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COMMISSION STAFF WORKING DOCUMENT

EXECUTIVE SUMMARY OF THE 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) 88 final}

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Executive Summary Sheet

Impact assessment on the Revision of the CO_2 emission performance standards for new heavy-duty vehicles

A. Need for action

What is the problem and why is it a problem at EU level?

Three key problems have been identified at the EU level: (1) heavy-duty vehicles (HDV) contribute insufficiently to increased ambition on GHG emissions reduction and need to reduce EU energy dependency; (2) transport operators and consumers missing out on the opportunities of energy-savings and related cost-reductions; and (3) the HDV value chain in the EU is at risk of losing its technological and innovation leadership.

What should be achieved?

The initiative aims to achieve the following specific objectives: (1) contribute to the 2030 at least 55% GHG emissions reduction target and to the 2050 climate neutrality objective, by reducing CO_2 emission from HDV cost-effectively, in line with the EU climate goals while contributing to improve EU energy security; (2) provide benefits for transport operators and users, resulting from a wider deployment of more energy-efficient vehicles; (3) strengthen the technological and innovation leadership of the EU automotive value chain and stimulating employment.

What is the value added of action at the EU level (subsidiarity)?

Climate change is a transboundary problem. Without EU action, national and local action are likely to be insufficient and risk fragmenting the internal market. EU action would provide the entire automotive value chain with the necessary long-term, stable market signal and regulatory certainty needed for large capital investments necessary to deploy zero-emission vehicles.

B. Solutions

What are the various options to achieve the objectives? Is there a preferred option or not? If not, why?

Various policy options were explored, grouped in three main categories: (i) extension of the scope; (ii) CO_2 emission target levels and timing for new HDV; (iii) specific regulatory mechanisms, such as incentive schemes for zero- and low-emission vehicles (ZLEV); (iv) mechanism to account the potential contribution of renewable and low-carbon fuels for the purpose of target compliance assessment; (v) governance issues.

Under the preferred option, several currently unregulated HDVs are included within the regulatory scope. The CO_2 emission targets decrease in five-year steps and are significantly strengthened as of 2030. Cost-optimal energy efficiency standards are set for trailers. Small volume manufacturers are exempted from meeting the targets. The possible excess emissions premium revenues remain part of the general EU budget.

The current incentive mechanism for ZLEV is removed as of 2030. A 100% mandate for zero-emission urban buses is set by 2030. No mechanism to account for the potential contribution of renewable and low-carbon fuels is introduced. On governance, some flexibility is included to ensure a cost-effective implementation of the legislation while safeguarding its environmental integrity.

What are different stakeholders' views? Who supports which option?

Based on the results of the OPC and the feedback of the CfE, stakeholders generally support the scope extension while exempting small volume manufacurers. Extending the scope to trailers was generally supported with the exception of some transport operators.

Environmental NGOs and ZEV manufacturers called for the greatest ambition supporting a 100% reduction by 2035 and the adoption of interim objectives between 2025 and 2030 combined with a strengthening of the 2030 target. Large vehicle manufacturers, transport operators, component suppliers and suppliers of fuels and gases supported less ambitious targets providing mixed views ranging generally from low to medium ambition levels. Large manufacturers and fuel suppliers in particular did not favour setting a 100% reduction target by a certain date. Large vehicle manufacturers, component suppliers and transport operators supported the current 5-year steps extension while NGOs and ZEV manufacturers called for targets decreasing in shorter steps.

Manufacturers and transport operators supported maintaining the ZLEV incentive mechanism after 2030 whereas NGOs called for its removal after 2030 and to limit the incentive up to 2030 only for specific vehicles categories. Suppliers of electricity and hydrogen support a scheme benefiting only ZEV. Setting a ZEV mandate for urban buses was supported by NGOs and ZEV manufacturers and by some larger manufacturers. The other large manufacturers and suppliers of fuels were against any ZEV mandate.

Suppliers of gases and fuels supported the introduction of a mechanism to account for fuels in the standards while NGOs argued against and large manufacturers expressed mixed views.

C. Impacts of the preferred option

What are the benefits of the preferred option (if any, otherwise of main ones)?

The projected (tailpipe) cumulative emission reductions between 2031 and 2050 are 35-48% for motor HDV, compared to the baseline and additional 1.4% for trailers as from 2031, compared to the medium scenario. The HDV standards contribute to reducing air pollutants by around 7 to 17% % in 2035, 15 to 38% in 2040 and by 66 to 80% in 2050, compared to the baseline.

Benefits in terms of average net savings in total cost of ownership for the first user are up to 6000-9800, 17 400 – 25 800 and 29100 – 47 000 EUR/vehicle for 2030, 2035 and 2040. Net savings for the second and third users show similar trends, with smaller benefits. Societal benefits over the lifetime are estimated at 2 400-6 300, 18 300-31 900 and 33 7000-59 800 EUR/vehicle for 2030, 2035 and 2040. Net savings for first users of new trailers registered in 2030 show savings of 9 000-29 000 EUR/trailer, depending of the type, while net economic savings over the vehicle lifetime from a societal perspective scale up to 11 500-42 500 EUR/vehicle.

Over the period of 2031 to 2050, final energy consumption from motor HDVs decreases by 11-19% compared to baseline. Savings in fossil fuels (mostly diesel) in the range 215 - 281 Mtoe are achieved with respect to the baseline, reducing the import dependency of the EU economy by 150-200 bn EUR. Setting energy efficiency standards in trailers saves additional 23 Mtoe of fossil fuel over the period 2031 to 2050, equivalent to 16 bn EUR.

Net jobs increase in 2030, and even more in 2040 and 2050, and GDP is projected to grow 0.06% -0.11% by 2040.

What are the costs of the preferred option (if any, otherwise of main ones)?

Costs for HDV manufacturers increase as additional technologies need to be deployed in new vehicles to meet the stricter CO_2 targets: 3 400-9 700, 5 300-11 800 and 6 500-13 100 EUR/vehicles for 2030, 2035 and 2040. This would need additional investments from manufacturers estimated at around EUR 4.9 to 8.7 billion annually, between 2031 and 2050.

Extra costs per average trailer or semitrailer are 2500-5 250 EUR/vehicle compared to a 2020 baseline.

What are the impacts on SMEs and competitiveness?

Medium and small enterprises find no affordability restrictions across any of the three ambition target scenarios. Their total cost of ownership also shows savings. Second hand ZEVs are always affordable.

The development and supply of ZEV (ZEV shares in %: 20-35, 35-57 and 57-100 by 2030, 2035 and

2040), leads to a positive impact on innovation and industry's technological leadership and competitiveness.
Will there be significant impacts on national budgets and administrations?
While the overall GDP impacts will be positive, the fuel duty revenue loss in 2030 is estimated at around 0.004% of the EU-27 GDP. These losses can be balanced at the Member State level, for example through indirect taxation. There are no significant administrative impacts on national administrations as needed provisions are already put in place.
Will there be other significant impacts?
Providing a clear regulatory signal and predictability for industry to develop and invest in fuel-efficient HDVs will encourage technological innovation development of the industry in the EU.
Proportionality?
The proposed action is proportionate to achieve the climate objectives that the EU has committed to.
D. Follow up
When will the policy be reviewed?
A review of the effectiveness of the new legislation will be foreseen, aligned with the review of other pieces of legislation contributing to the increased climate ambition.

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PART 1/2

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IMPACT ASSESSMENT

Part 1

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GLOSSARY

Term or acronym	Meaning or definition
ACEA	European Automobile Manufacturers Association
AFID	Alternative Fuels Infrastructure Directive 2014/94/EU
AFIR	Proposal of the Commission for a Regulation on the deployment of Alternative Fuels Infrastructure
BEV	Battery Electric Vehicle
CNG	Compressed Natural Gas
CTP	Climate Target Plan
CO_2	Carbon Dioxide
EED	Energy Efficiency Directive
EIB	European Investment Bank
ESR	Effort Sharing Regulation
EU	European Union
EU ETS	EU Emission Trading System
EURO VI	Regulation (EC) 595/2009 on type approval of vehicles with respect to emissions
EURO 7	Successor of Euro VI covering both light and heavy-duty vehicles
EV	Electric Vehicle: covers BEV, FCEV and PHEV
FCEV	Fuel Cell Electric Vehicle
FQD	Fuel Quality Directive 98/70/EC
GDP	Gross Domestic Product
GHG	Greenhouse Gas(es)
HDV	Heavy-Duty Vehicle(s), i.e., lorries, buses and coaches (road motor vehicles with TPMLM over 3.5 tons)
HEV	Hybrid Electric Vehicle(s)
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle(s)
IEA	International Energy Agency
LCA	Life-Cycle Assessment
LCF	Low-carbon Fuels
LCV	Light Commercial Vehicle(s): van(s)
LDV	Light-Duty Vehicle(s), i.e. passenger car(s) and light commercial vehicle(s)
LEV	Low-Emission Vehicle(s), as defined in the respective applicable CO_2 standards

LPG	Liquefied Petroleum Gas
LNG	Liquefied Natural Gas
Mission Profile	A trip with certain characteristics in terms of length, slope and speed used for the purpose of VECTO simulations
NGO	Non-Governmental Organisation
NO_x	Nitrogen oxides - (nitric oxide (NO) and nitrogen dioxide (NO_2))
OEM	Original Equipment Manufacturer (HDV manufacturer)
Payload	Weight that a vehicle can carry
PHEV	Plug-in Hybrid Electric Vehicle(s)
PM	Particulate Matter
RED	Renewable Energy Directive
RFNBO	Renewable Fuels of Non-Biological Origin
RRF	Recovery and Resilience Facility
R&D	Research and Development
SVM	Small Volume Manufacturer
t	Tonne (1,000 kg)
tkm	Tonne-kilometre
TCO	Total Cost of Ownership
TEN-T	Trans-European Transport Network
TFEU	Treaty on the Functioning of the European Union
TPMLM	Technically Permissible Maximum Laden Mass
Trailer	A road vehicle for transporting goods designed to be hauled by a road transport vehicle
TTW	Tank to Wheel
UNFCCC	United Nations Framework Convention on Climate Change
VECTO	Vehicle Energy Consumption Calculation Tool
WTT	Well to Tank
WTW	Well to Wheel
ZEV	Zero-emission Vehicle(s), vehicles with zero tailpipe emissions (as defined in the respective applicable CO_2 standards)
ZLEV	Zero- and Low-Emission Vehicle(s), as defined in the respective applicable CO_2 standards

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

1.1. 1.1. Overall context

The **European Climate Law**, one of the key elements of the European Green Deal, enshrines in legislation the EU's commitment to reach the climate neutrality target by 2050 and raise the intermediate ambition by setting the target of at least 55% net emission reduction by 2030 compared to 1990. In order to deliver on these increased climate targets, the Commission adopted in July 2021 a comprehensive package of consistent policy proposals as part of the **'Fit for 55' package.** The crisis linked to the invasion of Ukraine by Russia makes the case to reduce EU dependency on fossil fuel even stronger. In March 2022 the European Council agreed through the **Versailles Declaration** to phase out Europe's dependency on Russian energy imports as soon as possible by, among other measures, accelerating the reduction of EU overall reliance on fossil fuels and improving energy efficiency. This is at the core of the **REPowerEU Plan** that sets out actions to save energy, diversify supply, substitute fossil fuels and carry out smart investments and reforms in all economic sectors.

As regards the **transport sector**, the REPowerEU Plan underlines the need to enhance energy savings and efficiency and accelerate the transition towards zero-emission vehicles combining clean electrification and fossil-free hydrogen to replace fossil fuels. Road transport, in particular, is responsible for one third of all final energy consumed. Oil-derived fuels account for more than 90% of energy consumption in road transport which is responsible for about three quarters of total energy use in transport. The case for moving to **zero-emission mobility** and reducing transport greenhouse gases (GHG) emissions by 90% by 2050, as laid out in the European Green Deal and the Smart and Sustainable Mobility Strategy, becomes even stronger and clearer in view of reducing as quickly as possible EU energy dependency.

This impact assessment looks at the role of the heavy-duty vehicles (HDV) sector to deliver on the new EU climate and energy targets and more specifically at the scope and ambition of the CO_2 emission standards for new heavy-duty vehicles set out in Regulation (EU) 2019/1242 (HDV CO_2 standards). The HDV sector is responsible for more than a quarter of GHG emissions from road transport in the EU and for over 6% of total EU GHG emissions[1] as well as for 42% of the EU's diesel consumption in road transport, a significant share of which comes from Russia.[2]

The analytical works underpinning the Climate Target Plan and the "Fit for 55" package as well as the analytical work underpinning the REPowerEU Plan show that larger greenhouse gas emission reductions from HDV and a larger deployment of zero-emission HDV are necessary by 2030 and beyond in order to achieve the increased climate and energy security ambition. The necessary decarbonisation of the production of electricity and hydrogen used to operate battery electric and fuel cell vehicles is being addressed by the proposed strengthened EU Emission Trading System (ETS) and Renewable Energy Directive (RED) legislation.

While a future deployment of zero-emission vehicles must go hand in hand with a comprehensive enabling framework[3], a clear long-term regulatory signal to foster zero-emission vehicles (ZEV) deployment in the EU would help the manufacturers to create the needed safe investment environment and to overcome current market barriers.

[1] CO_2 represents about 99% of GHG emissions from HDV
[2] T&E. Addressing the heavy-duty climate problem. Why all new freight trucks and buses need to be zero-emission by 2035.
[3] ACEA, Position paper on the review of CO_2 emission standards regulation for heavy-duty vehicles. July 2022

While the COVID-19 pandemic has had a severe impact on Europe's transport sector, the **NextGenerationEU** is supporting Member States to provide stimulus packages and recovery measures, alongside continued investments in batteries and other zero emission technologies. This has been instrumental to attenuate the negative economic impacts and help kick-start the market for zero-emission vehicles (see Annex 6).

Furthermore, from a global perspective, the demand for zero-emission vehicles is also surging as the road transport sector is shifting from internal combustion engines towards zero-emission mobility also due to stricter regulatory expectations for the decarbonisation of the sector. As highlighted in the **New Industrial Strategy for Europe**, this also creates opportunities for manufacturers in the EU. Thanks to the EU single market, "EU companies benefit from a springboard to compete globally. By providing a common regulatory space and scale, the single market is the driver of competitiveness […]"[4].

1.2. 1.2. Description of the heavy-duty vehicles[5] sector

Road freight transport is essential for the development of trade and commerce on the European continent. Lorries carry 73% of freight transported over land, delivering also essential public services such as garbage collection, firefighting and construction.

Five major manufacturers dominate the EU heavy lorry market, summing up to over 98% of production. The picture is more varied for smaller lorries and buses and coaches, where Small and Medium Enterprises (SMEs) are active. In fact, electrified powertrains for many vehicle types are mainly developed by relatively small and medium-sized companies (see Annex 7 for more information on the HDV sector market).

The trailer sector has its own peculiarities, as the largest manufacturers offer a range of standardised vehicles produced in large quantities, leaving specialised trailers to smaller companies who build highly customised products. There is also a high number of very small companies building only a few, usually highly customised, trailers per year.

Zero-emission heavy-duty vehicles market

According to the European Automobile Manufacturers' Association, ZEVs, namely battery-electric (BEV) and hydrogen-powered[6] vehicles, will have to become the backbone of road transport to reach the decarbonisation objective[7]. The production of ZEVs in the EU is slowly increasing. Registrations in the EU of new zero-emission lorries over 5t increased from around 142 in 2019 to nearly 170 in 2020 and 120 for the first half of 2021. Meanwhile, sales of new zero-emission buses and coaches over 7.5t is developing more rapidly: registrations increased from over 1 500 units in 2019 and almost 1 600 in 2020, to over 1 440 for the first half of 2021.

Still, even though the registrations of ZEVs are increasing, their current share of the EU market is very small. In 2020, around 0.2% of all lorries over 3.5t and nearly 1% of buses in use in the EU were electrically rechargeable (ZEV, PHEV and extended-range vehicles). The Netherlands (12.4%) and Luxembourg (6.6%) have the highest share of BEV within their bus fleets while Germany is leading on the absolute number of sales of ZEV lorries by far.

[4] A New Industrial Strategy for Europe, COM(2020) 102 final

[5] Heavy-duty vehicles are defined for the purpose of this legislation as freight motor vehicles and trailers with a technically permissible maximum laden mass of more of more than 3.5 tonnes (lorries) or passenger transport vehicles of more than 9 seats including the driver (buses and coaches).

[6] Hydrogen-powered vehicles comprise fuel cell as well as hydrogen internal combustion engine vehicles.

[7] ACEA, Position paper on the review of CO_2 emission standards regulation for heavy-duty vehicles. July 2022

The transition is currently led by battery-electric lorries and buses with ranges up to 250-300 km, and capable of recharging overnight after performing well-defined and predictable routes such as return-to-base operations, suitable for urban and regional delivery and urban passenger transport with guaranteed charging spots. According to the opinions expressed by relevant stakeholders (see Annex 7), this trend would be followed at first by electric lorries with ranges beyond 400 km. Longer-range battery-electric lorries and hydrogen-powered long-haul heavy lorries could arrive in the market as from the second half of the decade. Some EU manufacturers have also made announcements on the shares of ZEV, ranging from 7% to 10% in 2025 and from 35% to 60% in 2030, which they would be technically ready to deliver (see Annex 7). This shows the technological readiness of the manufacturing sector to deploy such types of vehicles. However, as the experience with cars and vans shows, adopting a voluntary approach does not work: while the technology had been available for a while, the number of ZEV LDV increased significantly only after the CO_2 emission standards entered into force.

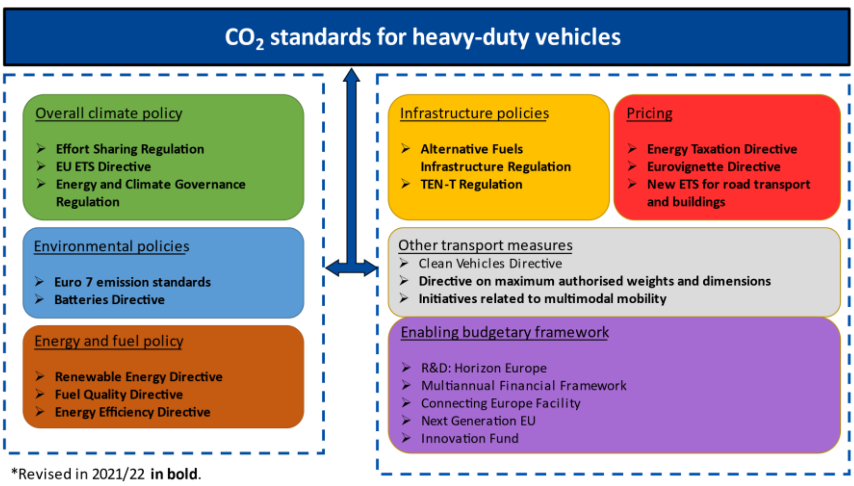
At the same time, the traditional competitive advantage of the EU heavy-duty vehicles industry is being challenged by the development of foreign competitors, mainly from China and the USA, currently investing largely in zero-emission technologies. More information on the zero-emission regulatory status in other countries can be found in Section 2.1.3 (Problem 3) and in Annex 7.

1.3. 1.3. Interaction between CO_2 emission standards for heavy-duty vehicles and other policies to deliver increased climate ambition in the road transport sector

The Climate Target Plan (CTP) and the Smart and Sustainable Mobility Strategy clearly concluded that there is no silver bullet and that a basket of measures is necessary to address the challenge of the decarbonisation of the transport sector. This includes setting targets, standards, price signals and infrastructure.

Therefore, several EU legislation are relevant for the decarbonisation of heavy-duty road transport. The policy measures to deliver on the increased climate ambition, including those already proposed to be revised as part of the Fit for 55 package, interact in many ways with the HDV CO_2 emission standards. The main regulatory and non-regulatory instruments interacting with the HDV CO_2 standards are summarized in **Figure 1**.

Figure 1: Policy context and overview of interactions.



The **Effort Sharing Regulation** (ESR) sets binding greenhouse gas emission reduction targets per Member State, which cover emissions from road transport among others. The ESR provides a framework for Member States to set out and implement policies to reduce emissions in the key sectors concerned (in particular, buildings, road transport and agriculture). The national policies to be defined at Member States level need to be complemented by EU wide legislation where there is value-added for action at EU level. As described in more details in section 3, there is an EU added value for CO_2 emission standards for new vehicles (be they cars and vans or heavy-duty vehicles), since they reduce emissions in road transport and therefore support Member States in meeting their targets under the Effort Sharing Regulation (ESR). In absence of EU-wide standards, lack of coordinated EU action would translate into Member States acting individually, leading in turn to a risk of market fragmentation due to the diversity of national schemes, differing ambition levels and design parameters. Lack of EU-action would also put at risk the capacity of Member States to meet their ESR targets. The Impact Assessment underpinning the ESR proposal shows that the Member States targets are set on the basis of increased ambition of the current HDV CO_2 standards. In addition, fragmented national policies would lead to higher costs. For all these reasons, the need to set stronger EU level CO_2 emission standards is fully supported by Member States and stakeholders.

The **new EU ETS for road transport and buildings** (ETS 2) caps emissions from the sectors within its scope and thereby puts a price on these emissions. However, this demand-side action needs to be complemented by the HDV CO_2 emission standards, due to road transport limited elasticity and responsiveness to price changes. The CO_2 emission standards play a key role for the supply of new zero-emission vehicles, while the new emissions trading concerns the fuel use in the entire vehicle stock (existing and new vehicles). There are clear complementarities and mutual reinforcements between the HDV CO_2 emission standards and the ETS 2. The ETS 2 will increase the demand for more fuel-efficient vehicles and their business case, facilitating the fulfilment of the CO_2 reduction targets of the vehicle manufacturers. The CO_2 emission standards ensure that this demand can be fulfilled by addressing the supply of more fuel efficient and zero-emission vehicles, setting requirements on vehicle manufacturers with regard to their new vehicles' fleets.

Regarding the charging infrastructure, the proposal for **Alternative Fuels Infrastructure Regulation** (AFIR) sets mandatory minimum targets for the roll-out of recharging and refuelling infrastructure across the TEN-T core and comprehensive network and thus contribute to facilitating the uptake of ZEV. Specifically, the AFIR proposes mandatory targets for the roll-out of publicly accessible recharging and hydrogen refuelling stations on the TEN-T network including for HDVs. Therefore, the AFIR is a necessary complementary instrument to address the market barrier on the deployment of infrastructure. It is also completed by the revision of the **TEN-T Regulation** to support the deployment of infrastructure.

Moreover, fuels-related legislation provides an additional contribution to the CO_2 emission reduction by incentivising the use of renewable and low-carbon fuels in existing vehicle fleets, considering that many HDV can stay on the road for up to 20 years after the first registration. In particular, the **Renewable Energy Directive proposal** sets obligations on the supply of advanced biofuels and renewable fuels from non-biological origin (RFNBO) and on the reduction of the GHG emission intensity of transport fuels. The CO_2 emission standards, supplying new zero-emission vehicles to the market, and the Renewable Energy Directive, incentivising the uptake of renewable and low carbon fuels for the combustion engine vehicles in the stock, are complementary instruments for the decarbonisation of road transport.

There are also other significant synergies between the CO_2 emission standards, the Renewable Energy Directive, and a strengthened EU ETS. The EU ETS and the Renewable Energy Directive will drive the decarbonisation of the power generation, so that zero-emission vehicles, incentivised by the CO_2 emission standards, are steadily powered by renewable energy sources, thus achieving a full well-to-wheel decarbonisation.

Furthermore, since the CO_2 emission standards incentivise the electrification of vehicles, they contribute both to the energy efficiency target (as electrified vehicles are significantly more energy efficient than internal combustion vehicles) and, by providing a complementary route to using renewable energy, also to the renewables objective. The CO_2 emission standards therefore contribute to achieving the targets of the **Energy Efficiency Directive and of the Renewable Energy Directive**. The **REPowerEU plan** also proposes to further strengthen the 2030 headline renewable and energy efficiency targets defined in these two proposals.

Current emission standards on air pollutants (**Euro VI**) ensure the uptake of cleaner internal combustion vehicles with respect to these pollutants. The Commission has adopted recently a proposal for more stringent standards for combustion engine vehicles **(Euro 7**), which should further reduce their air pollutant emissions.

Further information on other relevant policies to deliver increased climate and environmental ambition in the HDV road transport sector, including the proposed **Battery Regulation** and the relevant budgetary framework, is found in Annex 7.

The interactions are further explored and assessed in the next sections.

1.4. 1.4. Legal context

Regulation (EU) 2019/1242 sets CO_2 emission performance standards for new heavy-duty vehicles. The Regulation requires manufacturers to decrease the average CO2 emissions per tonne-kilometre (tkm) of their fleets for certain new heavy lorries by 15% from 2025 and by 30% from 2030, compared to the baseline emissions of 2019. The CO_2 emission standards for HDVs build upon the EU type-approval system through the HDV CO_2 Determination Regulation (EU) 2017/2400, which sets out the procedures for determining CO2 emissions and fuel consumption based on the VECTO tool. The Monitoring and Reporting Regulation (EU) 2018/956 regulates the monitoring of CO_2 emissions from HDV. Additional details on Regulation (EU) 2019/1242 and its implementation are outlined in Annex 5 – Regulatory Context.

1.5. 1.5. Evaluation of the implementation

The HDV Standards Regulation (EU) 2019/1242 was adopted and entered into force in 2019. It sets new binding CO_2 targets starting to apply from the year 2025 onwards.

An evaluation of the effective application of these provisions is, therefore, not possible at this early stage, and it can only be conducted after 2025 when it will be possible to gather data on the implementation and functioning of the system . However, the current Regulation was adopted to contribute to the old 40% emission reduction target by 2030[8], which is now superseded by the new climate ambition as enshrined in the European Climate Law.

