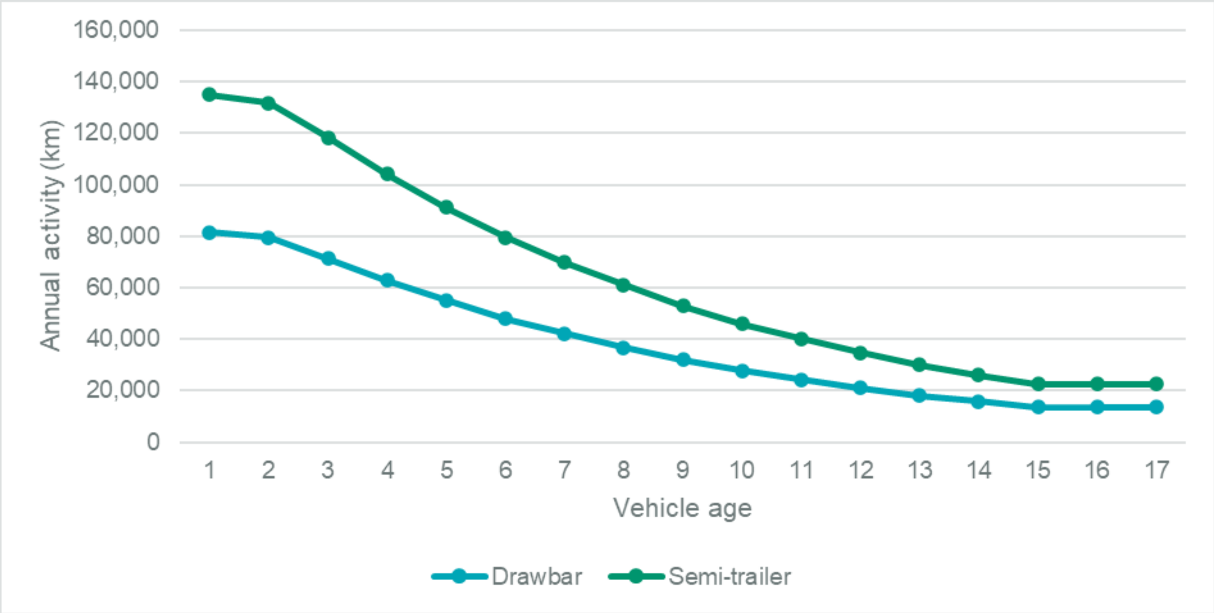
Annual trailer mileage profiles are shown in

[111] Bodies and trailers – development of CO2 emissions determination procedure; Procedure no: CLIMA/C.4/SER/OC/2018/0005

[112] Handbook on the external costs of transport: Handbook on the external costs of transport - Publications Office of the EU (europa.eu)

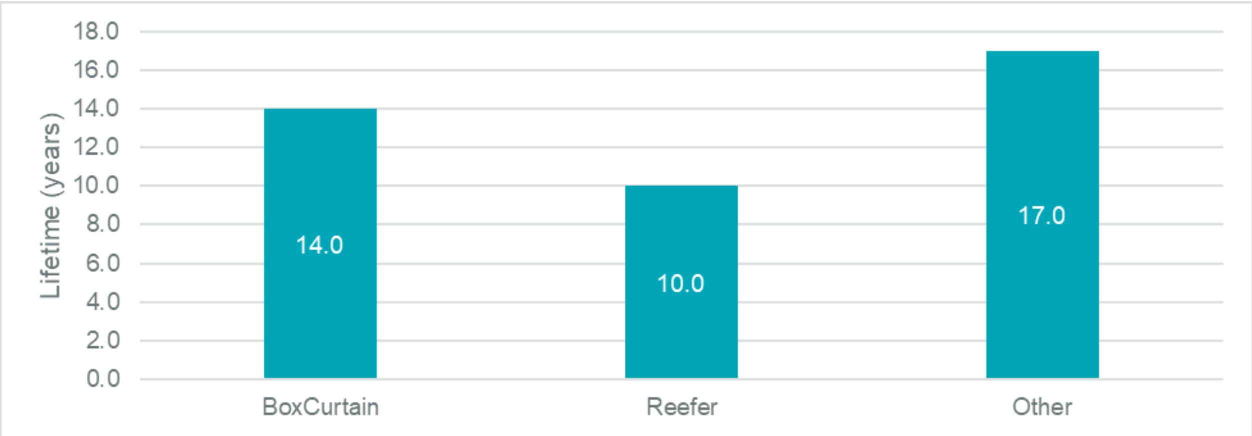
Figure 30 below as a function of the trailer/vehicle age. Vehicles pulling drawbar trailers (group 4, group 9) have a lower annual activity compared to vehicles pulling semi-trailers (group 5, 10, 12). Trailer mileage was aligned to vehicle mileage for drawbar trailers, as there are more vehicles (group 4 and 9) compared to drawbar trailers. The Semi-trailer mileage was scaled down as there are more trailers compared to vehicles (group 5, 10 and 12).

Figure 30: Annual activity profiles per vehicle age, for vehicles pulling drawbar trailers and vehicles pulling semi-trailers ('Other' trailers only)



Trailer types have different lifetimes, with reefer trailers averaging 10 years lifetime, whilst BoxCurtain trailers have a slightly longer lifespan of 14 years (Figure 31). The trailer lifetimes and lifetime activities were used to understand marginal TCO from different user perspectives, and also used in the trailer stock modelling exercise.