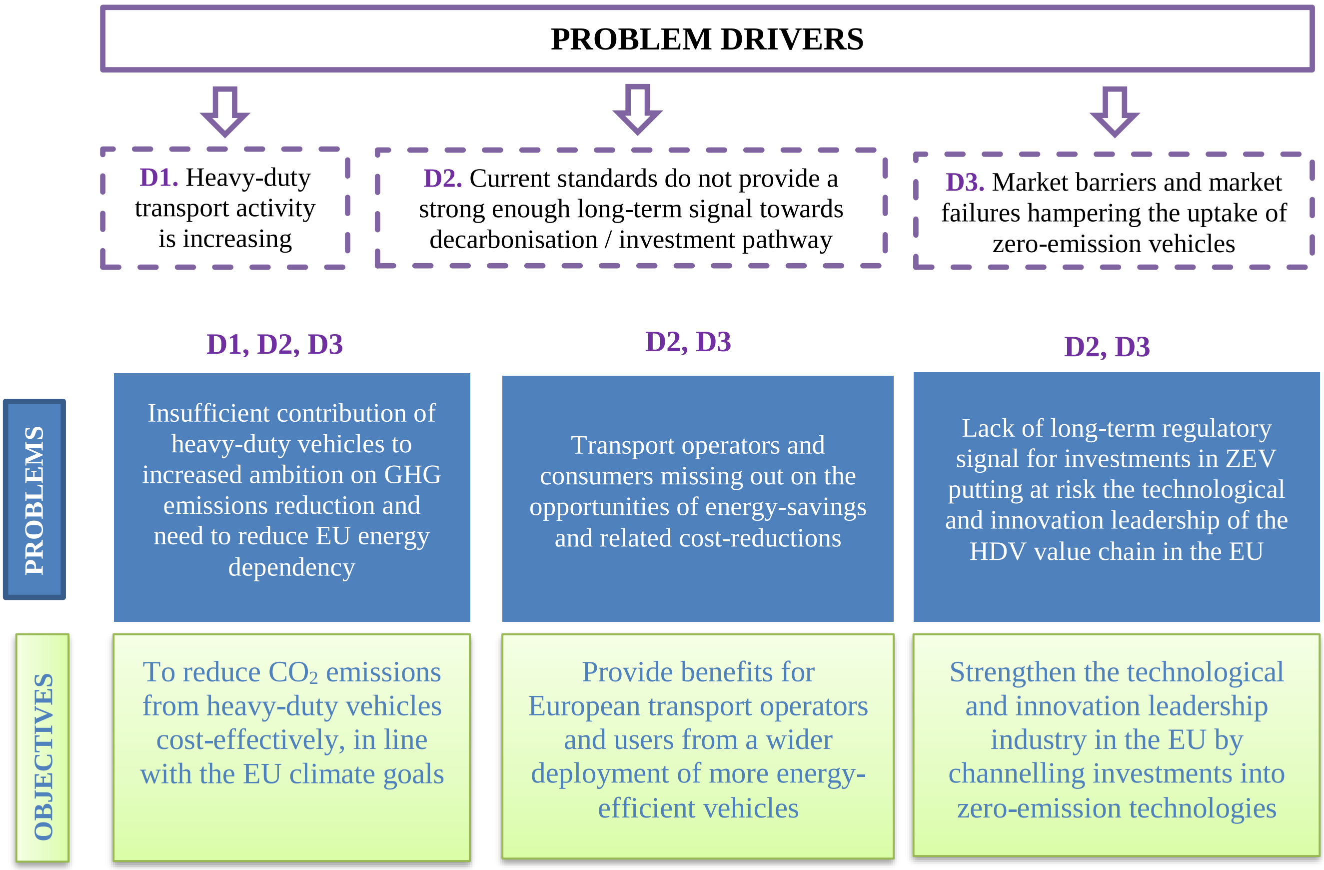
[8] Recital 5 of Regulation 2019/1242: "This Regulation […] contributes to the binding target of at least a 40% domestic reduction in economy-wide greenhouse gas emissions by 2030 compared to 1990 […]'

Furthermore, the underlying legislative elements of the HDV Standards, notably the determination of CO_2 emissions of HDVs with VECTO according to the provisions of the type-approval Regulation (EU) 2017/2400 and the monitoring and reporting of vehicle and CO_2 data to the Commission by Member States and manufacturers according to Regulation (EU) 2018/956, apply only since 2019. In the first two annual monitoring cycles, the respective procedures have worked in a satisfactory manner according to stakeholders. However, it is too early for a full evaluation of this underlying legislation for the review of the current HDV CO_2 Standards.

2. PROBLEM DEFINITION

This section describes the relevant problems and corresponding drivers (see summary discussed within this section in line with the "logic for intervention", as summarised in Figure 2 below).

Figure 2: Drivers, problems and objectives.



1.6. 2.1 What are the problems?

Three key problems have been identified.

2.1.1 Problem 1: Insufficient contribution of heavy-duty vehicles to increased ambition on GHG emissions reduction and need to reduce EU energy dependency

While this problem is not completely new, as it was one of the problems tackled through the current HDV CO_2 standards, its relevance and importance have been renewed in view of the higher climate ambition for 2030 and 2050. This new context also underpins the continued relevance of the other two problems described below.

Overall, road transport alone represents more than 20% of total EU GHG emissions and accounts for around 70% of EU transport emissions. As regards heavy-duty vehicles alone, they are responsible for more than a quarter of GHG emissions from road transport in the EU and for over 6% of total EU GHG emissions. The vast majority (99%) of heavy-duty vehicles in the current EU fleet are equipped with internal combustion engines, which are fuelled with (largely imported) fossil fuels that contribute to the EU's energy dependency.

The current HDV CO_2 standards will stimulate the gradual uptake of more efficient vehicle technologies, making them more affordable through increased supply, and will drive some emission reductions in the sector to the benefit of society. However, the level of ambition of the current HDV CO_2 standards was set for the HDV sector to contribute to the binding target of at least a 40% domestic reduction in economy-wide greenhouse gas emissions by 2030 compared to 1990. This will not be sufficient for this sector to ensure its cost-effective contribution to the new more ambitious EU 2030 and 2050 climate targets as enshrined in the Climate Law.

Such an increase of the overall ambition of the EU climate targets requires the revision of all the relevant legislative framework including the HDV CO_2 standards, as provided for by the Climate Target Plan (COM/2020/562 final) and set out in the European Green Deal. In all the scenarios underpinning the Climate Target Plan to reach the "at least 55%" target, an increased ambition for the HDV standards is necessary, as highlighted in the Annex of the Climate Target Plan Impact Assessment.[9] The same finding is confirmed by all the core policy scenarios underpinning all the proposals of the "Fit for 55" package, as documented in the methodological annex, common to all the "Fit for 55" Impact Assessments.[10] The above mentioned scenarios include an increase of the ambition level for the HDV CO_2 standards in line with the range analysed in detail in this Impact Assessment (see paragraph 5.2.2.1).

With the REPowerEU Plan and the need to end the EU's dependence on Russian fossil fuels while targeting the climate crisis, the Commission proposed, in May 2022, to increase the target in the Renewable Energy Directive to 45% by 2030, and the binding target in the Energy Efficiency Directive to 13% by 2030, based on an updated modelling scenario described in the Staff Working Document accompanying the REPowerEU Action Plan, SWD(2022) 230 final. This updated modelling scenario, which includes all the policies already proposed under the Fit For 55 package, confirms that an increase of the HDV CO_2 standards ambition is necessary, not only to contribute to the higher energy efficiency targets, but also for the promotion of renewable hydrogen as a substitute for fossil fuels. This is also highlighted in the EU Save Energy Communication (COM(2022) 240 final) as part of the REPowerEU package.

The analytical work underpinning this Impact Assessment shows that despite all the Fit for 55 proposed policies, the renewable energy and energy efficiency targets proposed as part of the REPowerEU Plan, and the relevant other legislation included in the Reference Scenario 2020[11], there is a **"CO_2 emissions gap"** for HDV. The baseline of this Impact Assessment factors in the all the above mentioned policies (including policies of the Fit for 55 package, as well as REPowerEU plan), and it fixes the HDV CO_2 standards to the levels and scope set out

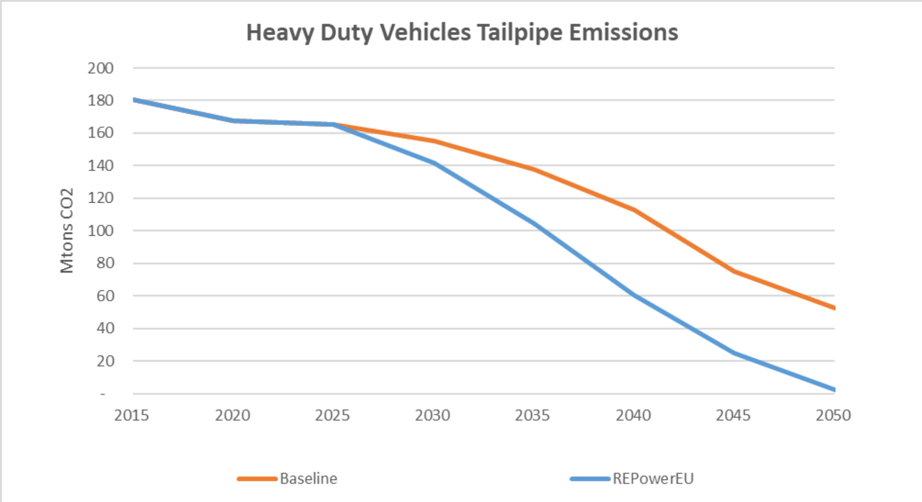
[9] See Table 37 of the Annex of the Climate Target Plan Impact Assessment (SWD(2020) 176 final)

[10] See, for example, the CO2 standards for cars and vans Impact Assessment, Annex 4, Table 25

[11] The Reference Scenario 2020 provides projections assuming the EU legislation in place to reach the 2030 climate target of at least 40% compared to 1990.

in the current 2019 HDV Regulation (see paragraph 5.1 for more details). Therefore, the baseline projects the evolution of the HDV sector in a scenario where the current Regulation on HDV standards acts together with all the other Fit for 55 and REPowerEU proposals. Figure 3 below shows the HDVs CO_2 emissions under the REPowerEU and the baseline scenario

Figure 3: CO_2 emissions from HDV under the REPowerEU and the baseline scenarios.



According to the projections of such dynamic baseline, CO_2 emissions from the HDV sector will decrease by only around 14% and 70% in 2030 and 2050, respectively, compared to 2015.

This analysis demonstrates that without further strengthening of the current HDV CO_2 standards, the emissions from the HDV sector would remain significatively higher than what is needed under the REPowerEU scenario. This **"CO_2 emissions gap"** is projected at 13 Mton CO_2 in 2030. This increases to around 50 Mton CO_2 in 2050[12]. This gap represents the further CO_2 emission reductions necessary for the HDV sector to provide a cost-effective contribution to the increased ambition in line with the Climate Law.

This "emissions gap" is due to the insufficient deployment of ZEV on the market under the baseline. In fact, in all the scenarios analysed in the Climate Target Plan, the Fit for 55 package and in the REPowerEU scenario, a significant increase of ZEV penetration in the fleet is observed, since the potential improvement of conventional powertrains is limited. For example, the share of zero-emission vehicles in the fleet of new vehicles increases in the baseline from 12% in 2030 to 31% in 2040, while in the REPowerEU scenario it increases from 34% to 57% in the same years.

This shows that maintaining the current CO_2 emission standards would be insufficient to drive down emissions to the levels consistent with the 2030 and 2050 climate targets. In addition, early action is needed to ensure that the necessary emission reductions for 2050 are achieved, in consideration of the long lead time needed for changes, especially for the fleet renewal.

[12] As a reference, the Commission proposal on CO_2 emission standards for cars adopted in July 2021 as part of the Fit for 55 package was projected to provide an additional contribution to CO_2 emission reduction in the sector, compared to the baseline used in that Impact Assessment, of around 19 Mton CO_2 in 2030, and around 180 Mton CO_2 in 2050.

2.1.2 Problem 2: Transport operators and consumers missing out on the opportunities of energy-savings and related cost-reductions

Transport operators, who usually face large operating costs due to fuel expenditures, have a strong interest in energy-efficient technical improvements of heavy-duty vehicles leading to fuel savings, if they decrease the total cost of ownership[13] (TCO). However, the market deployment of such technologies is happening only at a slow pace.

For the regulated vehicles subject to the current HDV CO_2 standards Regulation, a broad range of conventional technologies for reducing the fossil fuel consumption is expected to be used by manufacturers to meet their 2025 and 2030 CO_2 targets, as shown in the Impact Assessment underpinning the 2018 HDV CO_2 standards Commission's proposal.

However, as regards most of the currently unregulated HDV groups, which today represent almost two thirds of the HDV fleet, the deployment of advanced fuel efficiency technologies will happen, if at all, only with some significant delay and at higher costs unless specific regulatory incentives are created.

An additional significant potential for reducing fuel consumption expenditures, which is almost entirely untapped at the moment, lies in the optimisation of trailers with regard to their aerodynamic performance, rolling resistance and weight.

The largest potential to increase energy-savings lays with ZEVs. Amongst all technologies, ZEVs offer advantages to both transport companies and society in general. Electric motors or fuel cell technologies are more efficient than combustion engines. Less energy is therefore needed to drive ZEVs and users save on fuel/energy costs. ZEVs, as highlighted in the REPowerEU Communication, have the potential to replace vehicles running on fossil fuels, making operators and the society more independent from imported fossil fuels.

ZEVs are expected to decrease TCOs even after considering the higher initial purchase costs, as shown by different publications.[14] While for ZEV operation the necessary recharging and refilling infrastructure needs to be available, other initiatives (see section 2.1.3 on recharging and refuelling infrastructure) will address this need.

The implementation of the current HDV standards is projected to deliver a limited share of ZEV, around 12% and 31% in the EU new fleet by 2030 and 2040, respectively, as shown by the baseline of this IA, even when considering the effects of demand-side measures, such as the Eurovignette and carbon pricing on road fuel. Even in the currently regulated HDV groups, the current HDV CO_2 standards do not provide sufficient regulatory incentives for manufacturers to bring ZEVs to the market in numbers close to the scale suggested by the Climate Target Plan and the REPowerEU (see Sections 5.1 and 13.1.9).

Therefore, without further action on the supply-side, there is a risk that the scale of future uptake of ZEVs may not reach sufficient levels for transport operators to reap their benefits in terms of energy savings and total-cost-of-ownership.

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[13] The TCO of a vehicle is the cost of purchase plus the cost to operate the vehicle over its useful life (fuel, maintenance, taxes, charges, etc.). It is a measure that considers the total cost that a business will incur to operate a vehicle, not just the upfront acquisition cost.

[14] Recent studies expect parity of long-haul battery electric vehicles in the coming years, depending on the amount and intensity of available policy incentives and the technological improvements. See for instance OECD "Decarbonising Europe's Trucks. How to Minimise Cost Uncertainty"; ICCT, 2021 "Total cost of ownership for tractor-trailers in Europe: Battery electric versus diesel"; Traton group: "Both BEV and FCEV are likely to ultimately beat Diesel on cost; H2Accelerate: Analysis of cost of ownership and the policy support required to enable industrialisation of fuel cell trucks. 18 July 2022

The reasons why manufacturers may not deliver ZEVs in the numbers and varieties which would be beneficial for operators are several market barriers and failures. These are lined out in section 2.2.3 on Driver 3*: Market barriers and market failures hampering the uptake of more fuel-efficient technologies, in particular zero-emission vehicles".*

This size of this problem can be measured by monitoring the evolution of ZEV rates, and total and fossil energy consumption for HDV operators.

2.1.3 Problem 3: Lack of long-term regulatory signal for investments in ZEV putting at risk the technological and innovation leadership of the HDV value chain in the EU

The HDV industry in the EU has traditionally led the way in technological developments for internal combustion engines. New lorries in the EU have lower average fuel consumption than lorries in other regions of the world. The EU is a global leader in overall R&D investment, and this has led to competitive success. For instance, 50% of US heavy lorries are based on technology developed in the EU from local factories operated by major manufacturers or their subsidiaries in the EU. In addition, over a third of lorries produced in the EU are exported worldwide generating a trade surplus of around EUR 5 billion annually.

At the same time, ZEV demand is increasing globally as some countries are committing to put forward actions to improve air quality and decarbonise their economies. Several governments have already initiated policies to increase the zero-emission share of HDVs and have committed to phase out internal combustion engines. An overview of the regulatory status of ZEV in other countries is found in Annex 7.

In this global context, where zero-emission technologies are playing an increasingly significant role, the advantage of the HDV industry in the EU in terms of technological leadership could be put at risk unless clear long-term regulatory and investment signals are put in place

While there are practically no non-European manufacturers active on the EU lorries market yet, in other major global markets the situation is different: HDVs are supplied both by local manufacturers and European manufacturers (producing mostly locally). If the regulatory signal for ZEV in other markets is stronger than in the EU, manufacturers operating in the EU will be put in a commercially challenging and unfavourable position in terms of technological leadership. Meanwhile, the global competitors could essentially focus on ZEV development to enter the European HDV market after gaining valuable technological experience.

For instance, China, traditionally lagging behind in this sector, is currently, and by far, the main zero-emission global HDV market by deploying the vast majority of the world's zero-emission lorries and buses. As a result, the country produced 95% of the world's 'new energy' (plug-in hybrid, battery electric, and fuel cell vehicles) HDVs put on the market over the past decade. It accounts for nearly 90% of electric lorries registrations in 2021 (down from nearly 100% in 2017) and dominates the global zero-emission bus market.[15] China has also become a world leader in the patenting of green transportation technologies as regards charging stations. Some Chinese companies are well-known global leaders, such as Yutong or BYD, and are currently investing and participating in the growing ZEV EU market. Although some EU manufacturers are engaged into joint ventures or other business associations with some Chinese manufacturers, their participation in the Chinese market is not significant. In fact, during 2019 there was no EU presence among the 10 top selling ZE HDV manufacturers in

[15] IEA. Global EV Outlook 2022. Securing supplies for an electric future.

China (covering 66% of the market).[16] Regarding the USA, while half of the conventional heavy lorries are produced currently by European-owned factories based on European technology, it hosts innovative companies announcing significant commercial launches of ZEVs. Indian companies are also setting up own manufacturing facilities in the EU for supplying zero-emission buses, vans and light lorries for both European and foreign markets.

1.7. 2.2 What are the problem drivers?

2.2.1 Driver 1: HDV transport activity is increasing

Freight transport activity is growing steadily since 1995. Despite the economic and financial crisis in 2007 – 2009, road freight activity was 34% higher in 2015 compared to 1995 levels.

In the baseline, heavy-duty freight transport activity is expected to continue to increase by about 29% by 2030 and almost 50% by 2050 compared to 2015, while the activity of buses and coaches would grow at a slower pace (around 11% by 2030 and 25% by 2050 compared to 2015), roughly accompanying the increased economic activity and a higher demand for transportation of goods. The CO_2 emissions resulting from this activity increase will not be completely compensated by improvements in energy efficiency, with specific fuel consumption projected to be reduced by around 40% by 2050 for lorries and by around 24% for buses and coaches.

This initiative will not address this driver as CO_2 emission standards do not directly affect road transport activity. This driver is also addressed by policies targeting multimodal transport mobility and carbon pricing policies including the proposed new emissions trading system (ETS) for buildings and road transport. Although road activity is not directly tackled by this initiative, more ambitious standards would ensure that activity increase will not result in higher CO_2 emissions.

2.2.2 Driver 2: Current standards do not provide a strong enough long-term signal towards decarbonisation / investments pathway

The analysis of the baseline (see Section 5.1) shows that the current HDV standards would take time to show impacts in terms of changes to the fleet structure due to the slow turnover of the vehicle stock. The share of zero-emission HDVs in the total vehicle stock is projected to be very small by 2030, while internal combustion engine vehicles (conventional diesel by far dominating, with some mild hybrid and gaseous) would still remain very prominent in the fleet. However, the REPowerEU scenario shows that significantly higher proportion of ZEVs are necessary to reach the increased EU 2030 and 2050 climate targets.

The industry requires regulatory certainty to take investment decisions that would allocate the large capital investments necessary to shift to zero-emission powertrains. However, the current HDV CO_2 standards will not sufficiently drive the investments necessary to increase the market uptake of ZEV and thereby further reduce CO_2 emissions. Manufacturers and their suppliers may delay investment decisions with long-term implications, both concerning R&D and manufacturing in Europe, as well as in terms of developing the related recharging and refuelling infrastructure. In absence of stricter CO_2 emission standards and clear longer-term regulatory signals, there is therefore a significant risk that manufacturers may not produce and offer enough ZEVs for the EU market to contribute to the 2050 climate neutrality objective.

[16] ICCT. RACE TO ZERO. How manufacturers are positioned for zero-emission commercial trucks and buses in China. August 2021.

European manufacturers support a review of the CO_2 emissions reduction target as a fixed ambition level for 2030. Industry sees also possible setting target levels for 2035 and 2040 if they are to be reviewed again in due time in view of the status of the enabling conditions, especially the charging and refuelling infrastructure network.[17] The European Clean Trucking Alliance (ECTA[18]) sees the regulation on CO_2 standards for HDVs as the most important tool to drive the transformation of the sector towards zero emission trucks. Setting a regulatory signal such as more ambitious CO_2 standards is also supported by ICCT[19] and T&E.[20] On the other hand, only 5% of suppliers of fuels and gases considered important to strengthen the 2030 target while a higher figure (two-fifths) supported setting 2040 targets.

The **need to act** by setting stringer standards or even zero-emission vehicles mandates to accelerate the decarbonization of the sector and spur adoption of zero-emission technologies is substantiated also by several recent reports from reputed independent entities such as IEA and OECD.[21] [22] [23] [24]

This initiative will help address this driver by sending clear signals to stimulate the development and supply of ZEV.

2.2.3 Driver 3: Market barriers and market failures hampering the uptake of more fuel-efficient technologies, in particular zero-emission vehicles

The Impact Assessment accompanying the 2018 Commission's proposal for the current HDV Regulation showed that certain market barriers and failures prevent the reduction of fuel consumption and CO_2 emissions through market forces alone, even though the associated costs and/or payback periods of the applicable technologies may be low. As a result, transport operators and consumers risk missing on energy savings. For conventional vehicles using internal combustion engines regulated under the current HDV CO_2 Regulation, these barriers are tackled to a certain extent, but they still persist for the remaining unregulated groups.

When it comes to zero-emission powertrains, the identified barriers intensify due to the higher upfront costs of ZEVs compared to conventional HDV, the investments to be undertaken by manufacturers to produce them and the associated commercial risks, which are significantly higher than for introducing fuel-efficient technologies in conventional powertrains.

As electric motors or fuel cell technologies are more efficient than combustion engines, less energy is also needed to drive ZEVs and users may save on fuel/energy costs. They also do not emit tailpipe air pollutants, and they are more energy-efficient, also when considering a

[17] ACEA, Position paper on the review of CO2 emission standards regulation for heavy-duty vehicles. July 2022.
[18] ECTA is a group of over 20 companies and organisations from across Europe calling for zero-emission road freight. It covers urban logistics, long-haul freight, consumer goods, manufacturing, and supply chain management. https://clean-trucking.eu/publications/co2-standards-for-heavy-duty-vehicles/
[19] ICCT. The CO_2 standards required for trucks and buses for Europe to meet its climate targets. 30 March 2022. March 2022.
[20] T&E. Addressing the heavy-duty climate problem. Why all new freight trucks and buses need to be zero-emission by 2035. September 2022
[21] International Energy Agency. Trucks & buses, key findings. 1January 2022
[22] International Energy Agency. Global EV Outlook 2022. Securing supplies for an electric future.
[23] International Transport Forum (OECD). Decarbonising Europe's Trucks. How to Minimise Cost Uncertainty. September 2022.
[24] McKinsey&Co Preparing the world for zero-emission trucks. September 2022

lifecycle perspective, which includes the production of fuel/electricity and the battery (see Annex 7).[25]

Stakeholders responding to the public consultation ranked the importance of main barriers for the market uptake of zero and low-emission vehicles, from more significant to less significant: availability of recharging/refuelling infrastructure, vehicles price and TCO (affordability, uncertainty for purchasing decision), charging time, limited range of vehicles, reduced load capacity and lack of ZEV offer. Main market barriers and failures are discussed as follows:

Market barriers

** Affordability and access to finance.*

According to stakeholders' statements, zero-emission HDVs are nowadays still significantly less affordable than comparable ICEVs. Their upfront costs can typically be two to three times higher than those of conventional alternatives. The main underpinning reason is the significant costs of innovative zero-emission powertrain elements, in particular batteries for BEVs and fuel cells and hydrogen storage for FCEVs.[26]

Although it is generally agreed that ZEV prices will decrease in the coming years due to expected lower production costs linked to the decreasing trend of batteries costs (their costs have fallen faster than anticipated, by 90% in 2021 compared to 2010), there is a risk that ZEVs remain accessible just to a limited number of operators due to the still high upfront costs. Therefore, there would be limited demand for ZEVs, which in turn does not stimulate manufacturers to increase the supply offered.

ZEVs may not take off on the market, without additional regulatory measures to promote their deployment. According to several sources,[27] [28] [29] [30] [31] regulatory action on ZEV supply can break this vicious circle and provide a wider choice and more affordable ZEVs to customers.

[25] According to a study led by Ricardo on behalf of DG Climate Action "Determining the environmental impacts of conventional and alternatively fuelled vehicles through LCA", the average EU lifecycle Global Warming Potential impact of ZEV lorries up to 40t, either BEV or FCEV, is much lower than for any ICEV by 2030, as shown by the study 'Determining the environmental impacts of conventional and alternatively fuelled vehicles through LCA'. In 2050, the difference is even bigger as the electricity mix becomes more decarbonised[25]. The study projects that, while conventional diesel-powered lorries emit 132 gCO_2e/tkm by 2030 (84 gCO_2e/tkm in 2050), fuel cell vehicles emit 109 gCO_2e/tkm (24 gCO_2e/tkm in 2050) and battery electric vehicles emit 32 gCO_2e/tkm (11 gCO_2e/tkm in 2050). Results for smaller lorries and urban buses cases are similar

[26] ICCT, 2021. Total cost of ownership for tractor-trailers in Europe: Battery electric versus diesel

[27] IEA. Trucks & buses, key findings. '*More countries need to adopt new, or make stringer existing, CO_2 emissions standards as well as zero-emission vehicle mandates […]and existing ones need to be made more comprehensive and stringent to spur adoption of zero-emission technologies.'*

[28] OECD. Decarbonising Europe's Trucks. How to Minimise Cost Uncertainty. *'Stringent regulations can also help promote new energy-efficient powertrains such as battery electric vehicles'*

[29] ICCT. The CO2 standards required for trucks and buses for Europe to meet its climate targets. The paper explains that manufacturers' announcements (as reported in Annex 7) *"only represent their strategic vision and binding regulation is likely necessary to realize these reductions in emissions. Manufacturers' targets represent the minimum level of stringency that the European Commission should consider in the review of the CO_2 standards; the HDV CO2 standard, which applies to new vehicles, acts as the main policy lever to enshrine these manufacturer-led commitments into binding regulation."*

[30] ICCT. Road freight decarbonization in Europe: Readiness of the European fleets for zero-emission trucking - International Council on Clean Transportation. *'Regulation has a crucial role to play to incentivize increases in zero-emission vehicle production by establishing a clear roadmap for the industry. The review of the CO_2 standards for trucks and buses that will take place at the end of this year is a unique opportunity to secure an increase supply of vehicles.'*

In this context, access to finance for transport companies to buy efficient vehicles, and ZEVs in particular, is significant. While energy savings have the potential to enable an attractive payback time through a lower TCO, financial entities generally do not factor in energy savings as part of their lending criteria, as loan decisions are primarily based on the financial health of the transport company. As a result, transport companies may have difficulties to access finance, or may face higher financing costs (due to the higher upfront cost) which can result in longer payback periods and, consequently, less favourable TCO.

The situation is usually worse for smaller companies given that their financial position is typically less attractive. 80% of companies operating commercial transport[32] in the EU are SMEs and 30% of commercial road transport companies hold no more than 25 vehicles in their fleet[33]

This initiative will contribute to address the market barriers related to the affordability and availability of fuel-efficient technologies in the different HDV groups, including ZEVs, by sending clear signals to stimulate their development and supply resulting in a reduction of upfront costs through economies of scale. This will also help investors and industry to take informed investment decisions, thereby addressing the risk of industry in the EU losing its technological leadership.

On the other hand, this initiative will not address the barriers concerning capital financing. Access to finance will be supported by policies on sustainable finance and investments, such as the EU Taxonomy under which only heavy-duty ZEV, and LEV until 2025, are recognised to substantially contribute to climate change mitigation.

** Uncertainties for purchasing decisions, lack of ZEV offer*

Operators face several uncertainties when adopting new technologies. This is particularly the case for ZEVs. The residual value of the vehicle at the end of its life, the durability of batteries and fuel cells, future electricity or renewable hydrogen costs and the availability of recharging or refuelling infrastructure, among other factors, introduce additional uncertainty for the purchase decision. Also, buyers may find it difficult to understand or quantify their potential benefits, partly since on average the first owner holds the HDV only for a limited period, notably for lorries. As a result, customers may assign a risk premium to innovative vehicles. As shown in section 1.2, the very small number of ZEV models (or even the current absence in the case of long-haul lorries and coaches) on the market creates an additional barrier. While this may change in the future as manufacturers announce their technological readiness to produce more ZEV and broaden their portfolio (see their Announcements in Annex 7), the regulatory framework will play a significant role in driving a wider availability of ZEV models to be supplied to the market. The members of the European Clean Trucking Alliance (ECTA) consider the availability of ZEV the second barrier to the transition of their fleets to ZEV, and consider CO_2 standards a way to secure an increased supply of vehicles. **This initiative will help addressing this driver, by acting on the supply of zero-emission vehicles on the market.**

** Lack of recharging and refuelling infrastructure*

[31] T&E. Truck CO_2: Europe's chance to lead. Position paper on the review of the HDV CO2 standards. September 2022. '*by adopting strong CO_2 standards for heavy-duty vehicles, the EU can replicate the success of the cars and vans CO_2 standards and put trucks and buses on a similar path to zero-emission*'

[32] Commercial transport also includes passenger cars professional services as taxis, rent a car, etc

[33] Source: IRU

Confidence in the possibility to recharge and refuel seamlessly across borders is a crucial pre-condition for the deployment of alternative fuels in the long-haul transport sector. Information on such market barriers and infrastructure roll-out targets for the period 2025 onwards is considered in the Impact Assessment for the Alternative Fuels Infrastructure Regulation proposal (AFIR). The AFIR Impact Assessment shows that, without a clear European policy framework in this area, it is very unlikely that a sufficiently dense European network particularly of electric charging and hydrogen refuelling stations will develop that allows the deployment of an appropriate share of zero-emission vehicles into the heavy-duty segment.

The Commission's 2017 assessment of Member State National Policy Frameworks[34] and the 2021 assessment on the National Implementation Reports[35] identified that, in many Member States, projections on the uptake of alternative fuelled vehicles were rather low and consequently the infrastructure targets risk to be insufficient to support the expected growth in alternatively-fuelled vehicles.

This initiative will not address this driver directly. The AFIR is the key instrument addressing recharging and refuelling infrastructure, together with the Strategic Rollout Plan that supports the rapid deployment of infrastructure.

Market failures

** Environmental externalities:*

Environmental externalities, such as CO_2 and air pollutant emissions, are those costs that are generally not borne by the (transport) user and hence not considered when they make a transport decision. Even in a perfect market, market forces would then not find incentives to reach the societal optimum in terms of emissions.

This initiative will reduce environmental externalities by reducing emissions (of both GHG and air pollutants), while at the same time pricing policies, such as the proposed emissions trading for buildings and road transport as well as the revision of the Energy Taxation Directive and the Eurovignette Directive, will make sure users consider the cost of the remaining CO_2 emissions in their decisions. These effects are further analysed in the respective impact assessment reports of these pricing policies initiatives.

** Split incentives:*

A part of the HDV fleet is also affected by split incentives in the market, leading to an impeded or delayed market penetration of innovative vehicles, which are beneficial regarding their TCO, but require significant investments by manufacturers (R&D, new production lines) and have currently a higher initial purchase price.

Split incentives typically occur when the buyer of the vehicle sometimes is not directly responsible for all the vehicle's operational costs (fuel, road charges, maintenance, etc.) in the following situations:

a. Differentiated ownership of the vehicle: this refers to situations where the entity owning the vehicle (buyer) is not the same entity paying for operational costs. This is the case, for instance, of leasing. The buyer, supporting the upfront costs, will then find little incentive in purchasing fuel-saving technologies as not enjoying the operational savings. In the EU, the share of hired or leased heavy goods vehicles in total new registrations was estimated to be about 40% in 2017.

[34] SWD(2017) 365 final
[35] COM/2021/103 final

b. Fuel provisions in contracts: this refers to situations where fuel costs are borne by customers rather than operators of transport services so the latter would find little motivation in acquiring more fuel-efficient vehicles. A study found that such open-book contracts are used by roughly 20% of the surveyed companies, from which 80% considered fuel efficiency not an important parameter when acquiring a new vehicle. While the projected increase of fuel price may make the customers more aware of fuel efficiency importance, there may still be a lack of transparency on the efficiency of the vehicles, which hampers well informed decisions.

This initiative on the HDV CO_2 emission standards will also address the problem of split incentives by forcing the market players to overcome the initial inertia regarding the shift to zero-emissions mobility.

1.8. 2.3 How is likely the problem to persist?

As regards the 1st problem related to insufficient contribution of HDV to the CO_2 emission reduction, without more stringent standards and also considering the Fit for 55 policy package and the REPowerEU targets, the baseline shows that emissions from heavy-duty vehicles would only reduce by around 19% in 2030 and 73% in 2050 as compared to 2005, giving rise to the problem described in section 2.1.1. The main reason is related to the limited penetration of ZEV, which are necessary to ensure higher emission reductions.

As regards the 2nd problem related to the penetration of ZEVs and the expected benefits for consumers, their production costs are expected to decrease over the coming years via learning curve and mass production. However, without further strengthening of the CO_2 emission standards, the shares of ZEVs circulating on the roads in 2030 and 2050 would remain limited to around 2% and 28% respectively. This is largely insufficient for reaching the climate neutrality objective.

As regards the 3rd problem related to the lack of long-term regulatory signals for investments in ZEV, the many legislative and policy developments in other countries (see Annex 7) clearly point at a shift in the HDV sector to zero-emission. This on-going energy and technological transition will provide industry in these markets with a competitive advantage in the global market, thus challenging the current EU innovation leadership.

All existing policy measures detailed in section 1.3 address to a certain extent the drivers identified. However, without strengthened CO_2 standards, acting on the supply of vehicles, these existing measures are not sufficient for tackling them due to the barriers to a massive uptake of fuel-efficient technologies, including zero-emission powertrains, as explained in section 2.2.3.

3. WHY SHOULD THE EU ACT?

1.9. 3.1 Legal basis

Title XX (Environment) of the Treaty on the Functioning of the European Union (TFEU), Article 191 and Article 192, empowers the EU to act to ensure a high level of protection of the environment. Based on Article 192 of the TFEU, the EU has already adopted policies to address CO_2 emissions from heavy-duty vehicles through Regulation (EU) 2019/1242.

1.10. 3.2 Subsidiarity: Necessity of EU action

Climate change is a transboundary problem, where coordinated EU action can supplement and reinforce national, regional and local action effectively. EU action is justified on the grounds of subsidiarity, in line with Article 191 of the Lisbon Treaty. The EU has worked since 1992 to develop joint solutions and drive forward a global agreement to fight climate change.

Considering the ambitious emission reduction target put forward in the 2030 Climate Target Plan in the perspective of the climate neutrality objective by 2050, as well as the Zero Pollution Ambition of the European Green Deal, stronger EU action is needed to ensure a contribution of the road transport sector. As underlined in the Commission's Strategy for Sustainable and Smart Mobility, Regulation (EU) 2019/1242 needs to be reviewed to meet the targets and ensure a clear pathway from 2025 onwards towards zero-emission mobility.

1.11. 3.3 Subsidiarity: Added value of EU action

Initiatives at the national, regional and local level will not be sufficient or will be sub-optimal. Lack of coordinated EU action via the strengthening of CO_2 emission standards would translate into the need for Member States to act individually leading to market fragmentation due to the diversity of national schemes, differing ambition levels and design parameters. On their own, individual Member States would also represent too small a market to achieve the same level of results, including in terms of economies of scale. Therefore, an EU-wide approach is needed to drive industry level changes and to create economies of scale.

Market fragmentation would potentially translate into competitive distortions, a risk of tailoring national legislation to suit local industry, and compliance costs (passed on to owners) for both component suppliers and vehicle manufacturers. It would also weaken the incentive to design fuel efficient vehicles and deploy zero-emission vehicles to the overall EU market. Coordinated EU action therefore provides benefits for both manufacturers, component suppliers and consumers and it is necessary and justified in view of both the cross-border impact of climate change and the need to safeguard the single market.

Furthermore, while national, regional or local fiscal incentives play a role to promote the market uptake of zero-emission vehicles, they are normally temporary and, in any event, easily reversible, especially when funding them becomes problematic in light of competing objectives or strained budgets, and therefore they do not provide the needed long-term market signal and predictability. Coordinated EU action through the strengthening of the CO_2 emission standards could catalyse the transformation of the sector, and it would provide the entire automotive value chain with the necessary long-term, stable market signal and regulatory certainty needed to make the large capital investments that are necessary to deploy zero-emission vehicles on the market.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

1.12. 4.1 General policy objectives

The general objective of this initiative is to provide new emission standards to reduce CO_2 emissions and contribute to the shift to zero-emission mobility in the broader context of increased EU climate ambition by 2030 and EU climate neutrality by 2050 (i.e., achieve net zero GHG emissions by 2050).

1.13. 4.2 Specific objectives

1. To **reduce CO_2 emissions** from heavy-duty vehicles (lorries, buses and coaches), cost-effectively, in line with the EU climate goals while contributing to improve EU energy security.
2. To provide benefits for European **transport operators and users,** most of which are SMEs, resulting from a wider deployment of more energy-efficient vehicles.

3. To strengthen the **technological and innovation leadership** of industry in the EU by channelling investments into zero-emission technologies.

All specific objectives were found to contribute directly to the Sustainable Development Goals of the UN 2030 Agenda (see Annex 3).

The first specific objective concerns the contribution of heavy-duty vehicles to the **increased overall climate ambition** for 2030 and 2050. With these vehicles contributing to 6% of EU GHG emissions in 2019, improving the CO_2 efficiency of HDVs is of key importance.

Around 90% of respondents to the public consultation, including most of vehicle manufacturers and transport operators, considered ***reducing CO_2 emissions*** significant or very significant both for 2030 and 2050 (more information in Annex 2 – Stakeholder Consultation). All stakeholder's groups supported these objectives.

The effect of the CO_2 emission standards on the reduction of emissions from the running stock of vehicles is not immediate. The EU-fleet average age is 14 years for lorries and 13 years for buses, with most of the mileage concentrated in the early years. Early action is therefore important to ensure the cost-efficient achievement of the long-term objective.

The second specific objective is related, in line with the European Green Deal, to **providing benefits to transport operators and users** from a wider deployment of more energy-efficient vehicles, including zero-emission vehicles.

Further action on CO_2 emission standards for HDV should aim at incentivizing the market supply of more fuel efficient and zero-emission vehicles, which provide two main co-benefits:

i. improvements in air quality, in line also with the **zero-pollution ambition** of the European Green Deal and the Commission's Zero Pollution Action Plan;

ii. reduction of energy consumption, imported fossil fuels and energy bills, in line with the "just transition" objective of the European Green Deal. As indicated in the **Communication REPowerEU: Joint European Action for more affordable, secure and sustainable energy**, reducing dependency on imported fossil fuels will provide the best insurance against price shocks in the medium term. The energy security of the EU will improve as the demand for imported oil will decrease.

Most stakeholders considered the ***reduction of air pollution and other environmental problems*** as a significant or very significant co-benefit, largely supported by citizens and suppliers of electricity and hydrogen and by 48% of industry respondents. The objective of ***reducing EU energy consumption and dependence on imported fossil fuels*** was considered to be significant or very significant by most of respondents, namely by nearly 75% of transport operators and half of public authorities.

The third specific objective relates to **innovation and technological leadership** by providing a clear regulatory signal and predictability for industry. This objective is strongly rooted in the European Green Deal as the EU's new growth strategy, which aims at transforming the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy.

The objectives of ***strengthening technological and innovation leadership*** and ***stimulating employment*** were considered as significant or very significant by most of respondents of the public consultation, ranking highest for transport operators. However, only 30% of the suppliers of components and materials considered these objectives as significant.

Contributing to the three specific objectives implies more stringent CO_2 emission standards for HDV and increasing the share of ZEVs to reduce their emissions. The industry will have to adapt to accelerate transition towards zero-emission mobility and thereby increasingly channel investments in related technologies instead of the traditional investments into ICE technologies.

5. What are the various options to achieve the objectives?

This Section describes the options identified to address the problems listed in Section 2.1 and to achieve the objectives defined in Section 4. The options explored reflect the outcome of the open public consultation as well as internal and external study reports.

Annex 8 shows how these categories are related to the problems defined in Section 2.1.

1.14. 5.1 What is the baseline from which options are assessed?

The dynamic baseline for the assessment is built on a scenario which reflects the current legal situation (see Annex 4, Analythical Methods, for additional details).

More in detail, it factors in the proposed European Green Deal policies, including those part of the **Fit for 55 package**, as well as the revised 2030 Renewable Energy and Energy Efficiency targets as proposed in the **REPowerEU plan**.

As further detailed in Annex 4, the SWD implementing the REPowerEU Action Plan describes the results and the assumptions of the modelling scenario on how to achieve the objectives of the REPowerEU Communication to reduce the dependence of Russian fossil fuels. REPowerEU requires to reduce faster the EU dependence on fossil fuels. This implies inter alia boosting investments including to scale-up energy efficiency gains, increase the share of renewables, scale up renewable hydrogen.

The REPowerEU scenario therefore includes targets and actions both from the supply and demand side, in the short, medium and long term. The renewables reach a 45% share, the Energy efficiency target reaches 13% in 2030 and renewable hydrogen use reaches 20 Mt by 2030. This new context is relevant for the HDV sector which can contribute to further energy savings and has the potential to partially substitute the currently used fossil fuels products with renewable hydrogen, if the manufacturers deploy in the market new powertrains which can be powered by such energy carrier.

All other relevant legislation included in the Reference scenario 2020, such as the Clean Vehicles and the Eurovignette directives, as well as policies defined at the Member State level as included in the national Energy and Climate Plans, are also included. Concerning the HDV standards, the baseline reflects the provisions laid down in the current HDV Regulation, as described in Section 1.4. Additional details are provided in Section 6.1. With such approach, the baseline describes the evolution of the HDV sector in a scenario where the HDV standards are unchanged as compared to the current legislation, but all the other relevant policies, including the ones proposed as part of the Fit for 55 package, act on the sector.

The PRIMES and PRIMES-TREMOVE models are used to quantitatively describe the baseline scenario (and all the other scenarios presented in this IA), in a fully consistent way with the REPowerEU, Fit for 55 and the Climate Target Plan analytical scenarios. For the HDV sector, the model allows for a representation of the market dynamics, projecting demand for freight and passenger transportation services (based on the projected economic activity used for the REPowerEU Plan analysis) and the projected cost-optimal technology mix (based on the 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 delivers the vehicle stock turnover, and the dynamic baseline considers an improvement of CO_2 emissions that would occur due to the evolution of technological costs without additional action on the CO2 standards. A full description of the model functioning is available at JRC model inventory MIDAS.

Figure 3 above shows the trend of the HDV CO_2 emissions in the baseline scenario, Figure 4 below presents the main trends of the energy demand of the HDV sector. It shows a limited reduction in the overall energy demand (which increase slightly until 2030 and then slowly decreases, by 11%, in the following 20 years, see also Section 6.3.1.1.3).

Figure 4: evolution of the energy demand in the baseline for all HDV

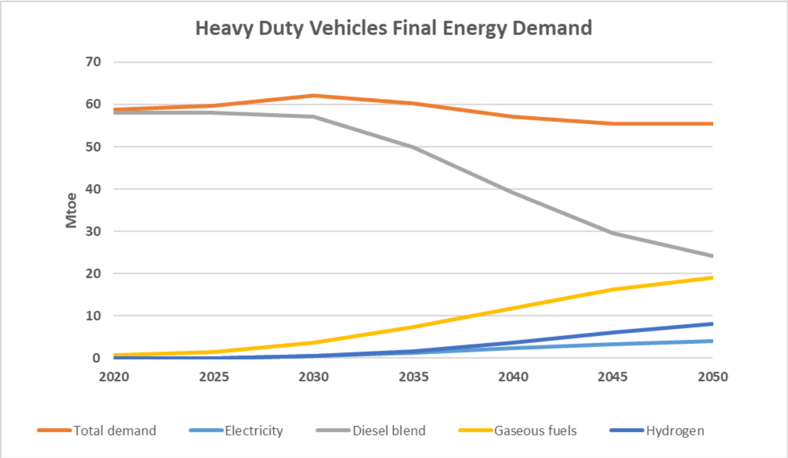


Table 1 shows the evolution of the fleet of new HDV in the baseline scenario. In line with the analysis presented above, it shows that only a limited share of the new fleet would be made of ZEV, with the current CO_2 standards. The analysis also shows that the current HDV standards would take time to show impacts in terms of changes to the overall fleet structure due to the turnover of the vehicle stock.

Table 1: Evolution of the fleet of new vehicles in the baseline

HDVs (as in scope 1[36])	Diesel (including hybrid)	Gas-powered vehicles	PHEV	BEV	Hydrogen-powered vehicles[6]
2030	70%	16%	3%	8%	4%
2035	57%	21%	3%	11%	8%
2040	42%	25%	2%	16%	15%

[36] Scope 1 would extend CO_2 emissions standards to all vehicle groups falling under the HDV CO_2 Emissions Determination Regulation, including certain lorries with TPMLM above 5t and buses and coaches over 7.5t.

1.15. 5.2 Description of the policy options

5.2.1 Extension of the scope

5.2.1.1 Including vehicles with certified CO_2 emissions into the scope

The current HDV Regulation covers the CO_2 emissions of new heavy lorries above 16t with certain axle configurations. The rest of groups are not regulated yet, namely: heavy lorries up to 16t, medium lorries, lorries up to 5t, all buses and coaches and vocational and special purpose vehicles. In addition, there is large room to improve the energy efficiency of trailers.

Significant CO_2 emissions reduction and fuel saving potentials lie in these unregulated vehicle groups as they still represent around 27% of total CO_2 emissions of the HDV sector for new vehicles (see section 2.1.1 and further information on the Scope of HDV groups in Annex 8).

An essential prerequisite for including a certain vehicle category in the HDV Standards is that the CO_2 emissions of the vehicles are certified under type-approval legislation (so-called CO_2 Determination Regulation). Without such certification of their emissions, vehicles cannot fall under the scope of the CO_2 Standards. Therefore, the following three options are considered with respect to the scope extension of the CO_2 emission targets, as from 2030 (for more specific information, see Annex 8):

- Option SCOPE 0: Change nothing. No extension of the current scope;
- Option SCOPE 1: Extend CO_2 emissions standards to all vehicle groups falling under the HDV CO_2 Emissions Determination Regulation, while exempting manufacturers registering fewer than 100 new vehicles in a given year;
- Option SCOPE 2: On top of SCOPE 1, set energy efficiency standards for the trailers falling under the HDV CO_2 Emissions Determination Regulation. Manufacturers registering fewer than 100 new trailers in a given year would be exempted.

Option SCOPE 1 would ensure the widest possible regulatory coverage of motor vehicles by applying CO_2 emissions standards to as many HDV groups as possible, only limited by existing technical constraints (see Annex 8). Such vehicles are not regulated by the current standards as, at the time of their adoption, it was not technically possible to determine their CO_2 emissions according to a type-approval regulatory procedure. The additional vehicles covered under SCOPE 1 are medium lorries above 5t and buses and coaches above 7.5t. As a result, the very large majority of the HDV CO_2 emissions from new vehicles (nearly 98% of total sectoral emissions) would be covered.

The vehicles categories that are not currently included within the scope of the HDV determination procedures include heavy lorries with particular axle configurations, small lorries (up to 5t), small buses (up to 7.5t) and special purpose vehicles. The question of regulating the CO_2 emissions from these vehicles can only be addressed after the related CO_2 determination and monitoring procedures will be in place. For these vehicles, options to stimulate their zero-emission uptake are described under section 5.2.4.

Option SCOPE 1 would also imply regulating a larger number of manufacturers as there are manufacturers that are only present in the currently unregulated vehicle groups. However, smaller lorries, buses and coaches Small Volume Manufacturers (SVM) registering in the EU fewer than 100 new vehicles in a given year would be exempted from the Regulation given their more limited possibilities to reduce average CO_2 emissions of their vehicle fleet and to avoid them a disproportionate burden.

All stakeholders' groups supported setting new targets for lorries above 7.5t, urban buses and coaches. Concerning lorries between 5t and 7.5t or vocational vehicles, some manufacturers and the European Association of Manufacturers did not support their inclusion in the scope of the standards. Environmental NGOs proposed extending the scope to all possible groups. Small manufacturers and NGOs are in favor of a possible exemption to SVM whereas the rest of stakeholders remained rather neutral about.

Option SCOPE 2 would extend SCOPE 1 to those heavy trailers whose energy efficiency is determined under type-approval legislation[37]. A trailer is a non-motor vehicle towed by a motor vehicle. Although a trailer does not consume energy by itself, it demands energy from the towing motor vehicle to be moved. The optimization of the energy efficiency of trailers could offer the opportunity to reduce the CO_2 emissions of conventional lorries in a cost-efficient way while helping ZEV lorries increasing their range. Therefore, it may play an important role in the decarbonisation of the HDV sector. As for the motor vehicles that would be included under SCOPE 1, trailers are not regulated by the current standards as, at the time of their adoption, it was not technically possible to determine their CO_2 emissions according to a regulatory procedure determined under type approval.

Setting energy efficiency standards in trailers and semi-trailers, together with extending the scope to heavy trailers, is considered significant among almost all stakeholders. However, around half of transport operators fear a risk of over-regulation. Vehicle manufacturers and environmental NGOs stressed that operators should receive transparent VECTO-based information about the energy performance of trailers.

As for motor vehicles, SVM putting on the market fewer than 100 trailers would be exempted from the Regulation.

5.2.2 CO_2 emission targets and their timing

1.1.1.1 Target levels (ambition level) for new motor vehicles

Table 1Table 2 describes the proposed range of options considered along the trajectory over the period 2025-2040 in five-year steps. These target levels are consistent with the levels in the core policy scenarios underpinning all Impact Assessments accompanying the proposals of the Fit for 55 package[38]. The baseline represents the current policies situation.