Figure 31: Average trailer lifetime per trailer type

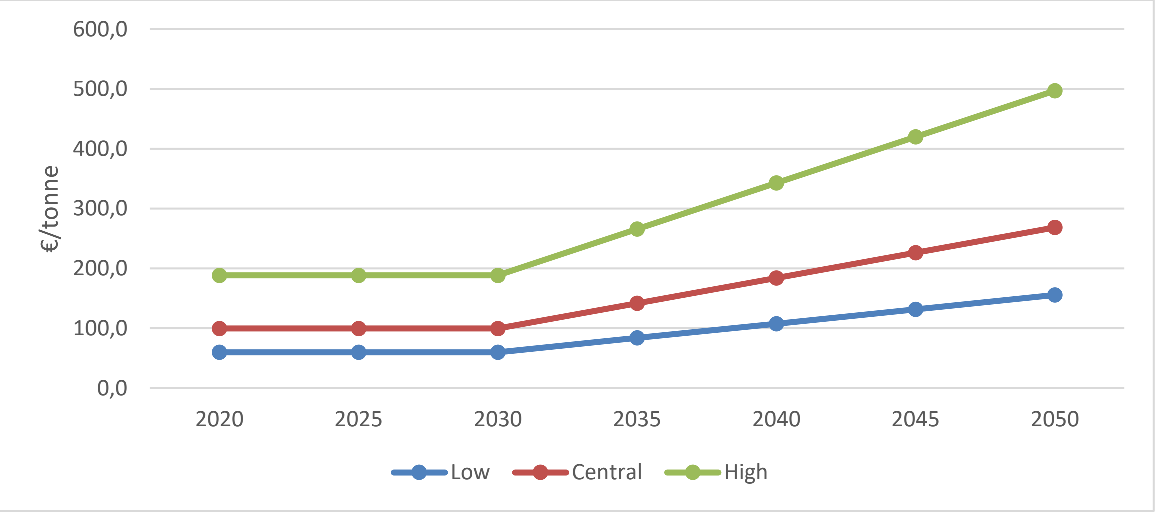


Source: Bodies and trailers – development of CO2 emissions determination procedure; Procedure no: CLIMA/C.4/SER/OC/2018/0005

The external cost of GHG emissions were taken directly from the Handbook on the external costs of transport (

Figure 32) in €/tonne, and multiplied by the total tonnes of GHG saved from implementing energy efficient trailers. For the purposes of target setting, the Central values were used to calculated GHG monetary savings from the social perspective. GHG external costs do not apply to the end user perspectives.

Figure 32: External costs of climate change from the Update of the Handbook on External Costs of Transport (in €/tonne CO2)



Source: Handbook on the external costs of transport: [Handbook on the external costs of transport - Publications Office of the EU (europa.eu)]

Marginal TCO assumptions

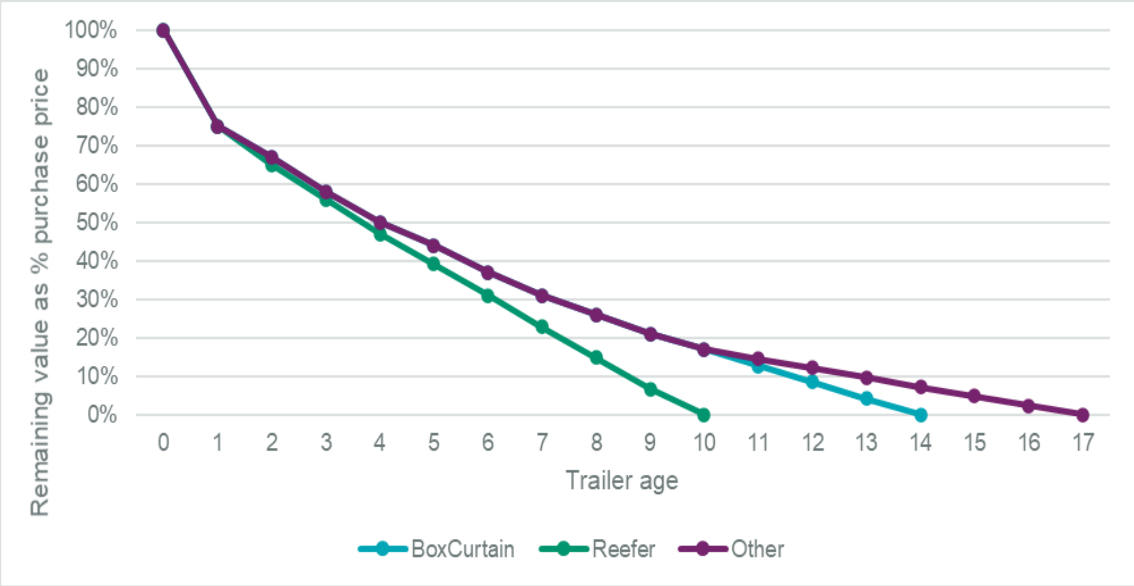
The marginal TCO calculations include the same vehicle segments and trailer groups as the fleet impacts analysis. The results are provided for new trailers across their lifetime for each powertrain type, and from two aspects:

1. **Marginal total cost to society**: excluding taxes on trailer CAPEX and fuels/electricity, including price of carbon for GHG emissions, and costs provided over the whole trailer lifetime. Social discount rates will apply.
2. **Marginal total cost to the end-user**: including taxes on trailer CAPEX and fuels/ electricity, excluding the price of carbon for GHG emissions, and costs provided over the payback period of the trailer. Private discount rates will apply.

The total cost to end-user is calculated on a trailer lifetime basis, as well as being further separated into marginal TCO for end-user 1 and end-user 2. This is to better understand the marginal TCO for second-hand trailers and accounts for trailer depreciation (see depreciation curves for trailer types in

Figure 33.

Figure 33: Remaining trailer value as % of purchase price, per trailer type



End-user 1's perspective represents a user purchasing a new trailer a keeping it for the end-user depreciation period (i.e. 5 years used in the analysis), and end-user 2's perspective will represent another user purchasing the trailer second hand after the end-user 1 period and using this trailer for a further period (i.e. also 5 years used in the analysis).

It is assumed that the following elements remain the same between the baseline trailer efficiency scenario and the energy efficient trailer scenario, so net to zero in the marginal TCO analysis:

- Maintenance costs (energy efficient technologies assumed to not increase maintenance cost)
- Driver costs (cost of the driver unchanged due to technologies)
- Taxes (except road charges)

The following elements may be different for the baseline trailer efficiency scenario and the energy efficient trailer scenario:

- Trailer CAPEX cost (due to technology costs, derived from cost curves)
- Energy cost (due to energy savings)
- Road charges (for non zero-emission powertrains)[113]

Weighted average targets

The energy-efficient trailer input targets are defined as a weighted average for the different vehicle groups under each trailer class (i.e. group 4 and 9 – drawbar; group 5 and 10 – semi-trailer). The % targets are based on the weighted averages, but the

[113] Road charges are aligned with the PRIMES-TREMOVE modelling outputs, and are proportioned down for energy efficient trailers based on the trailer target (e.g. a 5% reduction target will result in 5% reduction in road user charges)

costs/savings based on the disaggregated equivalent values for the specific vehicle group. In determining the actual costs, the equivalent % reduction for each class (e.g. group 4 and group 9 for drawbars) is calculated based on the differences in their maximum % reduction potential compared to the weighted average, e.g. for 2030

Maximum reduction potential from cost curve for drawbar:

- group 4: 7.8%
- group 9: 11.2%
- **Weighted Av.: 9.5%**

Implemented % reduction in the calculations for 7.6% reduction target (weighted average):

- group 4: 7.6%* 7.8%/9.5% = 6.3% (i.e. equivalent target for group 4)
- group 9: 7.6% * 11.2%/9.5% = 8.9% (i.e. equivalent target for group 9)

These figures can be considered the equivalent group-specific targets based on the 7.6% average target.