The overall targets TL_Low TL_Med and TL_High would apply to the average CO_2 emissions of new heavy-duty motor vehicles (excluding the effect of energy efficiency standards on trailers) in all the vehicle groups under the SCOPE 1. When specifying the actual legal requirements that are applicable to manufacturers, these overall targets have to be translated into specific targets for the different vehicle groups. This distribution will be performed according to the principle of cost-efficiency to meet a given overall target.

Table 2: Target levels under the options considered (% reduction compared to 2019-2020 baseline reference)

Reduction normalised to	2025	2030	2035	2040

[37] These are category O4 and O3 trailers with a box-type bodywork, TPMLM ≥ 8t and certain technical characteristics.

[38] Notably, TL_Low assumes the same targets as assumed in the MIX scenario and TL_Med the same targets as in the REG scenario of the IA supporting the Fit for 55 package. With the REPowerEU Plan the Commission proposed, in May 2022, to increase the renewables and energy efficiency targets as compared to the Fit for 55. Therefore, this Impact Assessment explores an option of higher ambition than in the Fit for 55.

the reference emissions				
Baseline	15%	30%	30%	30%
TL_Low	15%	35%	50%	70%
TL_Med	15%	40%	60%	80%
TL_High	15%	50%	70%	100%

None of the options include a change to the current 2025 emission targets as there would be too little lead time left after the adoption of such new targets for manufacturers and automotive suppliers to prepare their implementation, thus creating too much investment uncertainty.

Respondents to the public consultation provided overall support to strengthening the targets both in the long and in the short term. Environmental NGOs and ZEV manufacturers called for the greatest ambition supporting a 100% reduction by 2035 and the adoption of interim objectives between 2025 and 2030 combined with a strengthening of the 2030 target. Large vehicle manufacturers, transport operators, component suppliers and suppliers of fuels and gases supported less ambitious targets providing mixed views ranging generally from TL_Low to TL_Med. Large manufacturers and fuel suppliers in particular did not favour setting a 100% reduction target by a certain date.

1.1.1.2 Target levels for the energy efficiency of trailers

The improvement of the energy efficiency of trailers (notably their aerodynamic and rolling resistance) provides some further opportunity to reduce the CO_2 emissions of the towing vehicles (tractors) and to realise a reduction of TCO for operators. This would be associated with an increase of purchase costs as well as reduced fuel consumption and, potentially, lower road charges. The following options will be considered:

- TRAILER 0: no requirements for the improvement of the energy efficiency of trailers;
- TRAILER 1: set a minimum performance requirement for the energy efficiency of each individual trailer (e.g. 'eco-design' requirement);
- TRAILER 2: set a target for the average energy efficiency of the new trailers on the basis of cost-efficient reduction of CO_2 emissions.

For each of the options the specific rules for CO_2 classes of the Eurovignette Directive determining the road charges of tractor-trailer combinations would be amended such that the effects of the energy efficiency of trailers can be considered.

Vehicle manufacturers and environmental NGOs agreed on the need for trailers and semi-trailers to increase energy efficiency as part of the HDV Regulation whereas transport operators provided mixed opinions. No stakeholders mentioned the possibility of setting eco-design as a possible option.

1.1.1.3 Target timing

The current HDV Regulation sets out annual CO_2 targets. The stringency of these targets increases in five-year steps up to 2030.

The following options will be considered for defining the year(s) for which new targets could be set up for vehicles covered by the scope:

- Option TT 0: Target decreasing in five-year steps. New CO_2 targets start applying every 5 years.

- Option TT 1: Targets decreasing in shorter-than-five-year steps. New CO_2 targets start to apply annually or in some of the intermediate years. This may be combined with some degree of flexibility as regards compliance by manufacturers, such as through a credit and debt mechanism (see section 5.2.6.3).

Keeping targets decreasing every five years received support by large vehicle manufacturers, component suppliers and transport operators, underpinned by the need to provide certainty and the necessary lead time to plan and implement investments. Environmental NGOs and ZEV manufacturers called for targets decreasing in shorter-than-five-year steps in order to achieve more rapid reduction in emissions to contribute to the climate targets.

5.2.3 Use of the revenues from excess emissions premiums (fines)

The HDV Regulation review clause calls on the Commission to assess the possibility to assign potential revenues from excess emission premiums to a specific fund or relevant program to support the transition towards a climate-neutral economy.

The following options will therefore be considered, based on a similar approach:

- Option REV 0: Change nothing. Revenue from the excess emission premiums continues to be considered as revenue for the general budget of the Union;
- Option REV 1: Assign revenues to a specific fund or programme.

During the public consultation, all stakeholders were generally supporting assigning revenues to support 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. Vehicle manufacturers suggested the possible fines to be allocated to ZEV infrastructure and to provide market incentives, while transport operators called for channelling them into innovation in the industry and the purchase of ZLEV.

5.2.4 Incentive scheme for zero- and low-emission vehicles

The current HDV Regulation includes a bonus-only incentive scheme, in addition to the CO_2 targets, to foster the uptake of HDVs with zero or low emissions (ZLEV). Each ZEV, including those from unregulated groups, counts twice when the average CO_2 emissions of a manufacturer is calculated but only beyond the share of new ZLEV exceeding a certain benchmark as from 2025.

The options considered focus on ZEVs as these vehicles have the greatest potential contribution to reducing the CO_2 emissions in alignment with EU overall decarbonisation objectives. In addition, manufacturers are currently carrying out or planning investments mostly in zero-emission technologies and scarcely in low-emission vehicles.

The following options will therefore be considered as from 2030. These options can be combined with each other.

- Option ZEV 0: No ZEV incentive after 2030.
- Option ZEV BONUS: ‘Bonus only’ incentive scheme with increased benchmark levels according to the target levels ambition. This option would mean extending the current scheme, only for ZEV, with adjusted ZEV benchmarks, and further criteria for the zero-emissions range.

Vehicle manufacturers and transport operators expressed their support for maintaining the design of the current bonus-only incentive after 2030. Suppliers of electricity and hydrogen support a scheme benefiting only ZEV (with the latter suggesting some stronger incentives for long-haul fuel-cell electric vehicles). Environmental NGOs consider that the current scheme will be no longer needed beyond 2030 based on manufacturer's commitments and propose to limit the incentive before 2030 to only specific vehicles for which ZEVs are not yet available and based on higher benchmark levels.

Urban buses are especially suitable for earlier shifting to zero-emission due to their optimal usage pattern, e.g., they can recharge overnight after performing well-defined and predictable short routes. Because they are driven mostly in densely populated urban environments, their benefits to local air quality are increased. Furthermore, their market share is rapidly increasing as explained in section 1.2. The following options will therefore be investigated as regards the supply of urban buses:

- Option ZEV BUS: Setting a ZEV mandate for newly registered urban buses in a certain year, instead of a CO_2 emissions reduction target. The following two sub-options will be considered:
    - Sub-option ZEV BUS 1: ZEV mandate 80% in 2030 and 100% in 2035;
    - Sub-option ZEV BUS 2: ZEV mandate 100% in 2030.

Setting a ZEV mandate for urban buses received mixed views during the public consultation. Environmental NGOs and two large manufacturers expressed support for proposing such a mandate by 2030 (and even before 2030 in the case of some NGOs). Other two large manufacturers and suppliers of fuels were against. During the public consultation all stakeholders' groups, except environmental NGOs, were in general against setting a ZEV mandate for coaches.

As explained in section 5.2.1.1, some 'other vehicles' groups (heavy lorries with particular axle configurations, small lorries and buses and special purpose vehicles) fall outside the possible extension of the scope of the HDV Standards in absence of a robust method to determine their emissions for regulatory purposes. During the OPC, environmental NGOs called for a mechanism to incentivise the transition of these vehicles to zero emission. Such a mechanism could take the form either of a voluntary mechanism or of a mandate, as described below.

- Option ZEV OV (Other Vehicles): Introduce a mechanism to promote ZEV in the "other vehicles" category. Depending on the kind of instrument, two sub-options are considered:
    - Sub-option ZEV OV 1: Set a voluntary incentive mechanism. Under this option, ZEV produced by the manufacturers of "other vehicles" could be accounted by a manufacturer falling under the scope of the HDV CO_2 standards for compliance with its standards requirements.
    - Sub-option ZEV OV 2: Set a binding ZEV mandate for the manufacturers of 'other vehicles'. As a result, these manufacturers would be required to put on the market a minimum share of ZEV.

Environmental NGOs proposed during the public consultation to regulate vocational vehicles, special purpose vehicles and small lorries through dedicated ZEV mandates. This option was not supported by manufacturers.

5.2.5 Mechanism to account for renewable and low-carbon fuels when assessing vehicles manufacturers compliance with the CO_2 standards

Under the current HDV Regulation, the compliance of a manufacturer with its specific emission target is assessed against the tailpipe CO_2 emissions of its new fleet, determined as laid down in type approval legislation based on the VECTO tool through the CO_2 Determination Regulation. The review clause of the HDV Regulation calls for assessing the possibility of developing a specific methodology to include the potential contribution of renewable and low-carbon fuels to CO_2 emissions reductions of the HDV sector. The following three options will be considered:

- Option FUEL 0: change nothing
- Option FUEL 1: application of 'GHG correction factors' to the tailpipe emissions of the vehicles for compliance assessment, to reflect the carbon intensity and share of the eligible fuels (advanced biofuels and Renewable Fuels of Non-Biological Origin - RFNBO),
- Option FUEL 2: the introduction of a renewable and low-carbon fuels (LCF) crediting system. Fuel suppliers have an obligation to market certain amounts of renewable and low-carbon fuels to comply with the transport fuel targets set in the Renewable Energy Directive. Additional volumes of such fuels put on the market would generate credits, reflecting their life-cycle GHG emissions savings. Vehicle manufacturers may, on a voluntary basis, purchase these LCF credits and use them to meet their specific emission targets. To avoid that the LCF credits create a disincentive for manufacturers to invest in zero-emission technologies, the maximum LCF credits contribution should be capped.

Environmental NGOs and small ZEV-only manufacturers opposed any mechanism to account for renewable and low-carbon fuels due to the risk of creating loopholes, legal over-complication, shifting such fuels from other sectors and delaying the uptake of ZEVs. On the other hand, suppliers of fuels and gases supported the introduction of a mechanism to account in the CO_2 standards for renewable and low-carbon fuels. The European association of large manufacturers considered that fuels will play an important role in cutting CO_2 emissions of the fleet and remained neutral on the option of introducing a fuels accounting mechanism in the CO_2 standards. Individual large manufacturers expressed mixed views on this option. Responses from citizens and transport operators were mixed or rather neutral.

5.2.6 Governance provisions

1.1.1.4 Compliance assessment

The current legislation imposes a single compliance condition so that each manufacturer has one single emission reduction target across all vehicle's groups falling under the scope of the standards. This is justified by the fact that all the vehicles covered have similar features.

However, if the scope is extended to include different types of vehicles, the question arises whether to maintain a single compliance condition for each manufacturer or to set different conditions according to the groups of vehicles. In the current market structure, all lorries manufacturers produce vehicles in the different lorries' groups and some of them also manufacture buses and coaches. There are also manufacturers of buses and coaches only. Trailers are normally produced by different companies. The following options are therefore considered:

- Option COMP 1: A single combined compliance condition for all vehicles including trailers. The possible over and underperformances with regard to the targets requirements for the different vehicle groups could compensate each other;
- Option COMP 2: Two independent compliance conditions: one for all freight HDVs (lorries and trailers) and another condition for passenger transport vehicles (buses & coaches); the compensation for possible over- and underperformances could only be possible within vehicles falling under the same compliance conditions.
- Option COMP 3: Three independent compliance conditions: one for lorries, a second independent condition for buses & coaches and a third one for trailers.

Under all of the options, the specific CO_2 emissions of the different vehicle groups would be weighted according to their impact on the lifetime CO_2 emissions of the vehicles. This is the continuation of the current regulatory approach which is widely supported by stakeholders.

Large manufacturers producing both lorries and buses favoured a single combined compliance condition. Buses manufacturers had mixed opinions on this issue.

1.1.1.5 Flexibilities between manufacturers for compliance assessment

The current legislation does not allow combining the vehicle fleets of different manufacturers, or parts thereof, for the purposes of compliance assessment (pooling). It applies a specific target to each legally independent manufacturer, regardless of whether it is economically connected to another manufacturer. For example, also two legally independent brands belonging to the same group ("connected undertaking") are assessed separately for compliance.

The review clause of the HDV CO_2 Regulation calls on the Commission to assess the possibility to allow for an open, transparent and non-discriminatory pooling mechanism between manufacturers (see option FLEX 1 below).

In addition to pooling, a mechanism for the transfer of vehicles for accounting purposes between manufacturers is examined (FLEX 2). Such a transfer would be allowed between connected undertakings without limitations for reasons of competition law. For the transfer between non-connected undertakings, stakeholders have generally called for a mechanism that would focus on the promotion of the development and deployment of ZEV by smaller or start-up companies operating outside the business groups of large manufacturers. This would put these SMEs on the same competitive footing with entities producing ZEVs within such large groups. Such transfer between non-connected entities would be quantitatively limited to ensure that regulated manufacturers still invest on zero-emission technologies.

In summary, the following options are envisaged:

- Option FLEX 0: Change nothing, no flexibilities
- Option FLEX 1: Open pooling between all manufacturers. Manufacturers could agree for a certain period to combine their new HDV fleets for compliance assessment.
- Option FLEX 2: Allow for transferring individual HDVs between connected undertakings for compliance assessment in each reporting period without limits. Between non-connected undertakings, only ZEV could be transferred to an extent that in any reporting period the number of vehicles received by a manufacturer does not exceed 5% of the newly registered vehicles produced by the manufacturer itself.

Large manufacturers were rather neutral but favoured the introduction of flexibility. ZEV manufacturers are in favour of unlimited credits exchange and NGOs generally expressed support for option FLEX 2.

1.1.1.6 Flexibilities across different target years (credits and debts mechanism)

The current HDV Regulation includes a mechanism of credits and debts (C/D) until 2029 to provide more flexibility for manufacturers to comply with their annual targets over a 5-year period. The C/D mechanism is designed to work within a period between two increasingly ambitious CO_2 emissions targets. As the current HDV Regulation does not foresee any higher ambition level coming in after 2030, the C/D mechanism ceases beyond this date.

The review clause of the current Regulation also states that the Commission shall assess the current incentive mechanism and the appropriateness of extending its application to 2030 and beyond. The following options are therefore examined:

- Option C/D 0: No credit/debt mechanism as from 2030.
- Option C/D 1: Continue the current credit/debt mechanism beyond 2030 (adjusted to the new emissions targets applicable in 2030 and beyond).

Environmental NGOs and manufacturers supported extending the current mechanism beyond 2030.

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

6.1 Introduction

The quantification of the impacts of the options defined in Section 5 relies on a number of models using as an input i.a. information on the costs and the CO_2 and energy reduction performance of technologies to be fitted in new vehicles. The same methodological approach has been used also in the Impact Assessment underpinning the proposal to revise the CO_2 standards for cars and vans in the Fit for 55 package, and it is also complemented by the estimation of aggregate costs and savings of combination of options.

The PRIMES-TREMOVE model is used, together with PRIMES, to quantitatively describe the baseline (see Section 5.1) and the other scenarios (in Section 6). The JRC DIONE model suite has been used for the assessment of net economic savings from different perspectives and of costs for automotive manufacturers. The Macroeconomic model E3ME has been used for the assessment of the macroeconomic impacts, while the other indicators come from PRIMES-TREMOVE. These models are described in Annex 4.

The assessment of the the impacts of the CO_2 standards for HDV is performed within the context of a policy environment, so called REPowerEU scenario, which underpins the **REPowerEU Plan Communication** and its analytical SWD, described in Annex 4. Compared to the Reference Scenario and to the core policy scenarios underpinning the Fit for 55 package, current and projected fuel prices are higher. In order to ensure full consistency also with other upcoming policy proposals acting on modal shift, namely the Combined Transport Directive and the Multimodal digital mobility services Regulation, the REPowerEU scenario also includes the effects of such policies. In line with the scenarios underpinning the Impact Assessments of the Fit for 55 proposal, such scenario includes stranghtened HDV standards as compared to current legislation.

As described in more details in Section 5.1, the baseline for the present Impact Assessment builds on the REPowerEU Scenario, but it assumes for HDV standards the targets set in the current legislation. It also assumes that the upcoming policy proposals acting on modal shift are not implemented. This approach allows to assess the impacts of different levels of HDV targets against a baseline where all other European Green Deal policies are considered, so to ensure policy consistency both with previously proposed policies under the European Green Deal. Detailed information on the methodological approach, on the key assumptions and on the baseline and the RepowerEU scenario can be found in Annex 4, and some additional results of the analysis in Annex 9.

The relevant contributions to the Sustainable Development Goals of the UN 2030 Agenda have been addressed in Annex 3.

6.1.1 Stakeholders' views on impacts

During the public consultation the stakeholders were invited to express their level of agreement on the likely impacts of strengthened CO_2 standards for HDVs. The majority of respondents agreed that *a growing supply of zero-emission HDV will bring down their costs over time* and that *a growing offer of ZEVs, combined with other measures strengthening sustainable corporate governance, will influence transport operators to purchase more of these vehicles*. However, vehicles manufacturers did not agree that *a growing supply of zero-emission HDV will bring down their costs over time.*

90% of respondent considered that the automotive industry will need to adapt, i.e. that *new skills and qualifications for workers will be needed*. 57% of respondents think that *new jobs would be created to produce different power trains and batteries*. 65% of stakeholders stressed that *the strengthened standards would lead the automotive industry to increase investments in zero-emission technologies*, recognized an opportunity for *innovative SMEs that will benefit from new business opportunities* and expected co-benefits as a *reduction of EU import dependence on fossil fuels and better air quality*.

On the other hand, the majority of stakeholders did not show major agreement on the probability of materialization of other impacts, as *macro-economic co-benefits* and *co-benefits in terms of energy dependency* and an *increase of the EU industry competitiveness on the global market*. Transport operators showed concern regarding the potential negative impacts on *costs, government revenues and EU competitiveness*.

6.1.2 Main assumptions

The most important assumptions for the analysis concerns the costs and energy/CO_2 reduction potential of different technologies applicable to the HDVs. For the purpose of this impact assessments, these assumptions have been updated based on a rigorous literature review and stakeholder consultation[39]. See Annex 4 for additional details.

The methodology for the derivation of battery cost projections relies on a public domain literature review, estimates derived through bottom-up costs analyses and expert consultations. The cost projections indicate that currently HDV battery costs on a per kWh basis are higher than for LDVs due to several reasons, including limited use in commercial vehicle applications. The costs are expected to reduce significantly in the next 10 years due to economies of scale resulting from increased demand for batteries from cars and vans. The analysis further confirms the costs assumed in the context of the Reference Scenario 2020, which were also used for the Impact Assessments supporting the CTP, all Fit for 55 proposals, including for the revision of the CO_2 standards for cars and vans.

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

Similarly, the methodology for the derivation of fuel cell cost projections relies on a public domain literature review, and expert consultation. The cost is expected to reduce significantly in the next 10-20 years as a result of increased technology development, also due to developments in the cars and vans sectors. See Annex 4 for additional details.

For the purpose of the analysis, one replacement of the battery and of the fuel cell stack over the lifetime of the relevant vehicles is also conservatively assumed, despite a number of HDV manufacturers consulted consider this as not necessary[40].

The analytical work also requires projections of international fuel prices. The projections used for this impact assessment are fully consistent with the assumptions in the REPowerEU analysis[41]. The prices are presented in Annex 4.

6.1.3 SME tests and impacts on fundamental rights

This initiative is considered to have a relevant impact on SMEs. Stakeholders have been consulted (see Chapter 5, 6 and Annex 2 for additional details). The impacts on SMEs transport operators have been assessed and the assessment shows that in general the affordability of vehicles is not a critical issue for HDV users (see Section 6.3.1.2 and Annex 9). The impact on smaller manufacturers can be minimised by exempting the Small Volume Manufacturers: this exemption would concern, for lorries and trailers respectively, up to 80% and 92% of manufacturers. On the other hand, also with this exemption 99.95% and 95% of the vehicles under scope would still be regulated. This exemption for lorries would therefore concern only about 0.05% of total HDV CO_2 emissions (see Sections 5.2.1 and 6.2.2) and have a very limited environmental impact. This initiative does not have any impact on fundamental rights.

6.2 Extension of the scope

6.2.1 Including vehicles with certified CO_2 emissions into the scope

6.2.1.1 Economic Impacts

In a Medium Ambition Scenario context (TL_Med, see section 6.3), option SCOPE 0 (i.e. not extending the scope of the regulation) would bring less economic benefits than SCOPE 1. The Total Costs of Ownership in 2030 both from a first user and societal perspective would increase by around EUR 10 000 and 11 000, respectively, per average vehicle as compared to TL_Med. This is due to the missed fuel savings and, to a more limited extent, to the increase in the capital costs determined by the need to comply with the targets with fewer options and less possibility to compensate costs across vehicle groups. By also regulating the energy efficiency of trailers, option SCOPE 2 extends the range of vehicles contributing to CO_2 emissions reduction compared to option SCOPE 1.

Under option SCOPE 2 the target levels for the energy efficiency of trailers are determined in a cost-optimised manner (see discussion under section 6.4). This option offers economic benefits to operators compared to option SCOPE 1, thanks to increased energy efficiency improvements.

Possible negative economic impacts on manufacturing SMEs are addressed by the exemptions for Small Volume Manufacturers (see further section 6.2.2).

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

[41] See SWD(2022) 230 (Section 7 – Annex), accompanying COM/2022/230 final

6.2.1.2 Social Impacts

SCOPE 0 drives equivalent impacts as setting a less stringent target to a broader scope of vehicles, SCOPE 1 and SCOPE 2. The impacts of SCOPE 1 and SCOPE 2 are described in chapter 6.4.3respectively.

6.2.1.3 Environmental Impacts

Between 2031 and 2050, in a Medium Ambition Scenario context (TL_Med, see chapter 6.3), SCOPE 0 option would lead to almost 180 Mtons additional CO_2 emissions as compared to SCOPE 1, equivalent to approximatively 14% of the emissions of the HDV sector in the same period. The impact of SCOPE 2 is described in chapter 6.4.2, which assess the environmental impacts of setting energy efficiency standards in trailers.

6.2.1.4 Administrative burden

None of the options SCOPE 1 and SCOPE 2 would create relevant additional administrative burden as the monitoring and reporting obligations are already in place for the vehicle groups brought into scope.

6.2.2 Exemption for small volume manufacturers (SVM)

Both options exempt SVM, defined as manufacturers of 100 vehicles or less along a given registration year, from meeting the standards targets. This threshold has been determined after analysing the available reporting data from registered vehicles. The exemption of SVM would cover, for lorries and trailers respectively, up to 80% and 92% of manufacturers, while keeping still regulated 99.95% and 95% of the vehicles under scope. See Annex 8 for details.

6.2.1.5 Economic Impacts

The introduction of new technologies is more expensive for SVM than for larger manufacturers, due to the small number of vehicles produced. The SVM exemption relieves small manufacturers from the high compliance costs that they would otherwise face if falling within the scope of the Regulation.

6.2.1.6 Social Impacts

SVM may face special challenges to meet new regulatory requirements, since they cannot take advantage of economies of scale and therefore may face higher costs to deploy efficient and zero-emission technologies. Consequently, SVM face higher risks also concerning the impacts on the employed workforce. Exempting SVM from meeting regulatory requirements will help such small companies to avoid negative employment impacts, and therefore avoid negative social impacts.

6.2.1.7 Environmental Impacts

As explained in Annex 8, SVM are responsible for only 0.17% of total HDV CO_2 emissions from new vehicles (0.12% from exempted buses and coaches and 0.05% from exempted lorries). Therefore, still 99.83% of the whole CO_2 emissions from heavy-duty motor vehicles would fall under regulatory scope. CO_2 emissions and related environmental impacts of the exempted vehicles are thus negligible.

6.2.1.8 Administrative burden

Exempting SVM from meeting the CO_2 targets would not change the administrative burden for such companies, since they already must comply with the monitoring and reporting obligations in the current legislative framework.

6.3 CO_2 emission targets and their timing

The target levels are presented in Table 2 and apply to the vehicles described under SCOPE1.

6.3.1 Target level (ambition levels) for new motor vehicles

One of the main impacts of the CO_2 emission standards for vehicles is the change in the composition of the EU-wide fleet of new HDV, which is one of the main drivers for the other impacts described in this chapter.

The results of the public consultation (see Annex 2) strongly highlight the support for further action to meet EU climate ambition. Nearly 90% of all stakeholders consider important or very important the objectives of reducing CO_2 emissions from new HDVs in a cost-effective way in line with the 2030 and 2050 EU climate targets while only 3% considered it not important. While not all transport operators and vehicles manufacturers agree, more than three fourths of them support reducing emissions for both 2030 and 2050.

Overall, there was more support for increasing the stringency of targets from 2040 than for strengthening the ambition of the 2030 targets.

The impacts of the different target levels on the fleet composition are shown in **Table 3**. It shows that the implementation of more ambitious targets levels leads to higher penetration of zero emission vehicles, namely battery electric vehicles (BEV) and hydrogen-powered vehicles[6] in the fleet of new vehicles in a specific year. A more disaggregated dataset can be found in Annex 9.

The results in table 3 show that in order to reach the target levels in all the options analysed, zero-emission technologies, including battery electric, fuel cells and hydrogen combustion engines vehicles are deployed by the manufacturers. These technologies are available and their increased needed market uptake is consistent with the vehicle manufacturer's announcemenents and investments. Small range battery electric trucks are already circulating while vehicles with longer range (battery and fuel cell) vehicles are expected to be commercialised in Europe in the coming years. The results also show that without such zero-emission technologies being deployed in the market, the targets cannot be reached, due to the limitation of improvements of conventional technologies on the CO_2 emission reduction from heavy duty vehicles. However, it has to be reminded that one of the objective of the increased target is to ensure that investments in zero-emission technologies materialise, thanks to the long-term signal that the targets provide to the market. In addition, reaching the target levels in each of the option requires investments for the eployment of refuelling and recharging infrastructure. Such investments are quantitieed in Section 6.3.1.1.4. If these investments do not materialise, the demand for zero-emission technologies may be negatively impacted with consequences for the complaince of the vehicle manufacturers. However, also with this respect, the CO_2 stanadrds aims at providing the right regulatory signals and the long term certainty for investments also in the infarstructure needed to support the deployment of zero-emission vehicles.

Table 3: Share of powertrain in the new stock, in specific years (rounding may apply)

All regulated HDVs		Diesel (including hybrid)	Gas-powered vehicles	PHEV	BEV	Hydrogen-powered vehicles[6]
2030	Baseline	70%	16%	3%	8%	4%
	TL_Low	62%	13%	5%	13%	8%
	TL_Med	58%	11%	6%	16%	9%
	TL_High	49%	8%	8%	22%	13%
2035	Baseline	57%	21%	3%	11%	8%
	TL_Low	44%	15%	6%	20%	14%
	TL_Med	36%	11%	8%	26%	19%
	TL_High	27%	8%	8%	33%	24%
2040	Baseline	42%	25%	2%	16%	15%
	TL_Low	26%	10%	7%	30%	27%
	TL_Med	18%	6%	6%	37%	33%
	TL_High	0%	0%	0%	52%	48%

6.3.1.1 Economic impacts

Different types of economic impacts across the three considered TL options are assessed.

(i) Net economic savings from different perspectives (societal, first use, second use) *(Section 6.3.1.1.1).*

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 buses, coaches and lorries. The total costs include the capital costs, the fuel or energy carrier costs, and the operation and maintenance (O&M) costs of the vehicles.

The savings from a societal perspective is the change in the average costs over the lifetime (15 years) of a new vehicle without considering taxes. In this case, the costs considered also include the external cost of CO_2 and air pollutants emissions. The additional investment costs of the vehicle manufacturers are included in the analysis. The end-user perspective is presented for various owners: the first (first 5 years after first registration), the second (years 6-10) and the third (years 11 to 15) users.

All such costs and savings are discounted.

(ii) Costs for automotive manufacturers (Section 6.3.1.1.2).

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 HDVs[42].

[42] The methodology used is the same as the one used in the Impact Assessments underpinning the 2018 proposal on HDV CO_2 standards, as well as the ones underpinning the 2017 and 2021 proposals on LDV CO_2 standards. The detailed description of the methodology, specialised for the HDV, is published in the JRC study "Heavy duty vehicle CO_2 emission reduction cost curves and cost assessment - Publications Office of the EU (europa.eu)"

(iii) Energy system impacts *(Section 6.3.1.1.3).*

EU energy system will be impacted by the revised CO_2 standards due to reduced fossil fuel consumption and higher electricity and hydrogen use. Benefits of reducing EU energy dependance are highlighted.

(iv) Investment in alternative fuels infrastructure (Section 6.3.1.1.4).

The investments needed for recharging and refuelling infrastructure have been estimated in line with the methodology set out in the revision of the Alternative Fuels Infrastructure Regulation. All costs have been factored in.

(v) Macro-economic impacts (Section 6.3.1.1.5) and Innovation and competitiveness (Section 6.3.1.1.6)

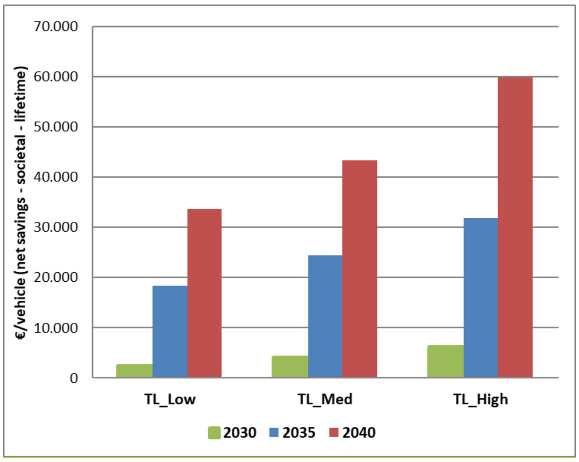
The below sections provide a summary of the main findings of the analysis.

6.3.1.1.1 Net economic savings from different perspectives (societal, first use, second use)

❖ **Net economic benefits over the vehicle lifetime from a societal perspective**.

Figure 5 displays the effect of the three target level (TL) options for the CO_2 emission standards from a societal perspective for a new vehicle registered in 2030, 2035 or 2040.

Figure 5. Average net savings over the vehicle lifetime from a societal perspective for a new average heavy-duty vehicle registered in 2030, 2035 or 2040.



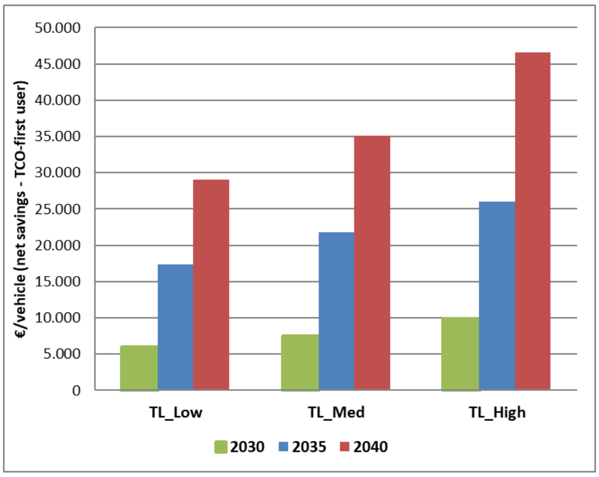
All three TL options lead to net savings, which increase with increasing target stringency.

❖ **Total cost of ownership (TCO) for the first user (TCO-first use).**

Figure 6 shows the average net savings (EUR per vehicle) resulting from the CO_2 emission standards from a first end-user under the three TL options for a new vehicle registered in 2030, 2035 and 2040.

The trends show a positive effect of the CO_2 standards, with stricter targets delivering higher consumer benefits. This is explained mainly by the fact that the savings in the fuel expenditure during the use of the vehicles exceed the higher upfront capital costs of more efficient and zero- and low-emission vehicles.

Figure 6. Average net economic savings from a TCO-first user (first 5 years) perspective



- ❖ **Total cost of ownership (TCO) for the second and third users (TCO-second use).**

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 show a similar trend as for the first-user, with lower benefits (see Annex 9 for detailed analysis).

- ❖ **Road charging**

The Eurovignette Directive provides for infrastructure road charges, which depend on the CO_2 emissions class of the vehicle. Annex 9 shows that 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 amount to up to EUR 1 300, 1 800, 6 300 for the average new regulated vehicle registered in 2030, 2035 and 2040. These savings increase with time and with the stringency of the targets. These savings are additional to the ones shown in the previous sections.

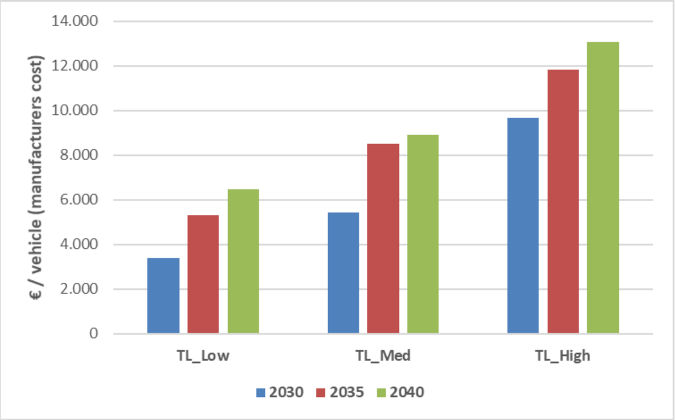
- ❖ **Sensitivity analyses**

The net economic savings from different perspectives have also been subject to two sensitivity analyses. One captures the uncertainty related to the projected evolution of zero-emission (and PHEV) technologies costs, to analyse a scenario where such costs decrease at a lower rate. The second assumes higher electricity and hydrogen prices. Their results confirm the results presented above. In particular, they show a positive effect of the CO_2 standards and that even with higher capital costs or fuel prices, savings in the fuel expenditure during the use of the vehicles exceed the higher upfront capital costs of more efficient and zero- and low-emission vehicles. Annex 9 provides detailed descriptions of the sensitivity analysis.

6.3.1.1.2 Costs for automotive manufacturers

The costs for automotive manufacturers depend on the costs of the technologies that they will deploy in the new vehicles fleet to meet the CO_2 targets and are shown in Figure 7.

Figure 7. Average costs for automotive manufacturers resulting from the CO_2 emission standards.



The HDV sector is also projected to face additional investments[43] as compared to the investments needed to comply with current CO_2 emission standards. These additional investments, which are necessary to meet the market demand of new vehicles and comply with the stricter CO_2 emission targets are shown in **Table 4** for the different target level options. Over the period 2031 to 2050, they are estimated at around EUR 4.9, 6.4 and 8.7 billion annually, for the options TL_Low, TL_Med and TL_High respectively. This represent an increase of around 6%, 8% and 10% compared to the investments needed with the current CO_2 emission standards. To support these additional investment, funding opportunites are available. For example, the Commission has approved on 15 July 2022 the "IPCEI Hy2Tech", the first ever Important Project of Common European Interest in the hydrogen sector, authorising under the State aid rules up to EUR 5.4 billion of aid, with HDV manufacturers being among the beneficiaries.

Table 4: Average annual additional investments between 2031 and 2050 compared to the baseline, for the different target level options.

	Period 2031-2050 [bn EUR]	% increase
TL_Low	4.9	6%
TL_Med	6.4	8%
TL_High	8.7	10%

6.3.1.1.3 Energy system impacts

Final energy demand and fuel mix

Under the baseline, demand was 61.6 Mtoe in 2015. It decreased significantly in 2020 due to the effect of the COVID-19 pandemic but is projected to increase again to above 62 Mtoe in 2030. From then on, it is projected to decrease over time as vehicles meeting the CO_2 targets set in the current Regulation enter the fleet. In 2040 and 2050, demand under the baseline is respectively 8% and 11% lower than in 2030. Under the different TL options, final energy demand decreases further and such trends become more visible from 2035 as a result of the

[43] The estimation considers 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.

fleet renewal.Over the period of 2031 to 2050, final energy consumption from motor HDVs decreases by 11-19% compared to baseline. Annex 3 includes figures showing such trends.

The CO_2 targets also have an impact on the demand per type of energy source for HDVs. While diesel remain the main fuels used until 2035, there is a clear shift away from fossil fuels in the years thereafter. Over the period 2031 to 2050, the target level options TL_Low, TL_Med and TL_High would result in cumulative savings of oil products with respect to the baseline of 215, 241, 281 Mtoe, respectively. This is equivalent to around EUR 149-168-196 billion at an oil price of EUR 95/barrel of oil, respectively.

Electricity and hydrogen consumption

Annex 9 shows the share of the total EU-27 electricity consumption used by HDV for the considered three TL options. The total HDV sector (with the highest contribution coming from long-haul applications) 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. It is important to add that, already in the MIX scenario of the Fit-for-55 package, 82% of the electricity is decarbonised in 2030[44]. The REPowerEU scenario then increases this ambition, as it increases the headline 2030 target for renewables from 40% to 45%. Hydrogen has also an important role to play in reducing emissions in HDV. In fact, expected consumption by lorries, buses and coaches in 2030, 2035, 2040 and 2050 will increase over time for the considered TL options by about 450 to 950 ktoe in 2030, 2 400 to 6 600 ktoe in 2035, 8 300 to 10 100 ktoe in 2040 compared to the baseline.

6.3.1.1.4 Investment in zero-emission alternative fuels infrastructure

In order to support the market uptake of the zero-emission vehicles projected in the scenarios assessed, additional annual investments in publicly accessible recharging and refuelling infrastructure will amount to around EUR 0.58, 0.66 and 0.79 bn per year, between 2031 and 2050, in TL_Low, TL_Med and TL_High, compared to the baseline. The AFIR proposal is the key instrument addressing recharging and refuelling infrastructure. The Connecting Europe Facility, Regional and Structural Funds, the Renovation Wave and InvestEU/ blends with EIB instruments could assist in funding these needs.

6.3.1.1.5 Macro-economic impacts

The three policy scenarios show a positive impact, compared to the baseline, on EU-27 GDP. It is projected that with stricter CO_2 targets for HDVs, increased consumer expenditure (thanks to lower fuel costs) as well as increased infrastructure and vehicle technology investment would be triggered. Annex 9 shows that the GDP would slightly increase, between +0.01 and +0.02% in 2030, between+0.06 and +0.11% in 2040, and between +0.09% and +0.10% in 2050, compared to the baseline. It also provides the sectorial results.

In all scenarios the most negatively impact sector is petroleum refining which loses 0.3, 2.8% and 2.4%of its output in 2030, 2040 and 2050 respectively, in TL_Med. The power and hydrogen supply sectors sector is the one with the highest percentage gain in output (0.1, 0.7% and 1.9% in 2030, 2040 and 2050). Metal and electrical equipment sectors show also gains in output that increase over time, but that are more moderate.

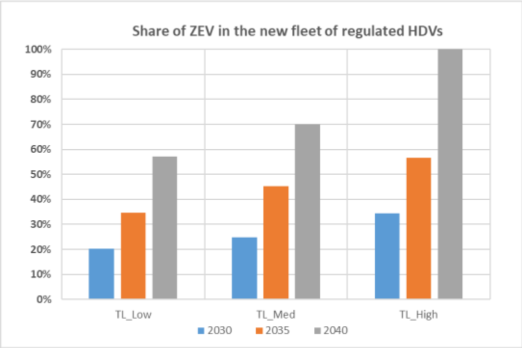
6.3.1.1.6 Innovation and competitiveness

[44] https://energy.ec.europa.eu/excel-files-mix-scenario_en

The different options considered for the target levels will have a positive impact on innovation. They are projected to incentivise the deployment of zero-emission technologies in the new vehicles fleet by stimulating an increased supply of zero-emission vehicles to the market, which will spur innovation in the sector.

The projections on the penetration of zero-emission vehicles therefore serve as a quantitative proxy of the impacts on innovation. **Figure 8** presents the evolution of the projected penetration of zero-emission powertrains for new heavy duty vehicles over time, for the different options considered for the target levels.

Figure 8. Projected shares of zero-emission vehicles in the new heavy-duty vehicles fleet



While all options have a positive impact on the deployment of zero-emission technologies, TL_High leads to a faster deployment of these technologies towards the whole vehicle fleet becoming zero-emission. It therefore has a higher impact on innovation.

If current CO_2 emission standards remained unchanged, the technological leadership of manufacturers in the EU would be at risk. Stimulating innovation in zero-emission technologies in the EU by sending the correct regulatory signals to the manufacturers would strengthen the technological leadership of the sector in the EU, as explained in Section 4. Stricter CO_2 emission standards provide certainty for the market deployment of zero-emission vehicles and a strong, long-term signal to automotive manufacturers to innovate. They can also drive innovation along the value chain, aiming at reducing the costs of production and securing availability of component, as well as deploying the necessary infrastructure.

In light of the above, stricter CO2 target levels driving the development and supply of zero-emission technologies can be expected to have a positive impact on innovation and automotive industry’s technological leadership. Innovation is key to maintain and strengthen the current EU leadership on the global markets, and industrial competitiveness, also considering that many governments are publicly considering or have already announced the intention to adopt measures to reduce tailpipe CO_2 emissions from new heavy-duty vehicles. The demand of zero-emission HDVs is increasing in main international competing markets, as China and USA, and many governments are setting up policies to increase ambition both on CO_2 emissions reductions and ZEV mandates for lorries, including ICE phase-out (see problem driver 3 and additional details in Annex 7).

Under the initiative “Global drive to zero”, which started during COP26 and continued to get support during the recent COP27, almost 30 countries, including EU member States, Canada, UK and USA, signed a Memorandum of Understanding that aims for all new heavy goods vehicles and buses to be zero emission from 2040, with an interim target of at least 30% of zero-emission sales by 203045. The Memorandum of Understanding is also endorsed by several representatives of sub-national governments, businesses, manufacturers and suppliers, fleet owners and operators, investors, financial institutions and development banks[46]. Such initiatives create markets for zero-emission technologies and therefore competitive advantage for those businesses who will produce such technologies.

Automotive manufacturers are announcing commitments to significantly increase investments in zero-emission technologies. This means that manufacturers link their future competitiveness to zero-emission vehicles, so that stricter CO_2 standards levels can be expected to better support their shift towards zero-emission vehicles. Manufacturers are also bringing to Europe the innovation projects that will enable the deployment of zero-emission vehicles in the most competitive way. For example, investments in batteries production in Europe are surging, also thanks to joint efforts under the European Battery Alliance[47], with positive effects on industrial competitiveness even beyond the traditional automotive value chain. Therefore the industrial transformation that CO_2 emission standards can propel also boost new sectors and activities like electronics and software, and battery manufacturing.

6.3.1.2 Social Impacts

As shown in **Annex 9**, with stricter CO_2 target levels resulting in an limited increase in economic output, there is also a limited increase in the number of jobs across the EU-27 compared to the baseline. The number of additional jobs also increases over time for all policy scenarios.

The overall impacts are small, with 9 000 to 13 0000 additional jobs in 2030, 38 000 to 83 000 in 2040 and 81 000 to 121 000 in 2050 (the more ambitious scenarios showing the highest number of jobs created). Positive impacts are mainly seen in electronics sector supplying to the automotive sector zero-emission technologies (linked to batteries, FCEV) as well as in the power and hydrogen sector. Other sectors experience some positive second order effects, e.g. as a result of overall increased consumer expenditure. The petroleum refining sector and, to a much more limited extent, the automotive sector would face some job loss, mainly linked to the negative effect for the suppliers of components for internal combustion engines (a detailed breackdown of the impact by sector is provided in Annex 9).

Impact on SMEs operators

The analysis considered whether and to what extent the CO_2 targets impact enterprises of different size. In particular, the analysis looks at the impacts of the different CO_2 target level options on the affordability of ZEVs for SMEs. The affordability of a vehicle is defined as the financial capacity for an enterprise to buy a vehicle, with or without a loan[48]. The detailed results and methodological description, is provided in Annex 9.

The analysis shows that in general the affordability of vehicles is not a critical issue for HDV users. The analysis shows that medium and small enterprises do not face affordability restrictions across any of the three assessed 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

[45] https://globaldrivetozero.org/MOU/

[46] Global Commercial Drive To Zero Program — Endorsement (globaldrivetozero.org)

[47] European Battery Alliance | Internal Market, Industry, Entrepreneurship and SMEs (europa.eu)

[48] 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 five years, provided that no more than 50% of gross profits can be designated to the loan repayment

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. There are also financing opportunities to assist SMEs in bridging the price gap. For instance, the State Aid guidelines for Climate, Environmental Protection and Energy 2022 and the Guidelines for the Recovery and Resilience Plan both cover the support for the acquisition of ZEV. The EIB will prioritise support for fleets of zero-emission lorries, through its transport lending policy. Furthermore, when looking from a TCO perspective, small and medium company are projected to experience savings, confirming that the results presented in Section 6.3.1.1.1 remain valid for SME. Annex 9 provides further details on the impacts for SMEs.

The conclusions of the analysis are qualitatively valid for each Member State. In each Member State, smaller enterprises are expected to experience relatively higher costs and higher savings than larger enterprises but are also more likely to face affordability issues.

Moreover, considering the distribution of impacts among Member States, firms in Member States with average gross profit lower than the EU average are expected to experience higher TCO savings relative to their earnings than the average EU firm of the same size. Conversely, firms in Member States with average gross profits higher than the EU average are expected to experience lower TCO savings relative to their earnings than the average EU firm of the same size.

6.3.1.3 Environmental Impacts

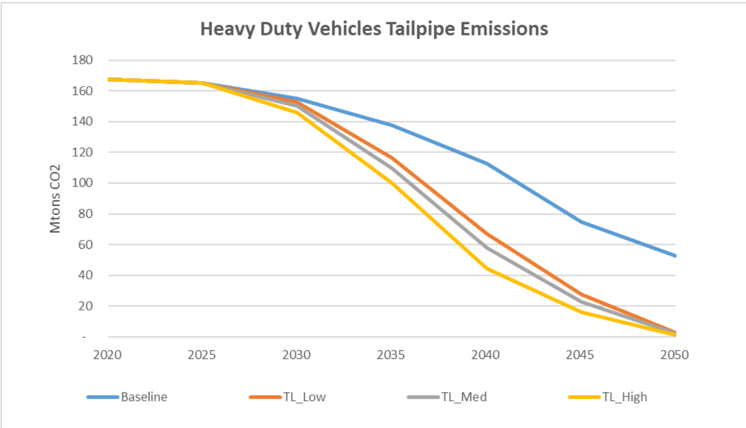
Cumulative discounted health benefits would sum up to EUR 7 to 14 billion between 2031 and 2050. More details are presented in section 6.10. Additional results in terms of the reduction of air pollutants emissions are presented in Annex 9.

6.3.1.3.1 Tailpipe CO_2 emissions

The expected evolution of tailpipe CO_2 emissions of lorries, buses and coaches between 2020 and 2050 in the EU for the baseline and considered TL options is shown in **Figure 9** below.

The cumulative savings of tailpipe CO_2 emissions between 2031 and 2050 amount to 730, 837, 996 Mtons in TL_Low, TL_Medium and TL_High respectively. These represent respectively 35, 40 and 48 % of the projected emissions in the baseline scenario over the same 20 years. This is manily driven by the penetration of the ZEV in the fleet rather than by the improvement of conventional engines.

Figure 9. Tailpipe CO2 emissions under different TL options



Well-To-Wheel CO2 emissions follow a similar trend. Additional details are provided in Annex 9.

6.3.1.3.2 Air Pollution

Many climate change mitigation in the transport sector would have several co-benefits, including air quality improvements and health benefits. 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. The most ambitions targets deliver the better results in terms of higher air quality co-benefits, as shown in Annex 9.

6.3.1.4 Administrative burden

None of the options would create relevant additional administrative burden as the monitoring and reporting obligations are already in place for all the vehicles independently of the target levels.

6.4 Target levels for the energy efficiency of trailers

The analysis for the energy efficiency of trailers is performed assuming the composition of the HDV motor vehicles fleet resulting from the medium ambition scenario TL_Med and the SCOPE 2 option.

6.4.1 Economic impacts

Both TRAILER 1 and TRAILER 2 options set cost-optimised energy efficiency targets of new trailers. Therefore, they both deliver a positive overall economic effect with respect to option TRAILER 0.

Option TRAILER 1 (eco-design requirements) would require all manufacturers to apply the same regulatory target for energy efficiency to each individual new trailer, i.e. essentially this same level of improvements (associated with technology costs) would have to be applied to all trailers. However, the use of individual trailers varies, e.g., according to average distances travelled and payload. From a cost-efficiency perspective it is appropriate that intensively used trailers are equipped with a higher level of efficiency improvement than less used trailers, that would not be possible with option TRAILER 1. In addition, certain technologies (e.g. side skirts) may not be installed on some 'rare trailers' with a very particular use case (e.g. operation in rough terrain), that would require a complex set of exemptive rules.

Option TRAILER 2 would implement energy consumption reduction target as averages for the entire fleet of new trailers. Manufacturers could 'distribute' different energy consumption reductions to different trailers, according to the specific use case and customer demand, and adjust the installed technologies accordingly., such that the average energy efficiency of all new trailers equals the regulatory target. Investment capital would therefore be used more efficiently than for option TRAILER 1 and the same average energy efficiency target could be implemented more cost-efficiently.

For option TRAILER 2, Annex 9 provides for different trailer types the TCO savings for a new trailer placed on the market in 2030 as a function of the energy consumption reduction target applied.

The cost-optimal energy consumption reduction target are the values corresponding to the maximum TCO savings, i.e. in 2030 7,5% for drawbar trailers and 15% for semi-trailers (for both, 1st user and societal perspectives) with respect to 2020. This analysis has only considered readily available technologies for improving trailer energy efficiency, such as aerodynamic devices, improved rolling resistance through better tyres/wheel bearings and light weighting. More advanced technologies, such as eTrailers, are not necessary to meet the proposed targets but could be used for compliance purposes and are therefore incentivised by this option.

Following the same procedure for determining energy consumption reduction targets, for 2035 and 2040 almost the same cost-optimal energy consumption reduction targets are obtained (variation less than < 1%). Apart from direct savings, more energy efficient trailers also facilitate the practical deployment of ZEVs, since due to a lower specific energy consumption ZEVs will have a longer operational range for a given technical configuration (e.g. battery capacity). This aspect will make ZEVs cheaper for a given application/operational range since it allows to reduce battery or on-board hydrogen storage capacity when they are used to tow trailers.

Option TRAILER 2 would also provide nearly up to additional 45 Mtoe of final energy savings over the period 2031-2050, compared to the TL_Med scenario. Out of those, around 23 Mtoe would correspond to fossil fuels savings, equivalent to EUR 16 billion at current oil prices of about EUR 95 / barrel of oil.

Option TRAILER 1 would provide a similar level of final energy savings, but at higher costs since it would require the installation of costly technologies also on trailers with a low usage. In addition, it would be more difficult to implement due to the possible need of exemptions for rare trailers with a special use profile.