1.41. 18.4.1.3 Calculation methodology

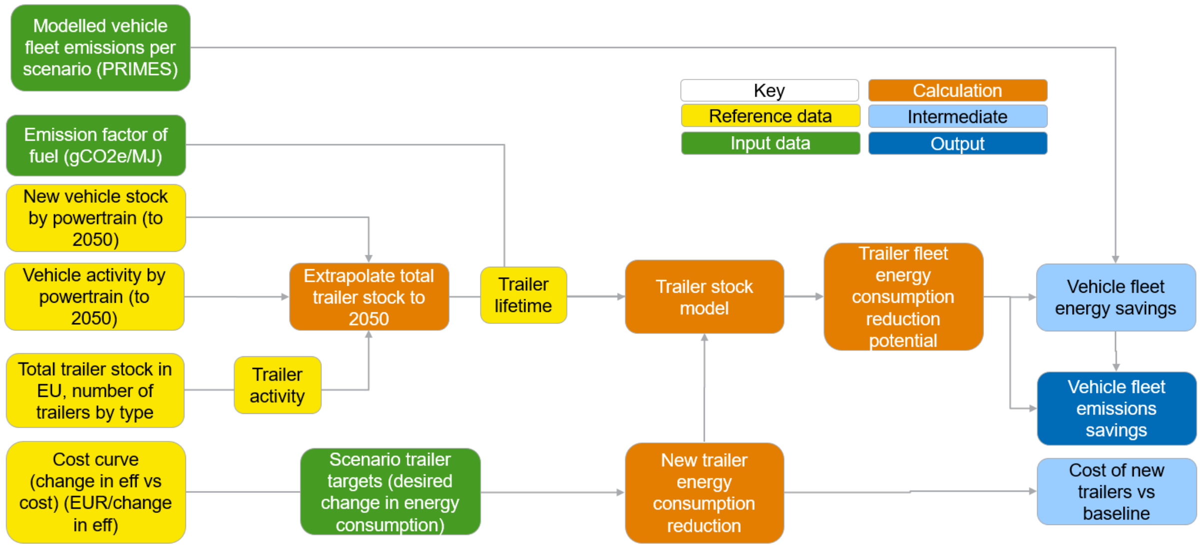
1.42. 18.4.1.3.1 HDV fleet impact analysis

The HDV fleet Impacts analysis schematic is shown below (

Figure 34), and the main calculations included:

- **Trailer stock extrapolation**. Extrapolation of the total trailer stock from 2025 to 2050, using the trailer/vehicle activity increase (from the relevant PRIMES-TREMOVE EC modelling scenario results data) as a proxy along with the CLEAR international trailer dataset. Activity ratios were derived per trailer type (BoxCurtain, Reefer, Others) to calculate the total activity per vehicle group and therefore the total trailers required to fulfil the required activity.
- **Trailer stock model**. Calculate the fleet-wide efficiency per year as a result of introducing new energy efficient trailers. The trailer stock included new trailers, removed trailers and total trailers. The new trailer introduced have the energy-efficient targets applied, and as a result the overall trailer fleet becomes more efficient.
- **Scenario emissions of the fleet**. Apply the fleet-wide trailer efficiency (relevant to the baseline) calculated in the trailer stock model to the baseline emissions (taken directly from PRIMES-TREMOVE modelling output).

Figure 34: HDV fleet impacts analysis schematic

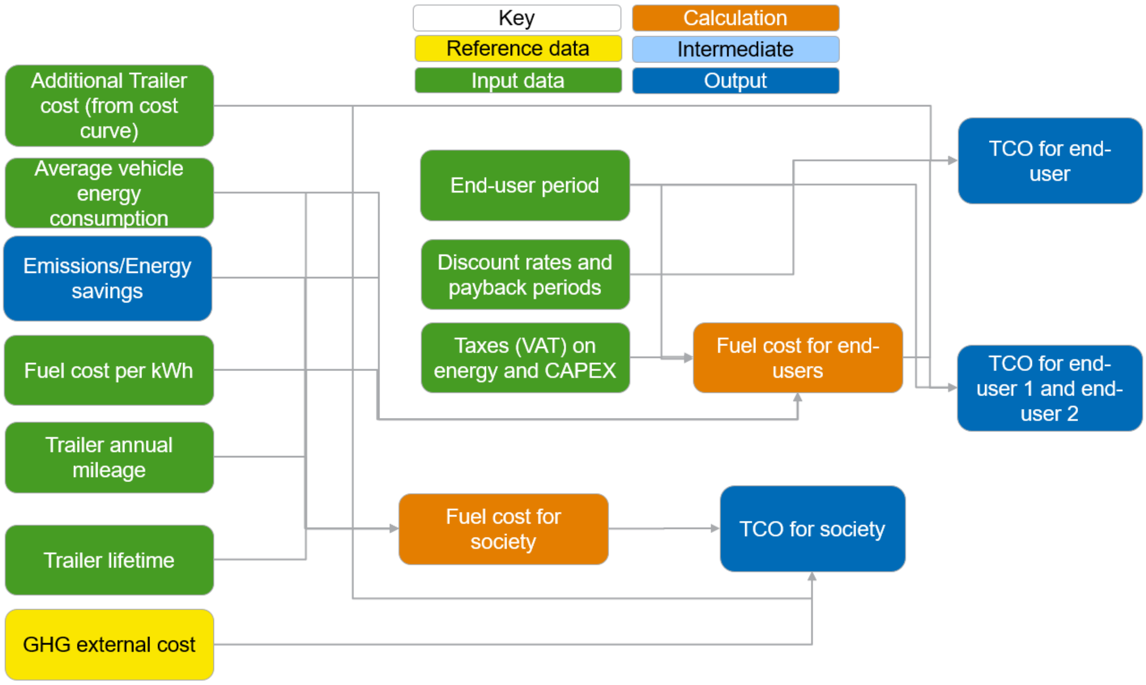


1.43. 18.4.1.3.2 Marginal TCO analysis

The schematic for the marginal TCO analysis is shown below. The main calculations included:

- **Fuel cost.** The total annual fuel cost calculated using the energy savings output (for the average lorry/trailer combination) from Module 1 and associated fuel costs per powertrain.
- **TCO for end-user**. The cost curves will be combined with the fuel cost (with taxes) and trailer cost (from cost curves) to calculate the TCO for the end-user.
- **TCO for society**. This module will use the fuel cost (without taxes), trailer cost (without taxes) and GHG externalities to calculate the TCO for society.

Figure 35: Marginal TCO analysis schematic



1.44. 18.4.2 Additional data

Figure 36: TCO savings for 1st user as a function of the energy consumption reduction target for trailers (for trailers registered in 2030)

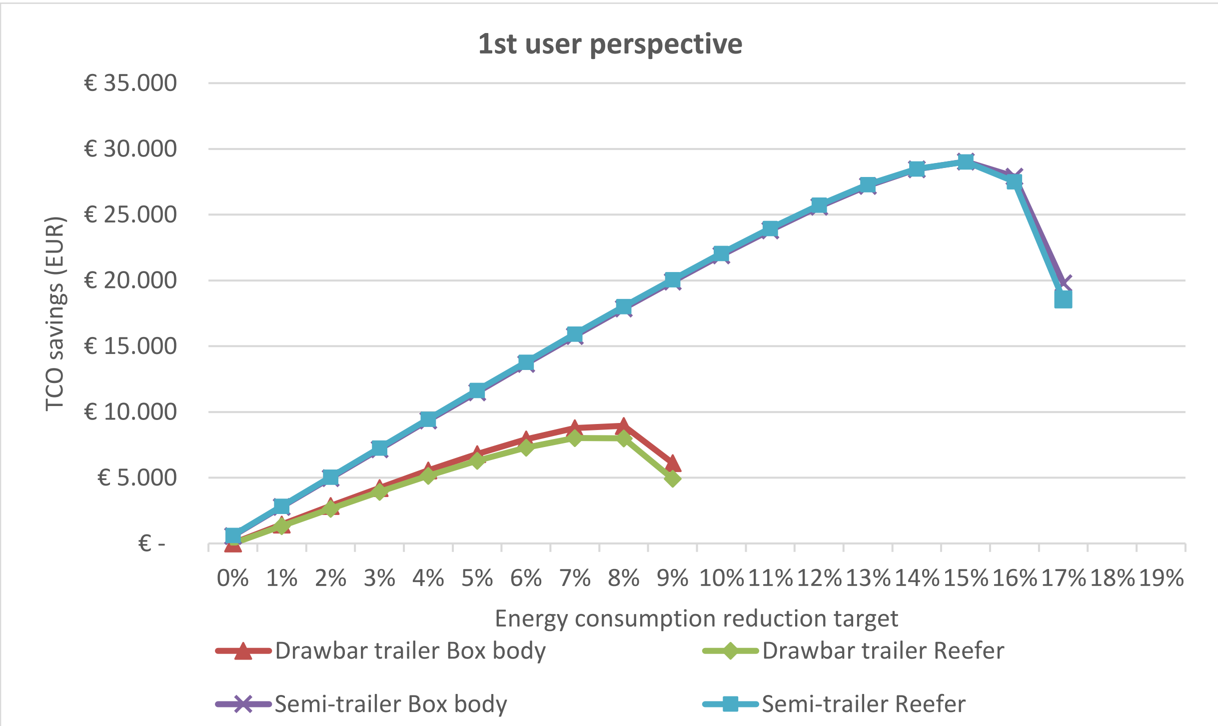


Figure 37. TCO savings from a societal perspective as a function of the energy consumption reduction target for trailers (for trailers registered in 2030).

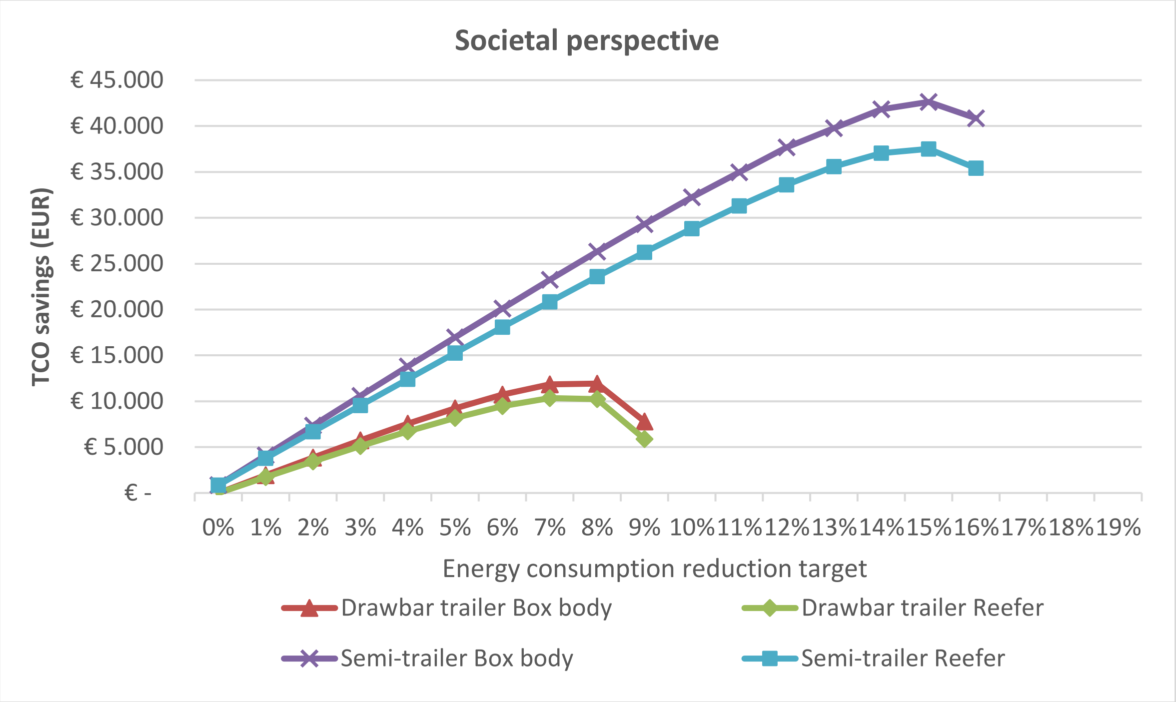


Table 27. and

Table 28 show various economic data for trailers determined for the cost optimal targets as presented above in figures 14 and 15 in chapter 6.4. In addition they also show the manufacturing costs.

Table 27. Trailer TCOs for cost optimal energy consumption targets from 1st user perspective (for trailers registered in 2030, compared to baseline).