6.4.2 Environmental impacts

Certain technologies necessary for achieving the cost-optimal energy efficiency targets determined for option TRAILER 2 cannot be installed on some rare use cases of trailers (e.g. certain aerodynamic devices) for technical reasons. This means that these technologies cannot be considered when defining an energy consumption reduction target for option TRAILER 1, because such target would be binding for each individual trailer and not just as a fleet average. For option TRAILER 1 either the energy consumption reduction target would have to be weakened or complex rules of exemptions for rare use cases of trailers would have to be defined. As a consequence, option TRAILER 1 would provide less energy efficiency improvement for the fleet of new trailers than option TRAILER 2.

Table 5 shows the savings for option TRAILER 2 over the period 2030 – 2040 of tailpipe CO_2 emissions in the HDV sector, if the cost-optimal energy consumption reduction targets are implemented, compared to a baseline without legislative requirements. The relative savings relate to the CO_2 emissions of the vehicle groups 4, 5, 9 and 10, which are main groups towing heavy trailers.

Table 5: Savings of tailpipe CO_2 emissions (option TRAILER 2)

CO_2 emissions savings		**2030**	**2035**	**2040**
Annual	**absolute in $ktCO_2$**	1,880	3,584	2,704
	relative	1.9%	5.1%	7.6%
Cumulative (as from 2025)	**absolute in $ktCO_2$**	5,671	20,182	35,461
	relative	0.5%	1.3%	1.9%

6.4.3 Other impacts

There are no particular social impacts resulting from setting any energy efficiency measures on trailers. In addition, none of the options would create relevant additional administrative burden as the monitoring and reporting obligations are already in place

6.5 Target timing (TT)

6.5.1 Economic impacts

Compared to the current scheme (option TT 0) of targets applying every 5 years, option TT 1 involves setting targets more frequently. This option limits the flexibility and restricts the lead time for manufacturers to meet the targets. In addition, they may face compliance challenges from unexpected market fluctuations (unless combined with a credit and debt mechanism, see section 6.9.3). Therefore, option TT 1 may lead to higher compliance costs for manufacturers. At the same time, option TT1 may incentivise manufacturers to anticipate the marketing of ZEV, bringing then earlier benefits for transport operators.

6.5.2 Environmental impacts

Option TT 1 would provide for earlier emission reductions than option TT 0, leading thus to higher CO_2 emissions reductions in the intermediate years.

The worst-case environmental scenario would be that manufactures do not anticipate any improvement. Under this scenario, the cumulative CO_2 emissions from HDVs over the period between 2030 and 2035 would increase by around 7% compared to option TT 1 (equivalent to around 50 million tons CO_2). However, in case the current credit/debt mechanism is retained after 2030 (see option C/D 1 from section 6.9.3) manufacturers would have an incentive to actually anticipate improvements.

6.6 Use of the revenues from excess emissions premiums (fines)

Option REV 1 assigns the revenues from possible excess emission premiums to a specific fund or programme, such as the Just Transition Fund. The analysis below provides an assessment of such option as compared to the current assignment of possible fines to the general budget of the EU (default option REV 0).

6.6.1 Economic impact

Assigning the revenue to a specific fund or programme may in principle lead to increased spending possibilities. The overall impact of that revenue may be, however, limited, considering that the CO_2 emission performance standards provides a framework for manufacturers to meet their specific emission targets. It does not aim at raising revenues.

6.6.2 Environmental impact

There are no direct environmental impacts. Where additional spending possibilities are created, there may be, however, some indirect beneficial impacts if the specific fund channels the amounts available into climate related expenditures.

6.6.3 Social Impact

While the possibility of specifically support the up-skilling and reskilling, including training, of affected workers may be foreseen in a specific fund, it is likely that it will have a limited social impact given the limited collected amounts.

6.6.4 Administrative burden

Assigning the revenue will increase the administrative burden.

Due to the variability and unpredictability of the revenue, mechanisms will be needed to ensure that before being assigned, the amounts reach a level that would at least exceed the cost associated to the additional administrative burden resulting from the assignment and the need to distribute the additional resources.

6.7 Incentive scheme for zero-emission vehicles

6.7.1 Bonus-only incentive scheme (ZEV BONUS)

6.7.1.1 Economic Impact

The incentive introduced by option ZEV BONUS would provide the manufacturers higher flexibility since, in theory, they could decide to market more ZEVs while limiting the technological improvement of conventional vehicles. However, the contribution from improvement of efficiency in conventional vehicles for the purpose of manufacturers targets compliance remains limited since such compliance is mainly projected to be achieved by deploying zero-emission technologies. Indeed, by meeting a certain ZEV benchmark (that would nonetheless need to be set at a higher ZEV share than those projected in chapter 6.3.1.1.6), manufacturers would actually find no need to improve less conventional ICE efficiency, as they would most likely anyhow overachieve their CO_2 targets. As such, it is very unlikely that a certain manufacturer would actually get any benefit from the introduction of such an incentive scheme, so it would very probably remain unused.

6.7.1.2 Environmental Impact

As just explained, it is very unlikely that a manufacturer would decide to meet the benchmark to benefit for a more limited improvement of the efficiency of ICE vehicles. Therefore, there would also not be any environmental impact.

6.7.1.3 Other impacts

No significant additional social impacts or administrative costs is expected.

6.7.2 ZEV mandate for urban buses

Already in the Medium Ambition Scenario (TL_Med, see chapter 6.3.1) the ZEV share for buses already reaches ZEV BUS 1 target (80% new ZEV buses in 2030). Therefore, such option would determine the same impacts as option TL_Med in 2030.

6.7.1.4 Economic impacts

Under ZEV BUS2 (setting 100% ZEV mandate by 2030), the total cost of ownership for the 1^{st}, 2^{nd} and 3^{rd} owners are positive and respectively around 21 500, 20 000 and 17 000 EUR higher than the TCO of the TL_Med scenario in 2030 for each new regulated bus. From a societal perspective, the additional average TCO saving is 50% higher that of the saving under the same target level without mandate (TL_Med), bringing an additional benefit of approximatively 37 000 EUR per regulated bus in the 2030 new fleet. A Figure is provided in Annex 9.

6.7.1.5 Environmental impacts

In a Medium Ambition Scenario, option ZEV BUS2 would save additional 9 Mtons of CO_2 between 2031 and 2050 (as compared to the TL_Med), which is equal to almost half of the emissions of the regulated buses sector. Additional savings of air pollutants in particular in urban settings would also appear.

6.7.1.6 Other impacts

No additional social impacts or administrative costs are expected.

6.7.3 ZEV incentive for 'other vehicles'

Options ZEV OV 1 and ZEV OV 2 would incentivise the deployment of ZEV in the "other vehicles" groups.

6.7.1.7 Economic Impacts

Manufacturers would benefit from the additional regulatory flexibility provided by the option ZEV OV1 as they would have more options to meet their target. On the other hand, option ZEV OV2 would provide less flexibility for the manufactures, as they would need to market a certain number of ZEV in the unregulated groups on top of the targets applied to the regulated groups.

6.7.1.8 Environmental Impacts

Option ZEV OV1 would not have a significant environmental impact in the short term as the number of ZEV would be similar than in TL_Med scenario: approximatively, for each additional unregulated ZEV a manufacturer puts on the market, this manufacturer could meet the target with one less ZEV in the regulated groups. However, this option would help stimulating a long-term ZEV shift in these groups of vehicles.

Option ZEV OV2 instead would create limited CO_2 savings, as it would push for more ZEV uptake in unregulated groups.

6.7.1.9 Other impacts

No additional social impacts or administrative costs is expected.

6.8 Mechanism to account for renewable and low-carbon fuels when assessing vehicles manufacturers compliance with the CO_2 standards

6.8.1 Economic Impact

6.8.1.1 Option FUEL1 – Application of GHG correction factors

Applying GHG ('carbon') corrrection factors that take into account the amount of renewable fuels projected in the REPowerEU scenario context to the type-approved CO_2 emissions of the vehicles would be equivalent to lowering the average specific emissions of a certain manufacturer.

Costs faced by manufacturers increase with stricter CO_2 emission targets, as more emissions reduction technologies would be needed to achieve these. Therefore, by lowering the average specific emissions, option FUEL 1 would generally lead to less compliance costs for manufacturers. Such costs would be lower than in TL_Low in 2030 and somehow between TL_Low and TL_Med in 2040.

The costs (EUR per vehicle) from a societal perspective and from the user's TCO perspective are higher under the option FUEL1 compared to the TL_Med scenario.The increase in costs is related to the lower market penetration of ZEV, and the consequent increase in the fuel expenditure. This is consistent with the analysis provided under section 6.3 as this option is equivalent to setting less ambitious CO_2 target levels.

6.8.1.2 Option FUEL2 – Renewable and Low-Carbon (LCF) crediting system

The introduction of a LCF crediting system would enable for individual manufacturers the possibility of obtaining credits for determining its average specific CO_2 emissions, and thus meeting its specific targets, provided that additional quantities of LCF are marketed by fuel suppliers. Such credits would be delivered by fuel suppliers marketing quantities of LCF which are higher than those required to comply with Renewable Energy Directive (RED) and Refuel Aviation and Maritime obligations. Therefore Option FUEL 2 acts as an incentive for the fuel industry to produce and market additional quantities of renewable and low carbon fuels.

In the economic analysis of this option, a comparison is made between (i) the costs for an additional newly registered zero-emission vehicle to meet the CO_2 target and (ii) the costs for the amount of CO_2 saved from LCF quantities that achieve the same effect for meeting the CO_2 emission standards as the additional ZEV. This allows a comparison of a target achievement strategy without the crediting scheme of CO_2 emission savings from LCF (current design of the legislation) and by purchasing additional amounts of LCF credits for target compliance, as shown in Table 6.

Table 6: Additional cost from manufacturer's perspective in EUR per tCO_2 saved.

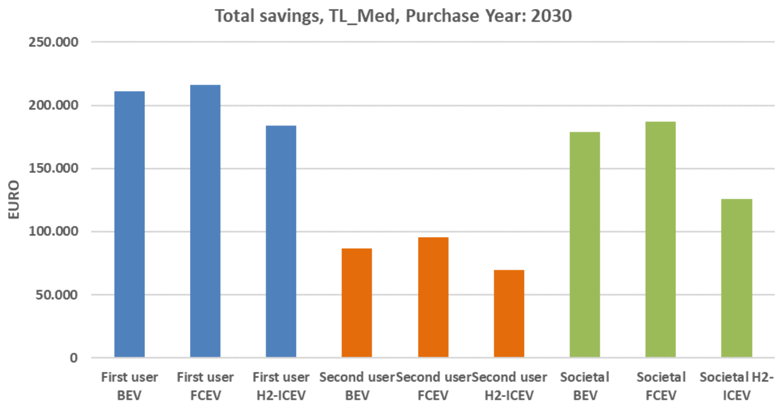
Route	Fuel/ZEV technology	2030	2035
(i)	BEV, vehicle group 5-LH	108	101
	FCEV, vehicle group 5-LH	90	56
(ii)	LCF bio-diesel	261	186
	LCF e-diesel	259	171

The cost analysis is limited to advanced biofuels (defined by Annex IX part A of RED) and Renewable Fuels of Non-Biological Origin (RFNBO), consistently with the revision of the Renewable Energy Directive. Annex 9 provides more details about the methodology used for the analysis.

This analysis shows that for a manufacturer the costs of purchasing LCF credits are significantly higher than complying with its targets by putting on the market additional BEV or FCEV. This is due to the higher production costs for such fuels.

If manufacturers were to purchase LCF credits to compensate for tailpipe CO_2 emissions the cost increase would be reflected on the increased TCO for the users, due to the additional fuel costs being passed-on to the users. Figure 10 shows the resulting savings for various types of powertrains of 5-LH group vehicles (lorry > 16 t) purchased in 2030, under the assumptions that LCF bio-diesel credits are bought by the manufacturer to compensate emissions from ICEVs.

Figure 10. Net economic savings (euro/vehicle) for various powertrain technologies compared to an ICE with LCF (bio-diesel) credits.



In case of LCF credits from RFNBOs, the TCO differences would be even bigger, with ZEV remaining the options providing the best TCOs for users.

Option FUEL 2 would lead to fewer ZEV marketed as from the moment the LCF credit would be used. This would blur the clear policy signal towards zero-emission vehicles and be detrimental for the technological leadership of European automotive industry.

Replacing ZEV with ICE vehicles compensated for by LCF credits would always lead to a decrease of the energy savings, due to the higher efficiency of ZEV (especially BEV), as illustrated in Annex 7. The electricity requirement for the production and downstream transportation and distribution of different types of e-fuels has been estimated to be from around 1.6-1.8 times higher for compressed gaseous hydrogen and between 2.2 to 6.7 times higher for liquid e-fuels, when compared to the direct use of electricity, depending on the specific fuel type. When considering not only the fuels production phase, but also the vehicle powertrain efficiency / losses when the fuels is used, the total efficiency declines even more.

Furthermore, providing more LCF on the market for the HDV sector would lead to less of such fuels available for the decarbonisation of the most hard-to-decarbonize transport modes, i.e. the aviation and maritime sectors which are subject to the specific fuels initiatives under the Fit for 55 package.

6.8.2 Environmental Impact

Option FUEL 1 would be equivalent to setting a lower ambition level for the CO_2 emissions reduction targets with corresponding negative environmental impacts (as discussed in section 6.3). Compared to the medium ambition scenario (TL_Med), the average CO_2 emissions per tkm of the new vehicles fleet of option FUEL 1 increases by around 13% in 2030. In 2030, FUEL1 option leads also to a higher uptake of ICEV, while the number of new ZEV decreases by around 25%. All in all, the CO_2 tailpipe emissions in FUEL 1 during the period 2031-2050 increase by about 8% of the cumulative emissions in TL_Med.

Option FUEL 2 may theoretically have neutral GHG emissions impacts, but the complexity of the system implementation raises strong doubts over the possibility to achieve such impacts on GHG emissions in practice. In addition, due to the higher share of ICE vehicles, the overall level of air pollutant emissions are projected to be higher.

6.8.3 Social Impact

Introducing the option FUEL1 would lead to social impacts equivalent to a lower level of ambition of the target levels. Consumers would not experience the fuel savings from the use of more efficient and zero-and low-emission vehicles, since the manufacturers would need less of these vehicles to meet their CO_2 emission targets. As regards the option FUEL2, the increase in the total costs for end users described under the economic impact will affect consequently the users.

6.8.4 Administrative burden

While option FUEL1 would not lead to additional administrative burden, the implementation of the LCF credits option under FUEL2 would significantly increase the complexity of the compliance system due to the following reasons:

- Establishment of a new crediting, monitoring and reporting system for the credits generated by fuel suppliers and also to allow manufacturers to purchase these credits.
- Additonal monitoring checks related to the issuing of the credits and annual checking of manufacturers compliance. Assessing compliance by vehicle manufacturers would require involvement of the national authorities responsible for the implementation of the RED.
- Matching of different timing in the reporting and compliance cycles: while the compliance cycle for vehicle manufacturers is annual, the reporting under the RED is every two years and the compliance with RFNBO and advanced biofuel mandates is not annual.

6.9 Governance provisions

6.9.1 Compliance assessment

6.9.1.1 Economic Impacts

The economic impacts of the options is driven by the market structure of the different HDV segments and the evolution of the fleet composition.

The emission reduction targets in the different vehicle groups are determined in a cost-efficient way and should reflect an equal distribution of burden between each vehicle group. However, the situation of individual manufacturers may be different.

On the one hand, option COMP 1 would provide a high degree of flexibility to major manufacturers that produce a wide range of HDVs as they could compensate a possible underachievement in certain vehicle groups (involving extra costs for not meeting the related specific targets) by an overachievement in other groups of vehicles.

On the other hand, option COMP 1 may put manufacturers that are only active in either the lorries or the buses/coaches segments into an unfavorable competitive position since those manufacturers cannot benefit from this high degree of flexibility. Looking at today’s market structure this potential competitive distortion is particularly relevant for specialised bus & coach manufacturers.

Option COMP 2 setting separate compliance conditions for lorries and trailers on the one hand, and buses & coaches on the other hand, would level the playing field for all manufacturers (as would option COMP 3).

Trailers having some capability for own propulsion through electric motors installed in their axles are being developed and are likely to appear on the market and would facilitate the transition to zero-emissions mobility. These ‘eTrailers’ would be incentivised by options COMP 1 and COMP 2 since credits from the trailer targets could be used for easier compliance with the motor vehicle targets.

Option COMP3 is the least flexible as it defines three separate compliance conditions and it would not incentivise the marketing of eTrailers.

6.9.1.2 Social Impacts

There are no specific social impacts resulting from these options.

6.9.1.3 Environmental Impacts

Different compliance conditions leading to the same global CO_2 emissions reduction do not affect the overall environmental outcome.

6.9.2 Flexibilities between manufacturers for compliance assessment.

Any options involving a vehicle transfer mechanism between manufacturers does not have specific social or environmental impacts. Therefore, the discussion can focus on economic impacts and administrative burden only.

6.9.1.4 Economic impacts

Option FLEX 0 does not provide any pooling/transfer option. This leads to difficulties for some manufacturers as ZEVs and other vehicle groups (e.g. medium lorries, buses) produced in legally independent, but economically connected undertakings (e.g. subidiaries) cannot be accounted for compliance.

Option FLEX 1 would solve this limitation by allowing a group of manufacturers to form a pool during a well-defined time period. The pool would be considered as a single entity for compliance assessment. However, this would risk deterioriating competition as explained in section 5.2.6.2).

In addition, if the option of a multi-annual C/D mechanism is retained (see section 6.9.3 below), option FLEX 1 would require defining complex rules and increase the administrative burden.

Under option FLEX 2, the transfer of vehicles between connected undertakings would be possible for compliance assessment in each reporting period addressing therefore the difficulties raised by option FLEX 0. Option FLEX 2 is not constrained by competition issues as, under competition law, economically connected undertakings are effectively considered as if they were a single manufacturer.

Furthermore, the possibility under option FLEX 2 of also transferring ZEVs between non-connected undertakings would provide some opportunities to independent specialized small and medium start-up companies, mostly present in the bus and medium lorry vehicle groups, supporting thus innovation within these smaller companies.

Both options bear the risk that large manufacturers might largely rely on ZEVs transfers for complying with their targets instead of investing in zero-emission technologies. This risk can be mitigating by limiting the number of ZEVs transferred to a manufacturer from non-connected undertakings.

6.9.3 Credits and debts (C/D) mechanism

The introduction of this mechanism has already been assessed in the Impact Assessment accompanying the current HDV Regulation. Its extension as from 2030 under option C/D 1 would not create relevant social impacts or administrative burden. However, it is expected to produce the following impacts.

6.9.1.5 Economic impacts and administrative burden

Option C/D 1 would keep providing flexibility to manufacturers improving then the cost-effectiveness of the policy. This is in particular relevant for the HDV sector where design cycles are much longer than for cars. The possibility to acquire credits, and to use them within a limited timespan after the application of more stringent targets, would also reward early adopters fostering thus sectoral innovation. Moreover, this option would help manufacturers managing flexibly market demand variations for instance in case of exceptional external economic situation, without endangering meeting their respective targets.

A particular downside could arise in case a manufacturer that has debts to be reimbursed would go out of business. This would create problems of liability for compensating the credit deficit for that period. This risk is addressed by limiting the borrowing to 5% of the specific emissions target, as set out in the current mechanism.

6.9.1.6 Environmental impacts

The current mechanism is set up in such a way to mitigate the risk of undermining the effectiveness of the CO_2 reduction target. Credits can only be acquired when the CO_2 emissions performance of a manufacturer's HDV fleet is below the emissions reduction trajectory (and not only below the emissions targets). As a result, manufacturers cannot gain 'windfall' credits for gradual adjustments of their fleet to new, more ambitious targets applicable soon. Furthermore, the CO_2 credits, which can be acquired, are also quantitatively limited and their use is limited to one compliance period. This ensures that technological developments are not unduly delayed. Maintaining the current mechanism (option C/D 1) therefore mitigate the risk of negative environmental impacts.

6.10 Overall costs and benefits and CO2 emissions of the most relevant combinations of options

6.10.1 Overall costs and benefits

This chapter presents the overall costs and benefits of the most relevant combinations of policy options. Such overall costs and benefits are driven by the options on the scope, target levels, mandate for ZEV buses and renewable and low-carbon fuels. All the other options concern the definition of modalities for manufacturers to implement the targets and, as such, their effect on the overall costs and benefits are negligible. Due to the large number of possible combinations of options, even when excluding those with negligible impacts on the overall costs and benefits, only the most relevant ones are presented. To ensure a correct comparison of such combination of options, the results are presented in different tables. In Table 7 only the target level changes, while other assumptions (scope, ZEV mandate and accounting of renewable and low-carbon fuels) are kept constant. On the other hand, in Table 8 to

Table 11 the target level is kept constant while the other assumptions change.

The tables below show the total costs, further broken down in capital, fuels and other costs (including alternative fuel infrastructure AFI, maintenance, tolls), as well as the monetisation of the environmental benefits (CO_2 and air pollutant emissions), using the methodology described in the Handbook on Transport external costs[49].

All the figures represent the difference between a certain scenario and the baseline. Costs are shown by positive values, while savings are shown by negative values. All costs and savings are discounted in line with the Better Regulation Toolbox (using a social discount rate of 3%). The results are based on the PRIMES-TREMOVE model results.

In all the tables below, the total costs, i.e. the algebraic sum of capital costs, fuel costs and other costs, provide negative values, since the fuels savings outweigh the capital and other costs. This means that in all the policy combinations, even without considering the monetisation of the CO_2 and pollutants, the policy options always determine economic savings. This confirms the same trend shown by the modelling results of the JRC DIONE model which has been used to calculate the 'Total Cost of Ownership' (TCO) for the new vehicles fleet, shown above.

Table 7 shows a comparison among combinations of options considering different target levels applied to the scope 1 option (i.e. scope expanded to currently non-regulated but monitored entities). The comparison shows that all the target levels result in savings as compared to the baseline, and such savings increase with the stringency of the target levels. Qualitatively a similar trend is observed for combinations of options considering the different target levels applied to scope 0 (i.e. scope not expanded to the currently non-regulated but monitored entities).

Table 7: detailed cumulative costs under different target levels (2031 to 2050; difference to the baseline)

	Costs (bn €)				**Monetised environmental benefits (bn €)**		**Total impact (bn €)**
Scenarios	**Capital costs**	**Other costs (AFI, maintenance, tolls, etc)**	**Fuel costs**	**Total costs (bn€)**	**CO_2 emiss.**	**Air pollution**	
TL_Low, SCOPE1	99	70	-237	**-68**	-60	-7	**-136**
TL_Med, SCOPE1	129	85	-295	**-81**	-70	-10	**-161**
TL_High, SCOPE1	173	106	-377	**-97**	-87	-14	**-199**

Table 8 shows a comparison of the two options for the accounting of renewable and low-carbon fuels applied in combination with increased target levels (at the level of TL_Med) and

[49] https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

for the same scope (scope 1). It shows that accounting for renewable and low-carbon fuels when assessing vehicles manufacturers compliance with the CO_2 standards always reduces the overall savings. This is due to: (i) an increase in the energy expenditures as more energy is needed to propel the fleet of vehicles, and (ii) a reduction in the monetised savings for CO_2 and pollutants emissions.

Table 8: detailed cumulative costs under different LCF options (2031 to 2050; difference to the baseline

	Costs (bn €)				**Monetised environmental benefits (bn €)**		**Total impact (bn €)**
Scenarios	**Capital costs**	**Other costs (AFI, maintenance, tolls, etc)**	**Fuel costs**	**Total costs (bn€)**	**CO_2 emiss.**	**Air pollution**	
TL_Med, SCOPE1	129	85	-295	**-81**	-70	-10	**-161**
TL_Med, SCOPE1, LCF_factor	100	73	-242	**-69**	-62	-8	**-139**
TL_Med, SCOPE1, LCF Credits	116	80	-273	**-77**	-69	-9	**-155**

Table 9 shows that, for targets set at the level of TL_Med, the extension of the Scope leads to additional savings (as fuel savings outweigh the increase in capital costs) and additional monetised environmental benefits. Setting in addition to the scope extension a 100% ZEV mandate for regulated buses brings further additional benefits both in terms of costs savings and monetised environmental benefits.

Table 9: detailed cumulative costs under different combinations of options, TL_Med (2031 to 2050; difference to the baseline)

	Costs (bn €)				Monetised environmental benefits (bn €)		Total impact (bn €)
Scenarios	**Capital costs**	**Other costs (AFI, maintenance, tolls, etc)**	**Fuel costs**	**Total costs (bn€)**	**CO_2 emiss.**	**Air pollution**	
TL_Med, SCOPE0	57	66	-181	**-57**	-55	-6	**-118**
TL_Med, SCOPE1	129	85	-295	**-81**	-70	-10	**-161**
TL_Med, SCOPE1, ZEV BUS2	132	86	-301	**-82**	-71	-11	**-164**

Error! Not a valid bookmark self-reference. shows that the same trends are observed for combinations of options with targets set at the level of TL_High.

Table 10: detailed cumulative costs under different combinations of options, TL_High (2031 to 2050; difference to the baseline)

	Costs (bn €)				Monetised environmental benefits (bn €)		Total impact (bn €)
Scenarios	**Capital costs**	**Other costs (AFI, maintenance, tolls, etc)**	**Fuel costs**	**Total costs (bn€)**	**CO_2 emiss.**	**Air pollution**	
TL_High, SCOPE0	80	89	-236	**-67**	-67	-9	**-143**
TL_High, SCOPE1	173	106	-377	**-97**	-87	-14	**-199**
TL_High, SCOPE1, ZEV BUS2	176	107	-381	**-98**	-87	-14	**-200**

Similarly,

Table 11**Error! Reference source not found.** shows that setting an additional 100% mandate for regulated buses in 2030 would increase the costs savings and the monetised environmental benefits also in conjunction with target levels as in option TL_Low.