Trailer group		Cost optimal energy consumption reduction target from a 1st user perspective	Manufacturing costs	TCO savings from a 1st user perspective	TCO savings from a 2nd user perspective	TCO savings from a societal perspective
Drawbar trailer	**Box body**	7,6%	2 521 €	9 025 €	5 568 €	13 199 €
	Reefer	7,5%	2 530 €	8 881 €	5 081 €	11 437 €
Semi-trailer	**Box body**	15,0%	5 076 €	29 036 €	17 613 €	42.632 €
	Reefer	14,9%	5 252 €	28 941 €	16 718 €	37 540 €

Table 28. Trailer TCOs for cost optimal energy consumption targets from societal perspective (for trailers registered in 2030, compared to baseline).

Trailer group		Cost optimal energy consumption reduction target from a societal perspective	Manufacturing costs	TCO savings from a 1st user perspective	TCO savings from a 2nd user perspective	TCO savings from a societal perspective
Drawbar trailer	Box body	7,6%	3 696 €	9 025 €	5 568 €	13 199 €
	Reefer	7,5%	3 400 €	8 881 €	5 081 €	11 432 €
Semi-trailer	Box body	15,0%	7 617 €	29 036 €	17 613 €	42 632 €
	Reefer	14,8%	6 978 €	28 935 €	16 727 €	37 548 €

1.45. 18.5 Impacts of CO*2* target levels options on SMEs

18.5.1 Introduction and data used

The analysis of the impacts on SMEs takes into account particular characteristics of these enterprises and is aimed to highlight when and how these particularities have implications in terms of impacts on the firms. To quantify and illustrate the impacts on SMEs, the firms of different sizes are compared.

The analysis relies on the same methodology as the analysis of impacts on consumers from different income groups in the Impact Assessment "as regards strengthening the CO_2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition"[114]. Due to variability of characteristics between firms in the SME segment, and varying conditions across Member States, the results of this exercise should be interpreted as sensitivity analysis of the main TCO calculations.

SME definition for Freight transport by road and removal services sector [H49.4]

[114] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021SC0613

Table 29 Number of firms, average headcount, turnover and gross profit by firm type in Freight transport by road and removal services sector

	Micro enterprise	Small enterprise	Medium enterprise	Large enterprise
Number of firms	203,692	52,006	6,726	715
Total headcount (number)	785,092	1,036,272	642,890	467,429
Average headcount (number)	3.9	19.9	95.6	653.7
Total turnover (m EUR 2018)	65,360	110,220	81,940	66,665
Turnover per firm (m EUR 2018)	0.32	2.12	12.18	93.24
Wages and salaries per firm (m EUR 2018)	0.1	0.4	2.2	16.9
Costs of goods and services per firm (m EUR 2018)	0.2	1.5	8.8	67.5
Gross profit per firm (m EUR 2018)	0.04	0.24	1.35	10.36
Gross profit per employee (EUR 2018)	9,254	11,823	14,167	15,853
Gross profit per employee (EUR 2020)	9,459	12,085	14,482	16,205

Source: Ricardo calculations, based on Structural Business Statistics database (Eurostat), 2018. Values for wages and salaries, costs of goods and services, and gross profit were reconstructed by assuming an equal share of turnover by company size.

Note: Gross profit in EUR 2020 is based on EUR 2018 and an assumed price index increase of 2.22% between 2018 and 2020[115].

The standard definition of SMEs refers to the firms with headcount less than 250 or turnover less than 50 million euros per year[116]. However, given the firm composition of logistics sector in the European Union, to analyse the potential impacts of different scenarios on SMEs, more granular approach is appropriate. For the purpose of this analysis, the firms are split into the following groups: Micro (0 to 9 employees), Small (10 to 49 employees), Medium-sized (50 to 249 employees) and Large enterprise (those with headcount higher than 250). Each group is characterised in terms of economic characteristics, such as average annual headcount, turnover and gross profit (see

[115] EC and the ECB's Harmonized Index of Consumer prices (HICP), which is computed based on the reported consumer price indices in member countries of the European Union. https://www.officialdata.org/europe/inflation/2018?endYear=2020&amount=100

[116] https://ec.europa.eu/growth/smes/sme-definition_en

Table 29), interest rates they face (see Table 30), and discount rates used for intertemporal analysis (see Table 31)[117].

In the absence of data for logistic sector specifically, *Freight transport by road and removal services* NACE sector (H49.4) has been chosen for the analysis as the one, where the issue of acquiring HDVs is most critical for operations.

Access to finance

As

[117] Driving behaviour and average annual mileage are assumed not to vary across firms of different size.

Table 29 shows, enterprises of smaller size have relatively lower earnings, on average. That is why, to purchase a vehicle, smaller enterprises are first, **more likely to need a loan**, and second, **more likely to request larger loan amounts**, leading to higher loan to income ratios. At the same time, as lower gross profits limit the capacity to quickly repay the loan, these enterprises will likely need loans with longer maturities. This translates to, on average, lower credit scores for the enterprises of lower size[118,119]. In addition to that, smaller enterprises may have less time to spend comparing the offers from different institutions and have less bargaining power to negotiate better loan conditions. All these factors lead to relatively higher average interest rates for smaller firms as a consequence.

Table 30 shows the assumptions on average annualised percentage rate (APR or average interest rate) for the enterprise of different size. These assumptions were made using the information on the evolution of the average interest rates spread for business loans across Euro-area Member States published by the European Central Bank.

Table 30 Interest rate distribution and assumed averages by firm size

	Micro enterprise	Small enterprise	Medium enterprise	Large enterprise
Assumed interest rate, %	4.5%	4%	3.5%	3%
Historical spread, %	R%			(R-1%; R-1.5%)

Source: Ricardo, based on Survey on the Access to Finance of Enterprises in the euro area (ECB, 2021)

Great variability of interest rates is observed inside and across different Member States, and in addition to firm size, the future rates will be influenced by different economic factors[120].

Although the observed ranges were acknowledged, for the purposes of modelling, it was assumed that the interest rate declines monotonously with the gross profit or firm size, that is, Micro enterprise faces an interest rate of 4.5% and each next group of firms sees an interest rate which is 0.5% lower than the previous group. This equal-spacing assumption with respect to the interest rate and make the results more illustrative as it avoids placing groups of enterprises too closely together.

Discount rate

Smaller firms, or firms with lower gross profits are shown to value the present more, when compared to larger enterprise and/or the enterprise with higher earnings[121]. Although, there is no common understanding or a general rule in the literature on how to translate differences in time preferences over time into specific discount rates, it is well understood [122] that smaller firms have higher cost of debt, cost of capital and discount rates as a consequence. A 9.5% discount rate, in line with the approach of the EU Reference Scenario 2020, is used to analyse lorry sector.

[118] Survey on the Access to Finance of Enterprises in the euro area (ECB, 2021). Available at: https://www.ecb.europa.eu/stats/accesstofinancesofenterprises/pdf/ecb.safe202111~0380b0c0a2.en.pdf

[119] EBA report on SMEs and SME supporting factor (EBA,2016). Available at: https://www.eba.europa.eu/regulation-and-policy/credit-risk/discussion-paper-and-call-for-evidence-on-smes-and-the-sme-supporting-factor

[120] The modelling assumes the interest rates stay constant in the future, to avoid making assumptions on interest rate evolution, as there are no official projections that cover the whole period of analysis.

[121] A Practical Guide to Business Valuations for SMEs, 2009

[122] Financing SMEs and Entrepreneurs 2022: An OECD Scoreboard, OECD, 2022

For this analysis, following the underlying assumptions of the main TCO analysis, differentiated rates are assumed, based on the size of the enterprise. It is assumed that the discount rate is 13% for Micro, Small and Medium enterprise and 9% for Large enterprise, being 9.5% the average (consistent with TCO analysis). Table 31 shows subjective discount rate assumptions by company size, based on the negative relationship between size and the discount rate.

Table 31 Discount rate assumptions by firm size

	Micro enterprise	Small enterprise	Medium enterprise	Large enterprise
LORRIES:				
Assumed discount rate, %	13%			9%

Source: Ricardo, based on the average values used for TCO and literature review.

Other assumptions

Maximum loan maturity is assumed to be 7 years, and two cases are considered for initial payment: (a) no initial payment, describing the case of business expansion, when a new vehicle is needed, and (b) used ICE vehicle of the same class is sold, describing the case of replacement. Up to 60% of firm's gross profits are assumed to be available for loan repayment. Table 32 contains the assumptions on these variables related to loans.

Table 32 Other assumptions

Other assumptions	
Ownership duration/ Maximum loan maturity (years)	7
Initial payment	0% or used ICE vehicle price
Maximum loan quota (% of gross profits)	60%

Source: Ricardo, based on own telephone benchmarking and literature review.

18.5.2 Methodology

In addition to the financial assumptions described above, it is also important to consider the fact that the vehicle age groups are interconnected through the market for used lorries, where 2nd users purchase their vehicles from the 1st users respectively. This analysis is performed separately for 1st and 2nd users.

The following Heavy (Class 5 Long Haul, Class 9 Municipal Utility and Class 12 Construction) and medium lorries (Class 2 Regional Delivery) are analysed. To get the average TCOs, the sales numbers by vehicle class and powertrain in each scenario has been used as weights[123].

The analysis of the impacts on SMEs looks at the impacts of the options considered on firms of different size in terms of (i) affordability of vehicles (access to finance), and (ii) 'subjective TCO' (total costs).

[123] Where more than one vehicle class is included in the group, in order for the results not to be biased by the total fleet evolution for each class, the total fleet for each class is normalized to year 2030 for each scenario.

Affordability reflects the variety of vehicle choice available to the firms[124]. It is defined in terms of financial capacity of an enterprise relative to the vehicle upfront price. A vehicle class/ powertrain is said to be affordable when a firm has sufficient earnings to be able to repay the loan for upfront capital costs in seven years, provided that no more than 60% of gross profits can be designated to the loan repayment.

Subjective TCO reflects total costs associated to the ownership of the vehicle[125]. It takes into account firm-specific parameters and is considered in relation to average annual gross profits per employee (as a proxy for earnings per vehicle). It is calculated as discounted sum of all loan payments, operation, maintenance and insurance costs, fuel costs minus residual value of the vehicle at the end of the ownership period.

To conclude on the impact of policy options on SMEs, affordability and subjective TCO are compared in the baseline scenario and policy scenarios. In addition, some other barriers were considered, combining a range of non-monetary factors that are likely to have unequal impacts for different firm sizes. The factors assessed include unequal access to information, charging infrastructure, sensitivity to global shocks and capacity to compare between financial options and the level of awareness about potential monetary savings. These factors are analysed qualitatively.

Affordability, access to finance and extra capital costs

For vehicles with higher initial purchase prices, firms will require access to higher initial capital, which is more limited for enterprises with lower earnings. As long as access to finance and financing conditions are linked to the earning of the firms, those with lower gross profits would find it harder to be able to acquire a vehicle due to credit restrictions. That is, some firms may not be able to afford a vehicle with lower TCO, some will only be able to do so with a loan, and others will have enough capital to cover the full upfront price.

Those who need a loan would also need to pay interests, which in its turn increases total capital costs that the firms face over the lifetime/ownership period. Affordability and access to finance are considered as follows:

- First, the amount **to be financed** is calculated: in one case (expansion) it is assumed to be the full vehicle price, and in another case (replacement) it is the difference between full vehicle price and the residual value of the existent vehicle (assumed to be an ICE vehicle of the same class). For used battery vehicles, it is assumed that the battery replacement takes place at the moment of purchase and the costs of this replacement are also being financed. Loan maturity is assumed to be 7 years, to match the ownership period in TCO calculations and the usual practice of the banks to finance purchase of a vehicle of these values. For more expensive vehicles and powertrains, longer loan maturity could be appropriate.
- Second, **loan payment** is calculated using the assumption on group-specific interest rate. It is assumed that up to 60% of gross profits can be used for loan repayment, following common practice by banks with respect to liquidity ratio[126].

[124] Analysis includes four vehicle classes (Class 2 (C2), Class 5 (C5), Class 9 (C9), Class 12 (C12, seven powertrains (ICEV, BEV, FCEV, H2-ICEV, PHEV, BCEV, LNG-ICEV) and two vehicle age groups (1st user, 0-5 years and 2nd user, 6-10 years).

[125] Based on survey conducted by Oeko, the analysis assumes that the HDV vehicles are mainly bought and owned.

[126]Ranges of liquidity rations accepted by banks vary from case to case and are Member State – and bank-specific. As an example (case of Spain), see https://aptki.com/publicaciones/ratio-endeudamiento/

So, if calculated loan payment exceeds 60% of firm's gross profits, it is concluded that this particular vehicle cannot be afforded by the firm.

Subjective TCO

A number of parameters need to be adjusted to depart from TCO calculated for average user and aim at estimating TCO as perceived by each particular group of firms. In addition to differences in interest rates, different firms have different discount rates, reflecting time patience regarding their cash flows and the opportunity cost of capital.