Table 11: detailed cumulative costs under different combinations of options, TL_Low (2031 to 2050; difference to the baseline)

	Costs (bn €)				**Monetised environmental benefits (bn €)**		**Total impact (bn €)**
Scenarios	**Capital costs**	**Other costs (AFI, maintenance, tolls, etc)**	**Fuel costs**	**Total costs (bn€)**	**CO_2 emiss.**	**Air pollution**	
TL_Low, SCOPE1	99	70	-237	**-68**	-60	-7	**-136**
TL_Low, SCOPE1, ZEV BUS2	104	71	-246	**-72**	-61	-8	**-141**

The results in Tables 9, 10 and 11 also confirm that savings and monetised environmental benefits increase with the stringency of the targets for all the relevant combinations of policy options.

In all policy scenarios, the benefits (fuel and operational savings and monetised environmental externalities) are around two times bigger than the costs (capital costs, infrastructure costs, battery and fuel cell replacement), without significant variations among the scenarios. This shows that the efficiency is comparable among the different scenarios. However, options with higher targets show significatively higher benefits in absolute terms.

6.10.2 Overall emissions reductions

In the tables below, the cumulative CO_2 tailpipe emissions reduction of the most relevant combinations of options are presented, for the entire HDV sector.

Table 12 shows the cumulative CO_2 savings among combinations of options considering different target levels applied to the scope 1 option (i.e. scope expanded to currently non-regulated but monitored entities). The comparison shows that all the target levels result in significant CO_2 savings as compared to the baseline, and such savings increase with the stringency of the target levels. Qualitatively a similar trend is observed for combinations of options considering the different target levels applied to scope 0 (i.e. scope not expanded to the currently non-regulated but monitored entities).

Table 12: cumulative CO_2 savings under different target levels (2031 to 2050; difference to the baseline)

Scenarios	Tailpipe emissions HDV - cumulative savings 2031-50 (Mtons CO2)
TL_Low, SCOPE1	730
TL_Med, SCOPE1	837
TL_High, SCOPE1	996

Table 13 shows a comparison of the two options for the accounting of renewable and low-carbon fuels applied in combination with increased target levels (at the level of TL_Med) and for the same scope (scope 1). It shows that accounting for renewable and low-carbon fuels when assessing vehicles manufacturers compliance with the CO_2 standards always reduces the overall CO_2 savings.

Table 13: cumulative CO_2 savings under different LCF options (2031 to 2050; difference to the baseline)

Scenarios	Tailpipe emissions HDV - cumulative savings 2031-50 (Mtons CO2)
TL_Med, SCOPE1	837
TL_Med, SCOPE1, LCF_factor	738
TL_Med, SCOPE1, LCF Credits	822

Table 14 shows that, for targets set at the level of TL_Med, the extension of the Scope leads to significant additional CO_2 savings. Setting in addition to the scope extension a 100% ZEV mandate for regulated buses brings further additional reduction in cumulative CO_2 emissions.

Table 14: cumulative CO_2 savings under different combinations of options, TL_Med (2031 to 2050; difference to the baseline)

Scenarios	Tailpipe emissions HDV - cumulative savings 2031-50 (Mtons CO2)
TL_Med, SCOPE0	657
TL_Med, SCOPE1	837
TL_Med, SCOPE1, ZEV BUS2	847

Error! Not a valid bookmark **self-reference. shows** that the same trends are observed for combinations of options with targets set at the level of TL_High.

Table 10 shows that the same trends are observed for combinations of options with targets set at the level of TL_High.

Table 15: cumulative CO_2 savings under different combinations of options, TL_High (2031 to 2050; difference to the baseline

Scenarios	Tailpipe emissions HDV - cumulative savings 2031-50 (Mtons CO2)
TL_High, SCOPE0	765
TL_High, SCOPE1	996

TL_High, SCOPE1, ZEV BUS2	1005

Similarly, **Table 16** shows that setting an additional 100% mandate for regulated buses in 2030 would increase the CO_2 savings also in conjunction with target levels as in option TL_Low.

Table 16 detailed cumulative costs under different combinations of options, TL_Low (2031 to 2050; difference to the baseline

Scenarios	Tailpipe emissions HDV - cumulative savings 2031-50 (Mtons CO2)
TL_Low, SCOPE1	730
TL_Low, SCOPE1, ZEV BUS2	746

6.11 One in, One out

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[50]. 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**.

7. HOW DO THE OPTIONS COMPARE?

This chapter compares the different policy options, presented in chapter 5 and analysed in chapter 6, across a set of four key criteria:

- ❖ Effectiveness: this criterion relates to the extent to which the proposed options would achieve the objectives outlined in section 4
- ❖ Efficiency: the extent to which the objectives can be achieved for a given level of resource/at least cost.
- ❖ Coherence of each option with the increased 2030 ambition level, the REPowerEU plan, the 2050 climate neutrality objective and the consistency with the overall ‘fit for 55%’ package;
- ❖ Proportionality, in terms of administrative costs and complexity.

1.16. 7.1 Extension of the scope

7.1.1 Including vehicles with certified CO_2 emissions into the scope

SCOPE 0 covers around 73% of the total HDV CO_2 emissions. Both options SCOPE 1 and SCOPE 2 are more effective than SCOPE 0, since they reduce CO_2 emissions and final

[50] Commission Regulation (EU) 2017/2400 and Commission Implementing Regulation (EU) 2022/1362, implementing Regulation (EC) No 595/2009, and Regulation (EU) 2018/956

energy demand while delivering positive economic effects (positive TCO results from societal and user perspectives), despite the increase of costs for manufacturers.

While SCOPE 1 ensures nearly an additional 25 percentage points in terms of emissions regulated compared to SCOPE 0, thereby reducing CO_2 emissions by around 180 Mtons of CO_2 for the medium scenario between 2031 and 2050, SCOPE 2 is more **effective** than SCOPE 1 as it extends the scope of regulated vehicles to trailers, saving additional 51 Mtons of CO_2 emissions.

SCOPE 1 and 2 are also more **efficient** than SCOPE 0 as they reach the same level of overall ambition with less cost, thanks to the inclusion of new groups of vehicles. In addition, SCOPE 2, with the inclusion of the trailers, provides additional economic benefits for users.

Regarding **coherence**, both options SCOPE 1 and SCOPE 2 contribute more than SCOPE 0 to the EU climate objectives and the REPowerEU energy saving goals. The wider coverage of SCOPE 2 makes such contribution of greater importance.

As monitoring and reporting systems already exist for all vehicles, none of the options would create relevant additional **administrative burden** or increase the complexity as compared to the current situation.

1.17. 7.2 CO_2 emission targets and their timing

7.2.1 Target levels (ambition level) for new motor vehicles

The options considered cover a range of target level trajectories up to 2040. As described in Section 6, the stricter the ambition level, the higher the overall **effectiveness, efficiency and coherence** of the corresponding target levels.

Among the considered options, stricter target levels determine higher average net savings from any perspective (societal, first, second and third user), final energy and fossil fuels demand reduction, CO_2 emissions reduction and air pollution decrease. In addition, more stringent targets trigger higher investment by manufacturers, strengthening innovation and technological leadership in zero-emission technologies. To the extent that such accelerated uptake of ZEV would yield economies of scale, this could further bring down vehicle costs and make ZEV more attractive/affordable for users.

Regarding macro-economic impacts, the three scenarios considered show positive GDP growth and overall jobs creation, which increase as the scenario gets more ambitious. At the sectoral level, there would be an increase in the electric vehicles supply chain, with a production increase in sectors such as electronics, metals and electrical equipment. This reflects the impact of increased demand for batteries, fuel cells, electricity infrastructure and electric motors. On the other hand, the automotive sector itself would see a decrease in turnover due to the decreasing use of combustion engines in HDV. Similarly, the power and hydrogen supply sectors would increase its output reflecting increased demand for electricity and hydrogen to power electric vehicles, while the petroleum refining sector would see a lower output. With more stringent target levels, these effects would become somewhat more pronounced.

With more ambitious CO_2 target levels resulting in an increase in economic output, there is also a small increase in the number of jobs across the EU-27 compared to the baseline. The main drivers behind the GDP impacts also explain the employment impacts. Shifts in sectoral economic activity will also affect the skills and qualifications required in the HDV sector. Re-skilling and up-skilling of the affected workers will be necessary.

In terms of **coherence**, more stringent targets would contribute more to the overall 55% emission reduction by 2030, and to supporting Member States in meeting their target under the Effort Sharing Regulation (ESR), as well as to achieving the 2050 climate neutrality objective. Higher CO_2 targets would also contribute more to the achievement of the energy efficiency objectives.

There are also clear complementarities between CO_2 emission standards and the emission trading for road transport and buildings. The CO_2 emission standards address the supply on the market of more fuel-efficient vehicles, ensuring a significant increase in the supply of new zero-emission vehicles over time. The ETS coverage concerns the fuel use in the entire vehicle stock and captures real-life emissions. It could increase the demand for more fuel-efficient vehicles, facilitating the fulfilment of the CO_2 efficiency objectives of the vehicle manufacturers.

The CO_2 emission standards are also a complementary measure to the RED. The RED incentivises the uptake of renewable and low carbon fuels for the combustion engine vehicles in the legacy fleet. It therefore complements the CO_2 emission standards, which drive the supply of more efficient vehicles, by acting on the fuels supply side.

Furthermore, it should be underlined that both the ETS and the RED contribute to the decarbonisation of the power generation, so that zero-emission vehicles incentivised by the CO_2 emission standards are progressively powered by renewable energy sources.

Table 17 below shows the tailpipe emissions of HDVs in different scenarios, and how the HDV CO2 emission standards contribute to the required emission reduction in the REPowerEU scenario. Higher ambition of the HDV standards allows to almost close the gap between the baseline situation and the REPowerEU scenario. This option is the most likely to deliver the reduction required from the HDV sector to deliver on climate targets, while still requiring additional initiatives leading to shift to more sustainable modes of transport, as explained in chapter 6.1.

Table 17. Tailpipe CO_2 emissions of heavy-duty vehicles in different scenarios.

HDV Tailpipe emissions (Mtons CO_2)	**2030**
Baseline	155
TL_Low	153
TL_Med	150
TL_High	146
REPowerEU	142

While the stricter CO_2 emission targets have an important impact already for emission reduction by 2030, the effect on the emissions reduction will be stronger in the period post-2030 as a result of the increasing number of zero- and low-emission vehicles on the road through the fleet renewal.

No meaningful differences were found across the different considered options in terms of **proportionality and administrative burden**.

7.2.2 Target levels for the energy efficiency of trailers

Both options including energy efficiency improvements for trailers are more effective in reaching the objectives as compared to the option excluding such vehicle category. As explained in section 6, due to a binding energy consumption target for each individual trailer and the impossibility to install certain technologies on certain trailer use cases, option TRAILER 1 would potentially provide less energy savings in trailers than option TRAILER 2 This results in lower final energy, fossil fuel demand and CO_2 emissions for TRAILER 2. Therefore TRAILER 2 is more **effective**. In addition, TRAILER 2 is also the most **efficient** option since it provides manufacturers with the possibility to consider the different characteristic of the trailers in their fleet. TRAILER 2 option allows the deployment of energy-efficient technologies according to the trailers specific use case and customer demand, which is not the case for option TRAILER 1. TRAILER 2 also provides for average net savings from any perspective (societal, first, second and third user), compared to TRAILER 0.

Regarding **coherence**, both options contribute more than TRAILER 0 as they contribute to reaching the climate and energy objectives. No substantive difference in terms of **administrative burden** exist among the different options.

7.2.3 Target timing

The option of setting targets decreasing in less-than-5-year steps (TT1) would provide greater certainty that a gradual CO_2 emission reduction will be effectively delivered. It therefore scores more positively in terms of **effectiveness** than the baseline (TT0).

However, option TT1 would leave manufacturers with much less flexibility to deal with year-to-year market fluctuations and to manage the introduction of new or upgraded models and technologies in the fleet. In terms of **efficiency**, it scores negatively as this option is likely to increase compliance costs for manufacturers. At the same time, economic savings for consumers and society are likely to increase.

In terms of **coherence and administrative burden**, no major differences could be identified between the options.

1.18. 7.3 Use of revenues from excess emissions premiums (fines)

The option REV1 of assigning the revenue from excess emissions premiums collected under the Regulation to a specific fund or programme should be considered in the context of supporting the transition towards a climate-neutral economy as well as the (re-)skilling and reallocation of automotive workers. It is therefore considered in the context of the first and third specific objective of this initiative.

It cannot be anticipated whether or how much manufacturers will exceed their targets. This means that the revenue from the excess emissions premiums will be uncertain and most likely very limited. Overall, this creates some doubts over the **effectiveness** of the option.

In addition, this option would likely increase the **administrative burden** as a complex mechanism will need to be put into place in order to make it operational. It is therefore uncertain at this stage whether the additional burden would outweigh the benefits achieved, making this option scores lower than the baseline in terms of **efficiency** and **proportionality**.

In terms of **coherence**, no major differences could be identified between the options.

1.19. 7.4 Incentive scheme for zero- and low-emission vehicles

7.4.1 General incentive scheme

Option ZEV BONUS does not provide any incentive to manufacturers to market additional ZEV, as explained in Chapter 6.7.1.1, as compared to ZEV 0. Consequently, ZEV BONUS is neither **effective** in reaching the objectives, nor **efficient**. It is also not **coherent** with the need to further incentivise the ZEV to reach the climate objectives, while it would not add **additional administrative burden** as compared to ZEV 0.

7.4.2 Incentive scheme for buses

An option setting a binding mandate for buses is **effective** and **coherent** with the EU climate goals as it achieves higher emissions reduction and further stimulate innovation. Such measure would also increase the **efficiency** as the TCO show slightly higher savings. It would not change the **proportionality** nor add any administrative burden. Imposing such a ZEV mandate, however, would reduce the flexibility of manufacturers compared to option ZEV BUS 0. The analysis shows that the benefits provided by the options analysed are higher for ZEV BUS 2, as ZEV BUS 1 would have the same impacts as TL_Med.

7.4.3 ZEV incentive for non-regulated vehicles groups

Option ZEV OV1 would slightly increase the **effectiveness** and **coherence** of the policy by indirectly stimulating a long-term ZEV shift in the unregulated groups of vehicles. Option ZEV OV2 would directly create limited and additional CO_2 savings, therefore also bringing some benefits in terms effectiveness and coherence.

In terms of **efficiency**, option ZEV OV1 scores positively as it increases the flexibility for manufacturers while ZEV OV2 would impose additional burden to manufacturers for limited CO_2 savings, scoring then negatively.

The two options do not have any impact in terms of **administrative burden**.

1.20. 7.5 Mechanism for renewable and low-carbon fuels accounting

The application of GHG factors from option FUEL1 scores the lowest in terms of effectiveness as it is equivalent to lower level of ambition of the target levels. Due to less economic savings for operators both from a societal perspective and from the user's TCO perspective, its efficiency is low. However, manufacturers would benefit from lower upfront costs.

Option FUEL 1 would lead to double counting of the contribution of LCF under the RED and under the CO_2 emission standards, which it is not **coherent** with the current policy framework.

In terms of **proportionality**, and though it does not imply extra **administrative costs**, option FUEL1 scores slightly negative compared to the baseline as it adds some degree of complexity through the application of GHG factors.

The introduction of a low-carbon fuels (LCF) crediting system from option FUEL 2 may be comparable to the 'no fuels accounting' option with regards to the CO_2 emission objective, only under the assumption that enough quantities of low-carbon fuels are marketed at the moment of vehicles registration to cover the entire lifetime consumption of the vehicles concerned. Such a strong assumption would also lead to lower availability of such fuels for sectors without decarbonisation alternatives, impacting negatively the climate neutrality objective. In addition, the complexity of the system implementation raises strong doubts over the possibility to achieve such impacts on GHG emissions in practice. Introducing an LCF crediting system would lead to negative impacts in terms of overall energy savings with regards to the production and use of RFNBO and e-fuels for the road transport sector. It would also increase air pollutant emissions as well as in the overall gasoline and diesel blended fuel prices. The LCF option would also be less effective in stimulating innovation in zero-emission vehicles. It therefore scores negatively on **effectiveness** compared to the baseline.

FUEL 2 option leads to higher costs for manufacturers from purchasing LCF credits compared to meeting the target due to the high production costs for producing such fuels. Costs are also higher for users and for society (hence increasing TCO compared to option FUEL 0). This option scores very low on **efficiency**.

Option FUEL 2 would foster the use of these fuels in road transport, lowering then their availability for other transport modes where less or no decarbonisation alternative exist. This is not **coherent** with the need to reduce economy-wide emissions as explained in the conclusions of the Climate Target Plan.

Finally, due to the inherent complexity of the design of the crediting system, and the need to avoid any potential loophole, the FUEL2 option would also significantly strongly increase the **administrative burden** of the compliance system. For this reason, it scores the lowest in terms of **proportionality**.

1.21. 7.6 Governance provisions

7.6.1 Compliance assessment

In all the options the level of ambition is the same, while the way compliance is assessed changes. Therefore, no major difference among options can be identified in terms of **efficiency**, **coherence** and **proportionality**. However, the following considerations should be taken into account.

Option COMP 1 provides higher flexibility to manufacturers thanks to the single compliance condition which drives cost-efficiency. However, for option COMP 1 there is a risk of introducing competition distortion in favour of large manufacturers covering many types of vehicles against smaller companies offering more specialized vehicles or a reduced palette of vehicle groups (e.g., buses and coaches-only manufacturers). COMP 2 and COMP 3, on the other hand, provide less flexibility to major manufacturers active in all segments but ensure a level playing field for smaller manufacturers or those only active in the bus and coach segment.

While today motor vehicle and trailer manufacturers are different entities and therefore options COMP 2 and COMP 3 would be almost equivalent, in the future the market structure may evolve. In a different market structure, option COMP 2 (and COMP 1) can provide incentives for eTrailers, while COMP 3 would not. This benefits operators/users and the technological leadership of manufacturers and therefore COMP 2 supports innovation more than COMP 3.

Therefore, option COMP 2 scores the highest in terms of effectiveness.

7.6.2 Flexibilities between manufacturers for compliance assessment

Under all options considered, the targets would be equally met. Therefore, there would be no big difference with regards to **effectiveness** of the different options. However, FLEX 2 would further support innovation in ZEVs produced by smaller manufacturers and start-ups, thereby scoring slightly better in terms of effectiveness.

However, FLEX 1 would introduce competition concerns by allowing pooling in a market dominated by a very reduced number of major manufacturers. It could lead to a narrow range of technological options available on the market and slow down competition and innovation. FLEX 1 therefore scores less positively in terms of effectiveness.

Option FLEX 1 (pooling) provides the greatest flexibility for manufacturers for meeting the targets, being thus more **efficient** than FLEX 2 that, allows for limited transfer of vehicles for compliance assessment.

Both options FLEX 1 and FLEX 2 are **proportional** but would generate **some administrative burden** compared to FLEX 0. The administrative burden would be higher in case of full pooling (FLEX 1).

7.6.3 Flexibilities across different target years (credits and debts [C/D] mechanism)

Extending the current credit/debt regulatory mechanism with option C/D 1 provides greater flexibility to manufacturers and hence increases **efficiency** through compliance cost reduction than option C/D 0 applying strict annual compliance targets. Furthermore, it would reward early performers.

Both options are **effective** as they are designed to ensure the same level of total CO_2 emissions over 5 years periods. Also, both options are **proportional** and create no significant **administrative burden.**

8. PREFERRED OPTION

When proposing its updated 2030 greenhouse gas emissions reduction of at least 55%, the European Commission also described the actions across all sectors of the economy that would complement national efforts to achieve the increased ambition. A number of impact assessments have been prepared to support the envisaged revisions of key legislative instruments.

Against this background, this impact assessment has analysed the various options through which a revision of CO_2 emission standards for heavy duty vehicles could effectively and efficiently contribute to the delivery of the updated target as part of a wider “Fit for 55” policy package and considering the REPowerEU Plan.

1.22. 8.1 Methodological approach

Drawing conclusions about preferred options from this analysis requires tackling two methodological issues.

First, as often the case in impact assessment analysis, ranking options may not be straightforward as it may not be possible to compare options through a single metric and no option may clearly dominate the others across relevant criteria. Ranking then requires an implicit weighting of the different criteria that can only be justifiably established at the political level. In such cases, an impact assessment should wean out as many inferior options as possible while transparently provide the information required for political decision-making.

Secondly, the “Fit for 55” package involves a high number of interlinked initiatives underpinned by individual impact assessments. Therefore, there is a need to ensure coherence between the preferred options of various impact assessments.

8.1.1 Preferred policy options

The specific analysis carried out in this impact assessment comes to the main following conclusions and would suggest the following preferred policy options for the revision of the CO_2 emission standards for heavy-duty vehicles. A summary table is shown below.

Table 18. Overview of the preferred options

Preferred options	
Scope	• Extend standards to all vehicle groups falling under the HDV CO_2 Emissions Determination Regulation, including trailers and semi-trailers. • Exempted manufacturers registering fewer than 100 vehicles per year
Targets	
Ambition of the targets	• Strengthen the CO_2 targets as of 2030. • Ranking options to be established at political level.
Timing of targets	Targets keep decreasing in 5-year steps
Revenues	Revenues remain part of the general EU budget
ZEV incentives	
Incentives for LZEV	Removed as from 2030
Incentives for urban buses	100% ZEV mandate by 2030
Incentives for unregulated vehicles	Unregulated ZEVs can be counted for compliance
Low-carbon and renewable fuels	Renewable and low-carbon fuels not included to assess compliance with the standards
Governance	
Compliance conditions	One condition for the freight sector and a different one for passengers' transport.
Transfer of vehicles for compliance	• Between connected undertakings: allowed • Between non-connected undertakings: Limited, only for ZEVs
Credits and debts mechanism	Extended after 2030

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 respectively. 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.

1) Extension of the scope

In order to contribute to the overall 2030 increased ambition level and the 2050 climate neutrality objective, the preferred option is to include within the scope of the legislation currently unregulated heavy-duty vehicles groups, and setting cost-efficient energy efficiency standards for trailers.

2) CO_2 emission targets and their timing

The preferred option is to significantly strengthen the CO_2 targets for heavy duty vehicles as of 2030. This will provide for the necessary steer to accelerate the supply to the market of zero-emission vehicles, bring benefits for vehicle users as well as stimulate innovation and technological leadership, while limiting the costs increase for manufacturers.

The choice of the level of ambition is left to the political decision-making process based on the analysis carried out in the IA that includes a comparison of the costs and benefits of the various options.

It is also preferable to maintain the regulatory approach of setting targets decreasing in 5-year steps in order to provide for sufficient flexibility for manufacturers to manage this transition.

3) Use of the revenues from excess emissions premiums (fines)

The possible revenues from excess emissions premiums would remain part of the general EU budget. The other options considered would significantly increase the administrative burden while not directly benefitting the automotive sector in its transition.

The small volume manufacturers would be granted an exemption from meeting the targets to improve the cost-efficiency and the proportionality of the legislation.

4) Incentive scheme for zero- and low-emission vehicles (ZLEV)

It is preferable to remove as of 2030 onwards the incentive scheme for zero- and low-emission vehicles (ZLEV). Such a scheme is not necessary in combination with the stricter CO_2 targets, which will drive higher shares of new ZEVs into the market. This would also simplify the legislation. It would avoid the risk of undermining its effectiveness in case of a bonus-only system. Since urban buses are especially suitable for earlier shifting to zero-emission, and such shift would provide additional benefits in terms of urban air quality, it is appropriate to set out a 100% mandate for zero-emission urban buses by 2030. To contribute to reaching the climate neutrality objective, it is also appropriate to introduce a mechanism to kick off the market deployment of ZEV in all HDV groups, including those ones not in the scope of the legislation and to be further considered in the future review of the legislation.

5) Mechanism for renewable and low-carbon fuels accounting

The preferred option is not to include an accounting mechanism for renewable and low-carbon fuels to assess manufacturers compliance with the CO_2 emission standards. Such a mechanism would undermine the effectiveness and efficiency of the legislation while increasing the administrative burden and complexity. In addition, it will lower the availability of such fuels for other sectors which have fewer options to decarbonise, such as aviation. Promoting the use of renewable and low-carbon fuels will be done through the revision of the fuels related legislation (such as RED II, emissions trading for buildings and road transport).

6) Governance

It is preferable to set out two separate conditions for compliance with the fleet targets: one condition applying to the freight sector, i.e. lorries and trailers, and the other one to passengers transport, i.e. buses and coaches.

The option setting out a compliance mechanism based on the possibility to transfer vehicles between connected undertakings, is preferred. Additionally, and in order to support the development and production of ZEVs in start-up companies, a limited transfer of ZEVs also between non-connected undertakings will be allowed.

It is preferred to continue the current credit and debts mechanism after 2030.

Overall, the above elements would strengthen the CO_2 emission standards for heavy-duty vehicles and help ensure that road transport makes the necessary contribution towards the more ambitious GHG target of at least -55% by 2030 as defined in the Climate Law. At the same time, it would be complementary to and fully consistent with the other legislative initiatives that contribute to the same objective, in particular the revision of the ESR, the strengthening of ETS and emissions trading for buildings and road transport, the revision of the RED II, the EED and AFIR.

1.23. 8.2 REFIT (simplification and improved efficiency)

Compared to the current Regulation, the abovementioned preferred policy options are not expected to increase the administrative costs caused by the legislation. In addition, they are not increasing the complexity of the legal framework, since the architecture of the legislation would remain the same, in spite of a possible expanded scope.