Subjective TCO is calculated according to standard TCO formula, but with two modifications:

- In addition to vehicle price, interest payments are incorporated. At the end of user life, it is assumed that the vehicle is sold, and the residual value of the vehicle is subtracted.
- Firm-size specific discount rate is used to calculate present value of future loan payments, fuel costs and operation, maintenance and insurance costs.

Other barriers

In addition to access to credit and higher interest rates representing a financial barrier for smaller enterprises, there are other barriers for EV uptake for some groups of the enterprises.

First, upfront costs for depot (overnight) charging (not included in this analysis) represent an additional need for investment. Smaller enterprises might find own charging not affordable, meaning they may be forced to rely on more costly public infrastructure. It will also be harder for them to go through the process due to more limited understanding of charging requirements (e.g. installation process, charger, location, charger suitability and network constraints), lack of understanding, awareness of technical or commercial solutions available to reduce connection costs; and suitability of these to individual SMEs.[127]

Second, access to information about financial options and lack of capacity to compare among different financial offers is already implicitly reflected through the different interest rates. It, however, constitutes a barrier on its own, as this may disincentivise smaller enterprise from exploring 'new' powertrains.

Third, potentially, SMEs are more sensitive to global shocks and supply chain disruptions (as their operations are somewhat more regional), and this may affect firm survival and ability to repay the debt, possibly causing some SMEs to 'shy away' from large loans or unwillingness of banks to extend these loans to the SMEs. These patterns are reflected by higher loan rejection rates, as the statistics from the European Central Bank and Eurostat illustrate[128].

Finally, access to information and lack of consumer awareness about potential savings may also limit uptake of alternative powertrains for smaller enterprises, despite of them being affordable financially and having lower TCO.

It must be acknowledged, however, that thanks to numerous EU and Member States individual policies targeted to SMEs and banking sector, many these factors are being alleviated. Examples of such policies include grants to help purchase a certain vehicle,

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[127] https://innovation.ukpowernetworks.co.uk/wp-content/uploads/2022/02/Final-Report-January-2022.pdf
[128] https://www.ecb.europa.eu/stats/accesstofinancesofenterprises/pdf/ecb.safe202111~0380b0c0a2.en.pdf

specifically for SMEs, collaboration with banks to make the loans less costly and more accessible in general.

18.5.3 Results

Affordability and access to finance

Table 33 summarises the results on affordability analysis for the baseline and the scenario ambition options in the years 2030, 2035 and 2040. Only Micro enterprises are included as only they are affected by affordability considerations.

A colour code included in the legend was designed to depict the differences across scenarios for each vehicle class, powertrain, timeframe and the enterprise size. The results also illustrate starting from which firm size a certain powertrains become affordable, for each scenario.

Large, Medium, and Small enterprises, have no affordability restrictions at any of the scenarios. For Micro enterprises also, in general, affordability does not seem to be a critical issue. While Micro enterprise will face some affordability restrictions, these restrictions do not vary across scenarios. In general, ZEV become affordable in later periods and are affordable in 2040 in all analysed groups. These trends are somewhat more pronounced in higher ambition scenarios for class 5.

The following Heavy (Class 5 Long Haul, Class 9 Municipal Utility and Class 12 Construction) and medium lorries (Class 2 Regional Delivery) are analysed. To get the average TCOs, the sales numbers by vehicle class and powertrain in each scenario has been used as weights[129].

Table 33 Overview of unaffordable vehicle types (powertrains) and segments for micro enterprises under the baseline and scenario options in 2030, 2035 and 2040

Legend: Green (affordable at all scenarios); red (not affordable in any scenario);ZEV= either BEV, FCEV or H2-ICE.

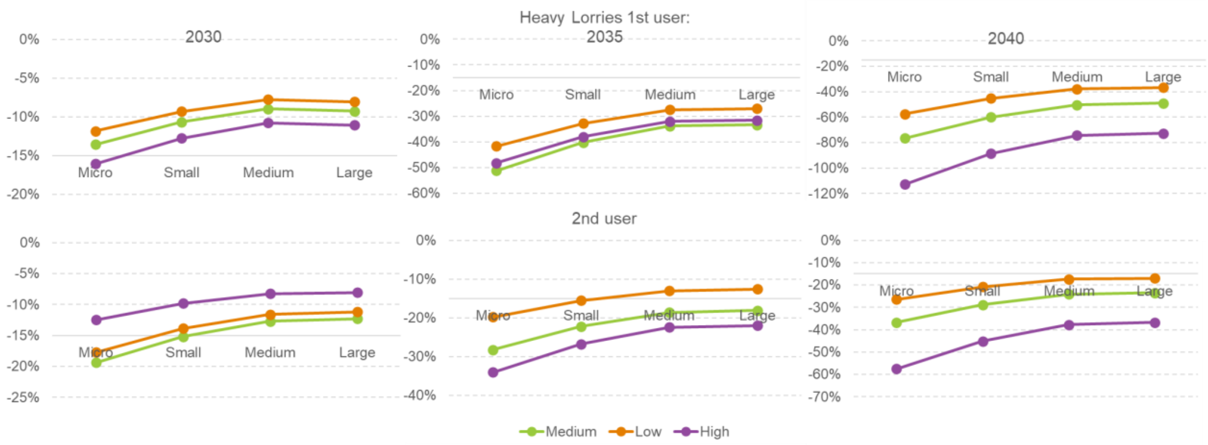
Subjective TCO

It has been assessed how each of the scenario options affects subjective TCO for affordable options, as compared to the baseline. For all scenarios, additional TCO and absolute net savings are positively associated with firms' earnings. Figure 38 and Figure 39 show the changes in subjective TCO per year (only accounting for the affordable

[129] Where more than one vehicle class is included in the group, in order for the results not to be biased by the total fleet evolution for each class, the total fleet for each class is normalized to year 2030 for each scenario.

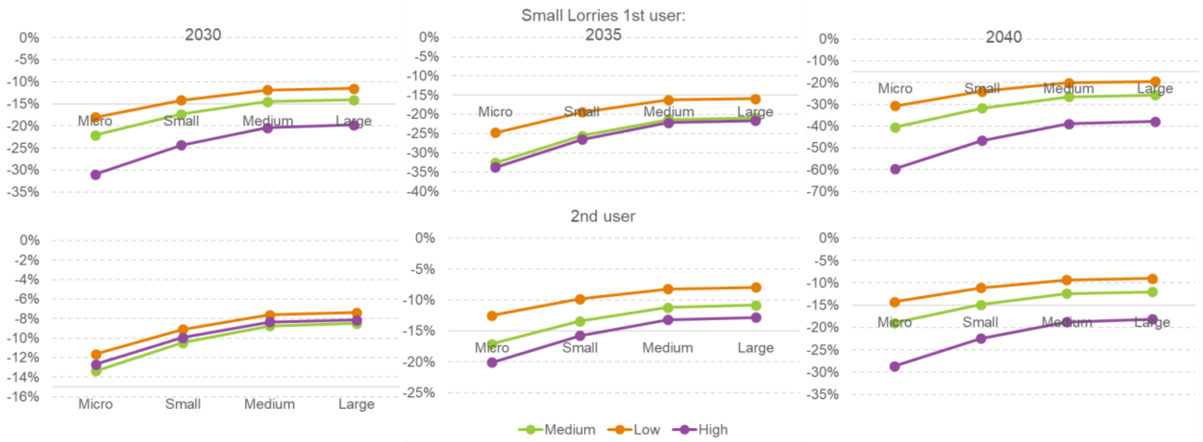
vehicles option per company size) divided by the average annual earnings per employee for different scenarios, as compared to the baseline. A negative value indicates cost savings.

Figure 38 Average "subjective" TCO changes for Heavy Lorries (% of gross earnings per employee) for firm sizes across scenarios for a vehicle purchased in 2030, 2035 and 2040



Note: Negative values represent savings.

Figure 39 Average "subjective" TCO changes for Small Lorries (% of gross earnings per employee) for firm sizes across scenarios for a vehicle purchased in 2030, 2035 and 2040



Note: Negative values represent savings.

The figures show that also SMEs would see savings, which are higher, relative to the gross earnings per employee, for smaller companies. This result is partially driven by the fact that even the same differences in technology costs would imply higher differences in savings across scenarios for smaller enterprises, when the savings are expressed in shares of annual earnings. It has to be, however, highlighted that the benefits for the smaller enterprises may be delayed in some cases, until they are able to access these more efficient vehicles in the second-hand market. Therefore, the faster these vehicles become available on the second-hand market, the faster the benefits for the smaller enterprises will materialise.

The results are broadly consistent across scenarios and vehicle groups. On aggregate, Micro and Small enterprises are projected to see higher net saving relative to their gross profit per employee compared to Medium and Large enterprise. On aggregate, the expected additional costs and savings are also increasing with the level of ambition of the

CO_2 emission standards and with time. Larger enterprises are expected to benefit less from higher ambition scenarios and will see lower increases in saving with time, compared to smaller enterprises.

18.5.4 Conclusions

In summary, the main results of the analysis show:

- Large, medium, and small enterprises, have no affordability restrictions at any of the scenarios. Micro enterprises face some restrictions at the first user market especially for xEVs in early years, but they still can access these vehicles on the second user market. These restrictions do not vary across scenarios significantly. There are some differences in affordability restrictions for Micro enterprise, depending on whether the purchased vehicle is intended to replace an old one from existing fleet or to increase the fleet. In general, there are less affordability issues in replacement case than in the expansion case for Micro enterprises.
- From a TCO perspective for the affordable options, smaller enterprises are projected to see higher savings relative to their annual income. These relative additional savings and costs increase with higher target levels.

1.46. 18.6 Fuel Crediting System – Assumptions and Methodologies for the economic impacts

Introduction and data used

A cost impact analysis was carried out for the option FUEL2 to assess the cost impact for the manufacturer, as well as for the vehicle users and society. These cost analyses were performed for vehicles in subgroup 5 Long-Haul as well as for coaches (P32) with the long-haul use case Coach.

Methodology and Assumptions

To assess the costs of the fuels crediting system option, the costs for manufacturers acquiring LCF credits are compared with the costs for further emission reductions through different ZEV technologies. Therefore, for the purpose of this analysis, the cost of compliance with the CO_2 standards through an additional newly registered ZEV is the reference against which the cost of compliance with LCF credits is assessed.

As the FUEL2 option provides the opportunity to comply with the CO_2 emission standards with LCF credits instead of introducing zero-emission powertrains, the extra costs for an additional ZLEV compared to the respective ICEV are related to the extra costs that the manufacturer would have to pay to the fuel suppliers in order to achieve the same level of CO_2 savings as the ZLEV under the CO_2 emission standards.

To estimate the amount of LCF credits that an OEM needs to buy, a frontloading approach is considered, which ensures that enough credits are available for the entire lifetime of the vehicles. For these calculations, a mileage equal to that of 10 years of driving with the mileage specified for the specific vehicle and use case in the Regulation (EU) 2019/1242 is assumed for the subgroup 5 Long-Haul vehicle. An annual mileage of 100,000 km for the duration of 10 years was assumed for the coach (P32) and its Coach use case[130].

[130] This value was derived from analyses for this impact assessment.

In order to determine the level of emission savings from additional quantities of LCF, the GHG emission values according to the RED calculation methodology are used, i.e. the emission reduction is calculated from the difference between the respective LCF and the RED fossil comparator of 94 g CO_2e/MJ. The GHG emission values used for the LCF in the calculation are from the calculations with PRIMES-TREMOVE and are 0 g CO2e/MJ (RFNBO) and 24 - 26 g CO2e/MJ (advanced biofuels), respectively.

The costs of additional quantities of advanced biodiesel and RFNBO are also in line with the scenario calculations with PRIMES-TREMOVE and literature, respectively, and represent the marginal costs for additional quantities of LCF production. These costs are also consistent with collected literature values for the RED Impact Assessment (notably those presented in its Figure 31).

Concerning the production costs of RFNBO diesel and petrol, though many of the necessary processes are well developed and are used in industrial processes today, no complete industrial-scale process chain is available today. First small-scale industrial plants are being built. Therfore, the production costs of RFNBO today are multiple times the costs of fossil fuels. Due to decreasing investment costs, especially for electrolysers, increasing process efficiency and decreasing electricity generation costs, the production costs of RFNBO can be expected to decrease significantly over time.

The same assumptions are also used for the user and societal perspective, through the calculation of the total cost of ownership (TCO). This includes not only the technology costs that are decisive for the manufacturer to comply with the CO_2 emission standards and that are reflected in the purchase price of the vehicles, but also the costs that arise during the use of the vehicles. These consist of the energy costs as well as O&M costs for insurance, vehicle taxes and vehicle maintenance. The cost assumptions required for this purpose were obtained from the scenario calculations with PRIMES-TREMOVE.

The additional technology costs compared to an ICEV, which are caused by either the crediting of emission savings from LCF or an additional ZLEV, are part the cost comparison from the user's and the societal perspective between the different possible compliance strategies of the manufacturers. In these calculations it is also considered that both strategies have the same emission reduction impact for meeting the CO_2 emission standards.