No changes in the monitoring regime are foreseen. In fact, in spite of a possible expansion of the scope, the current provisions on monitoring and reporting already apply to the currently un-regulated vehicles. The preferred options will therefore neither increase administrative costs for manufacturers and competent national authorities nor enforcement costs for the Commission.

The initiative will propose the merging of the existing HDV CO_2 Standards Regulation 2019/1242 with the HDV monitoring & reporting Regulation 2018/956 and therefore reduce the number of legislative acts.

9. HOW WOULD IMPACTS BE MONITORED AND EVALUATED?

The actual impacts of the legislation will continue to be monitored and evaluated against a set of indicators tailored to the specific policy objectives to be achieved. A mid-term review of the legislation would allow the Commission to assess the effectiveness of the legislation and, where appropriate, propose changes.

A well-established system build upon EU type-approval is already in place for monitoring the impacts of the legislation. The CO_2 emissions and fuel consumption of regulated vehicles are determined while the Monitoring and Reporting Regulation ensures that Member States report data annually to the Commission for all newly registered regulated lorries. The European Environment Agency (EEA) combines the registration data from national authorities with the monitoring data from manufacturers. The Commission publishes every year the final monitoring data of the preceding calendar year including the manufacturer specific performance against the CO_2 targets for each certified new vehicle registered in the EU. The legislation will continue to rely on this well-established and reliable framework.

Furthermore, the monitoring process, based on VECTO-based data, is reinforced with other two additional features to keep ensuring ensure the effectiveness of the initiative:

- Collection, publication, and monitoring of real-world fuel consumption data reported by manufacturers based on mandatory standardised devices.
- In-service conformity tests and obligation to report deviations from type approval values, which could be tackled by a correction mechanism.

1.24. 9.1 Indicators

For the specific policy objectives, each one linked to the problems described in chapter 2, the following monitoring indicators have been identified:

1. To **reduce CO_2 emissions from heavy-duty vehicles** cost-effectively, in line with the EU climate goals while contributing to improve EU energy security

- The EU-wide fleet average CO_2 emissions measured at type approval measured at type approval will be monitored annually on the basis of the monitoring data against the target level set in the legislation;
- Total HDV GHG emissions will be monitored through Member States' annual GHG emissions inventories;
- The costs and effectiveness of fuel-efficient technologies used in the vehicles to reduce emissions and reduced fuel consumption will be monitored on the basis of data to be collected from manufacturers, suppliers and experts.

2. To provide benefits for European **transport operators and users** resulting from a wider deployment of more energy-efficient vehicles.
    - The number and share of newly registered zero-emission vehicles will be monitored through the annual monitoring data submitted by Member States;
    - Developments in total and fossil energy consumption for HDV operators, including through the collection of real-world fuel and energy consumption data

3. To strengthen the **technological and innovation leadership** of the industry in the EU by channelling investments into zero-emission technologies
    - The level of innovation will be measured in terms of new patents by European automotive manufacturers related to zero-emission technologies through publicly available patents databases.
    - The level of employment will be monitored on the basis of publicly available Eurostat statistics on sectoral employment data for the EU.

The methodology for an evaluation of the legislation will put particular emphasis in ensuring that causality between the observed outcomes, based on the above indicators, and the legislation can be established. In this context, methodological elements will include the establishment of a robust baseline/counterfactual scenario and the use of regression analysis/empirical research.

1.25. **9.2** **Operational objectives**

Based on the policy options, the following operational objectives have been identified:

Operational objectives	Indicators
Reach a specific CO_2 emissions target level by the target year(s)	Compliance of manufacturers with their specific emissions target in the target year(s)
Achieve a certain level of deployment of zero-emission vehicles in a specific year	Share of zero-emission vehicles in that year
Increase technological innovation	Number of new patents registered by European manufacturers related to fuel-efficient technologies and zero-emission vehicles

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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.

RSB opinion: "what to improve"	**Response**
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.

<u>Main RSB findings</u>	**<u>Response</u>**
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.

<u>RSB opinion: "what to improve"</u>	**<u>Response</u>**
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.

<u>OBJECTIVES</u>

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

[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.

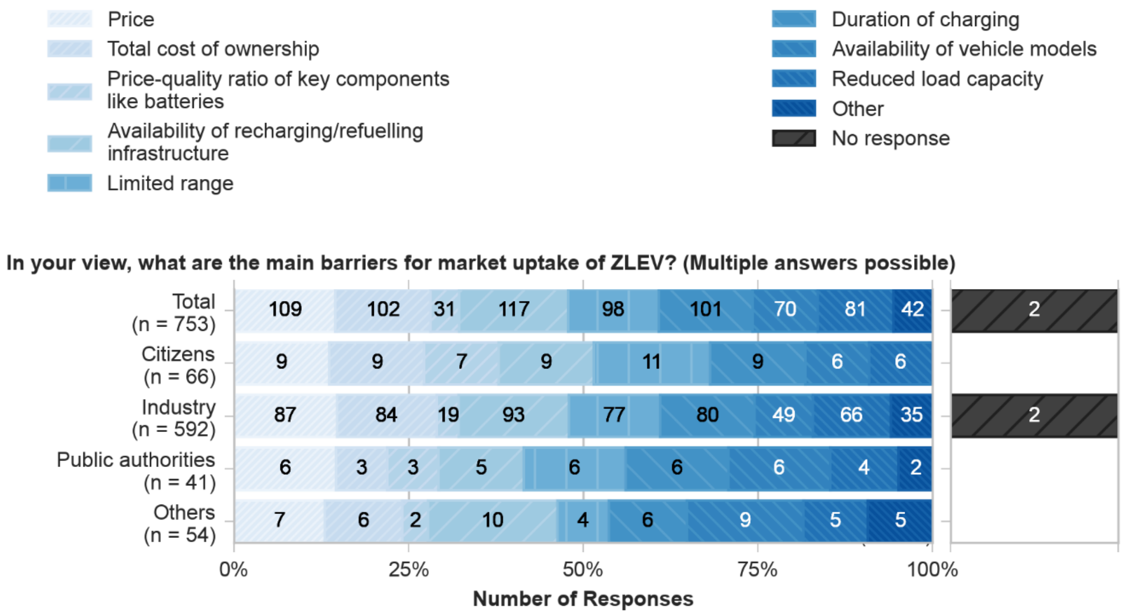
The main relevant themes in the responses from *citizens* were that low carbon fuels also have a role to play, and that financial support was needed for operators and public authorities to support their transition to low and zero emission mobility. The responses from *public authorities* suggested that: 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

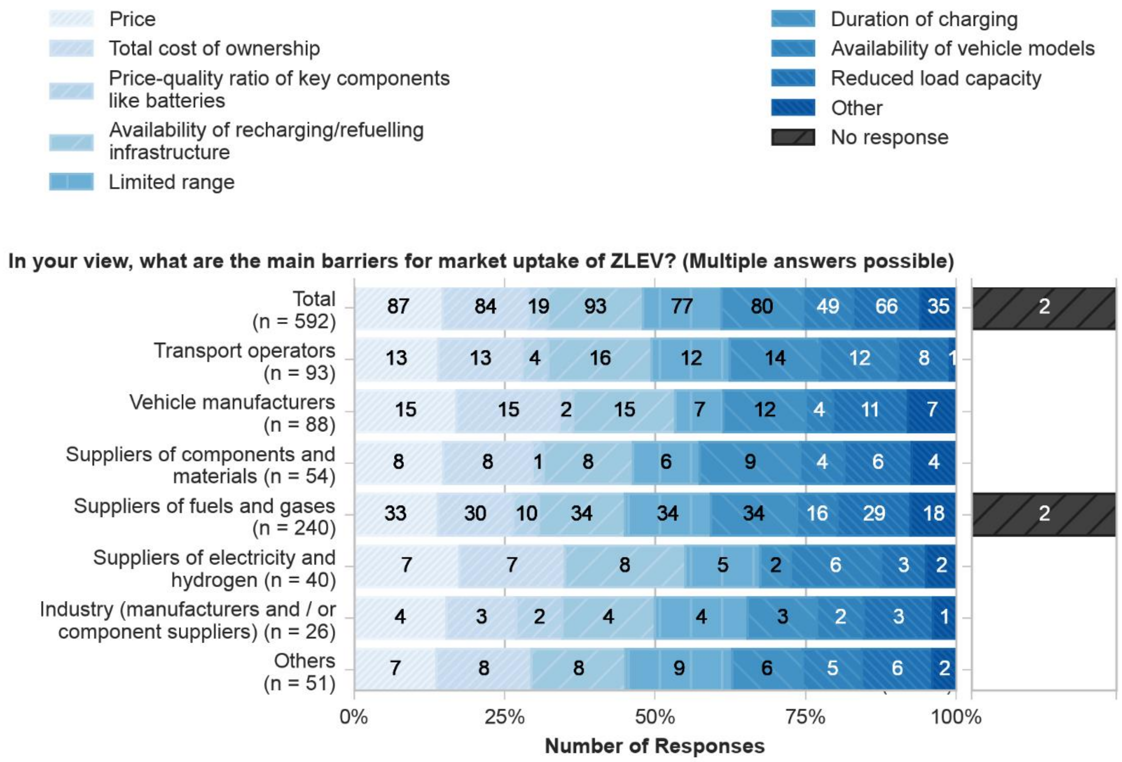


Of the options provided, four were identified as a main barrier by more than three quarters of respondents, which were ***availability of recharging/refuelling infrastructure*** (87%; 117 responses; two 'no responses'), ***price*** (81%; 109 responses), ***TCO*** (76%; 102 responses) and ***duration 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')

[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.

	Benefits 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	Investment and R&D 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 Benefits 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	Adjustment costs 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. Investment needs in new infrastructure 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. Benefits

	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	Benefits from reduced oil prices 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

<table>
<tr><th colspan="3">I. Overview of Benefits (total for all provisions) –</th></tr>
<tr><th>Description</th><th>Amount</th><th>Comments</th></tr>
<tr><td colspan="3">Direct benefits</td></tr>
<tr><td>Reducing CO_2 emissions from HDV cost-effectively, in line with the EU climate goals while contributing to improve EU energy security.</td><td>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.</td><td>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.</td></tr>
<tr><td>Benefits for European transport operators and users from a wider deployment of more energy-efficient vehicles: improvements in</td><td>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</td><td>The deployment of energy-efficient vehicles, including zero-emission</td></tr>
</table>

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	Manufacturing costs per motor vehicles 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. Manufacturing costs per trailer 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.

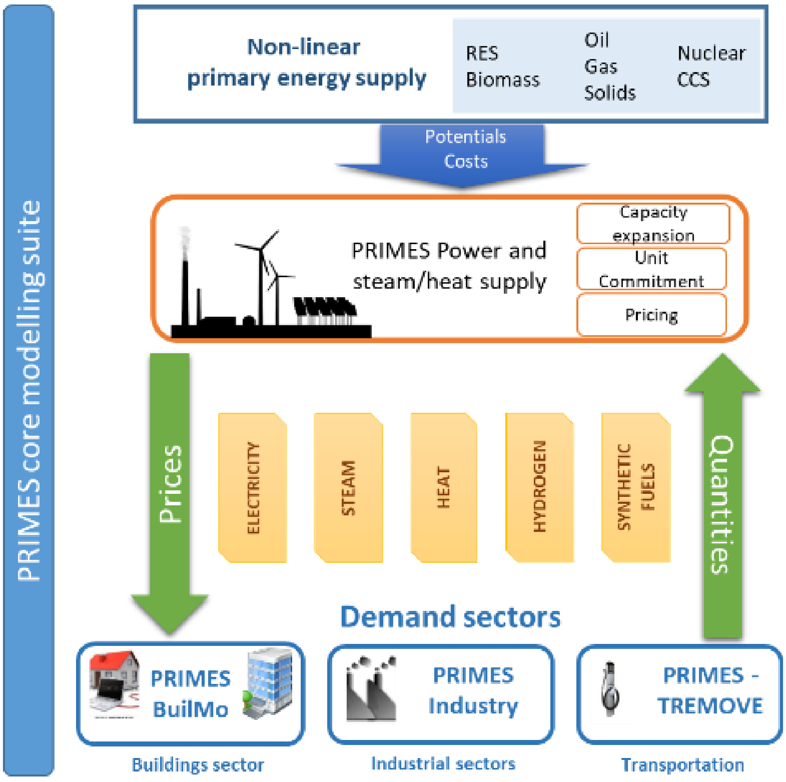
PRIMES offer the possibility of handling market distortions, barriers to rational decisions, behaviours and market coordination issues and it has full accounting of costs (CAPEX and OPEX) and investment on infrastructure needs.

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

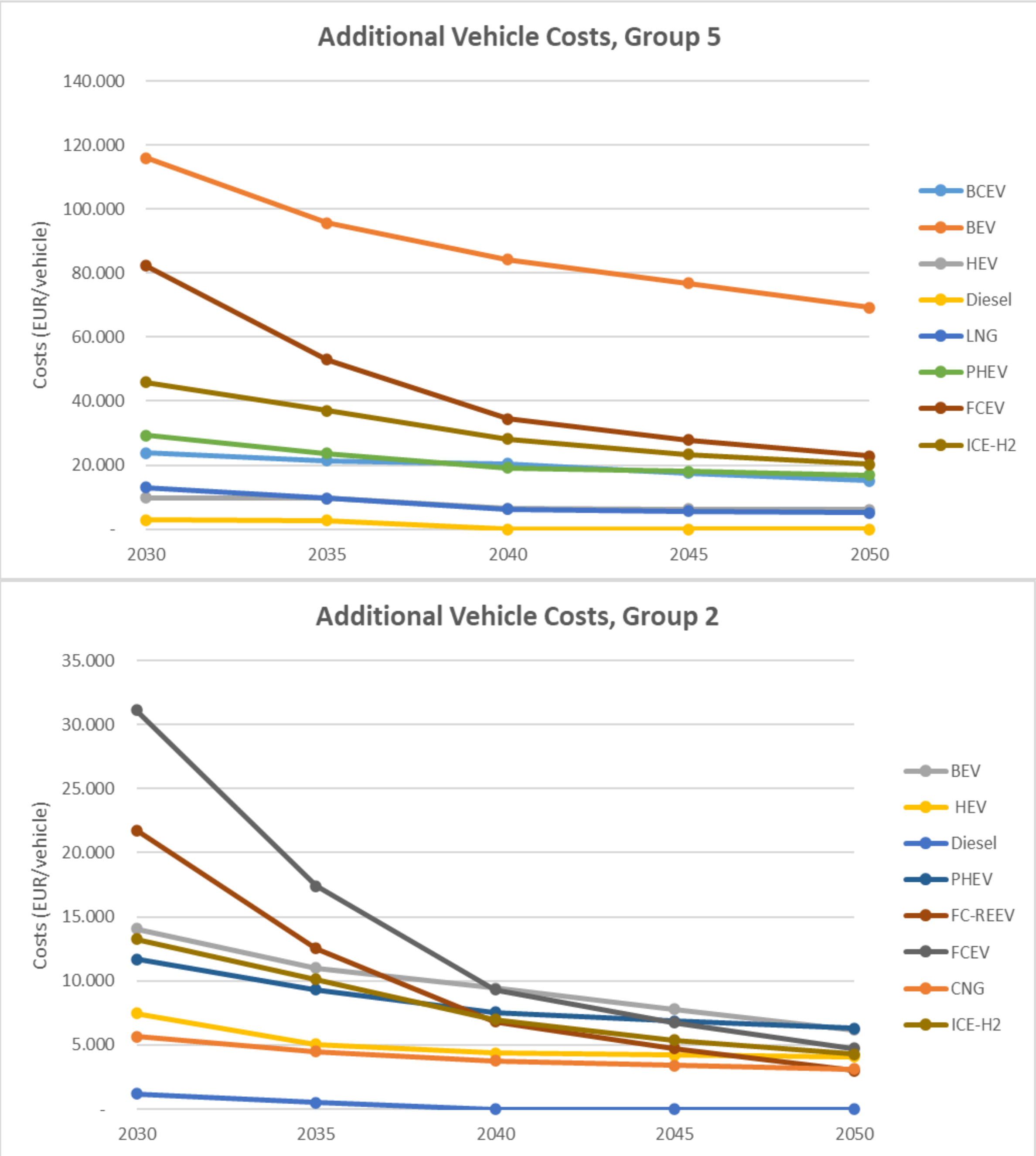
13.1.5 Assumptions

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

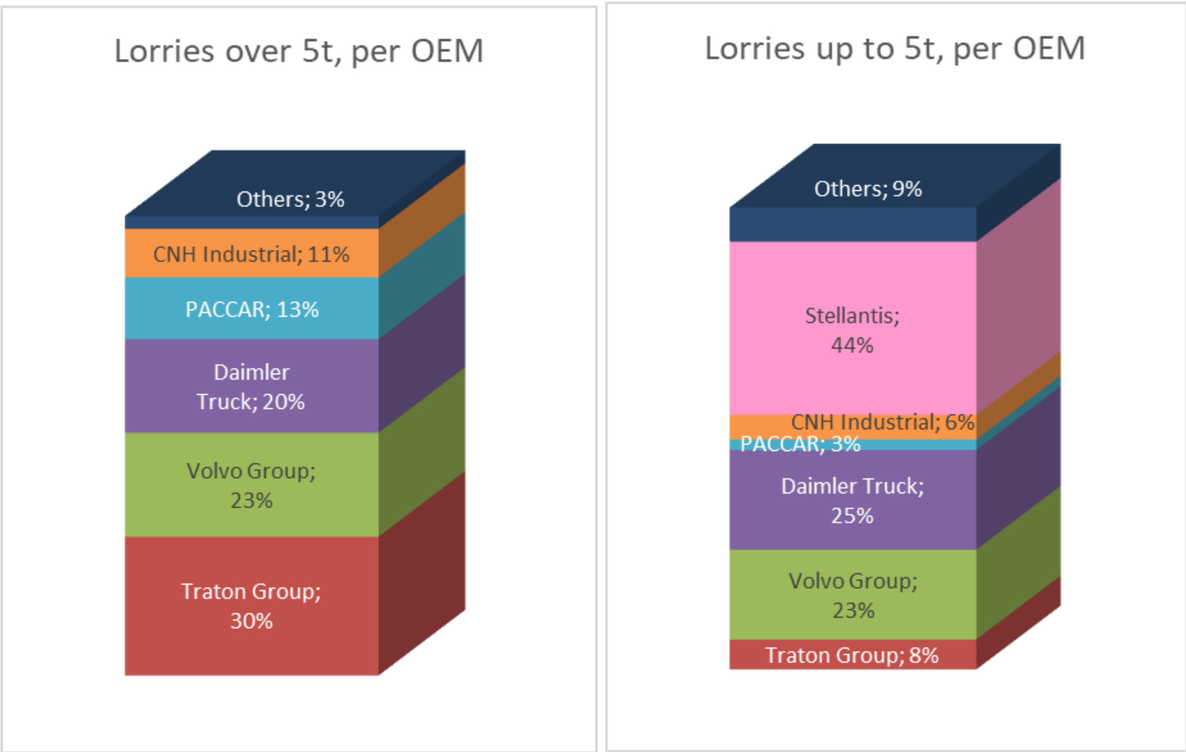
The market distribution of the different heavy-duty vehicles segments varies in nature across the several types, sizes, and powertrains of vehicles.[59]

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



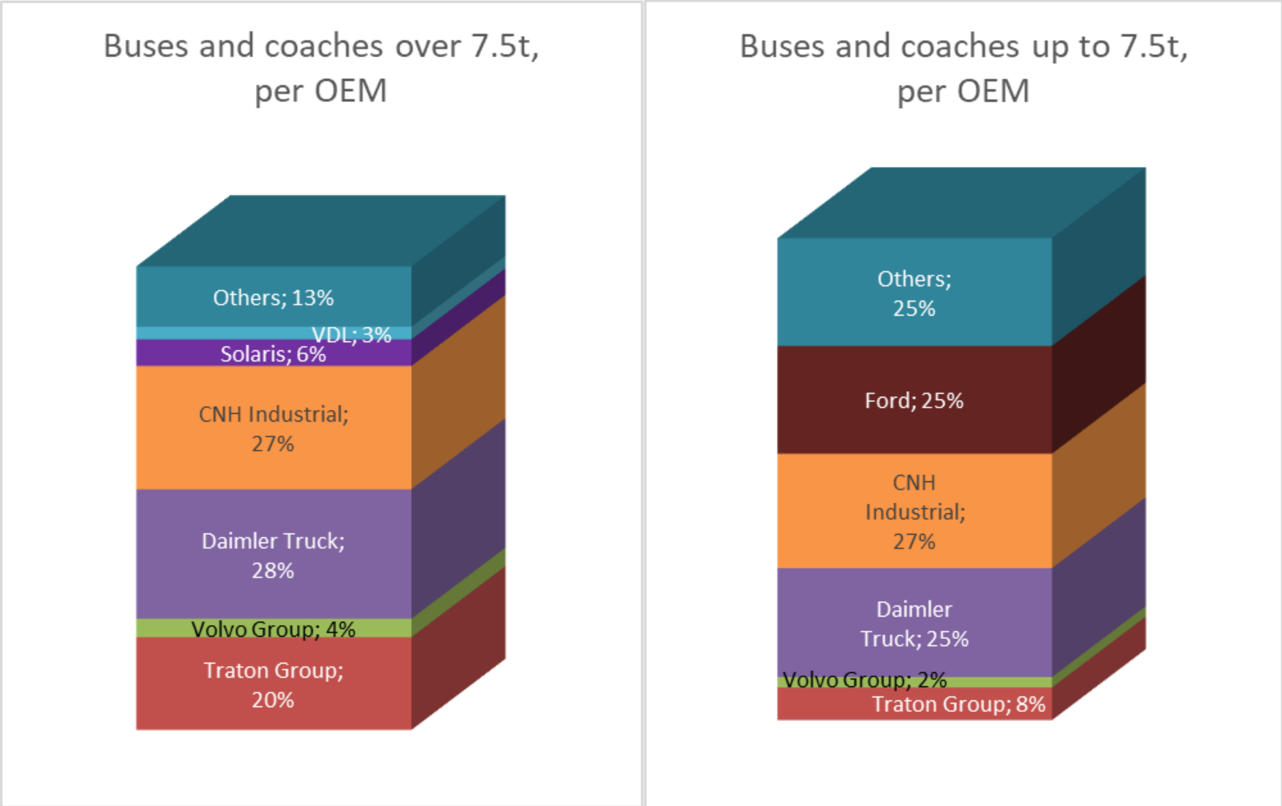
Main lorries' manufacturers registering vehicles in the EU and common trademarks are:

- 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



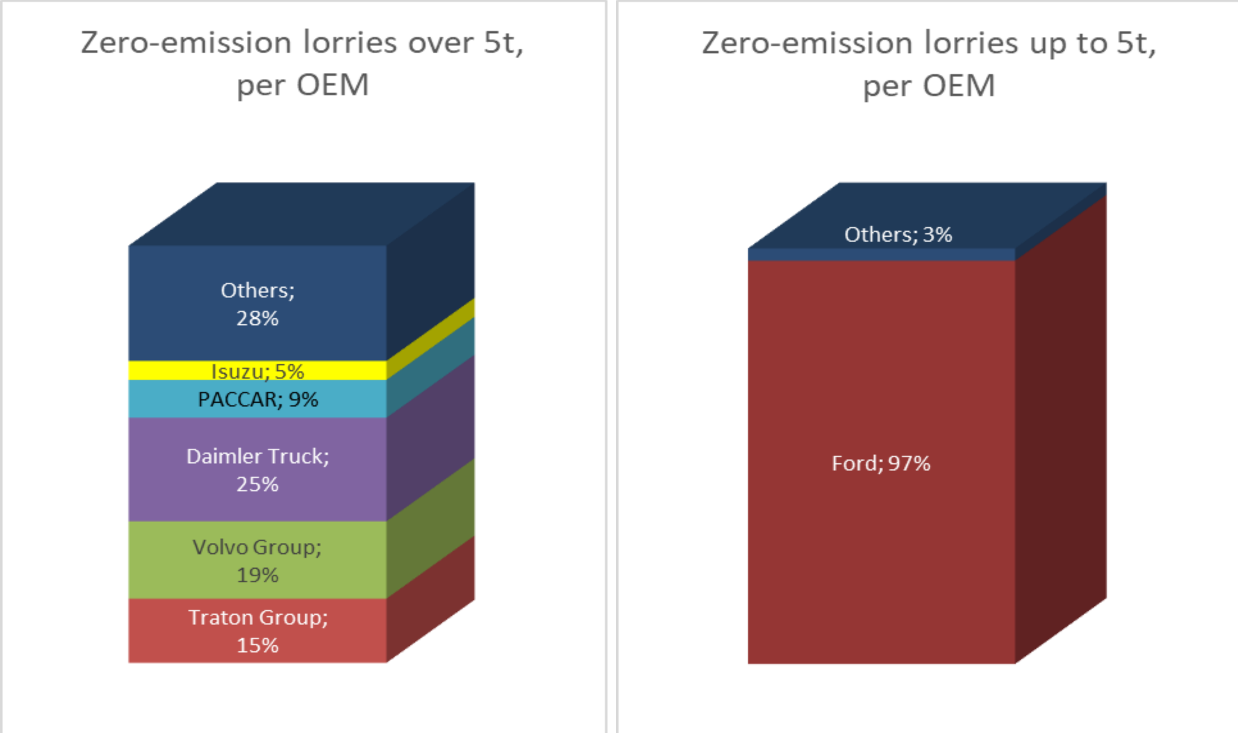
16.1.3 *Zero-emission heavy-duty vehicles market*

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]

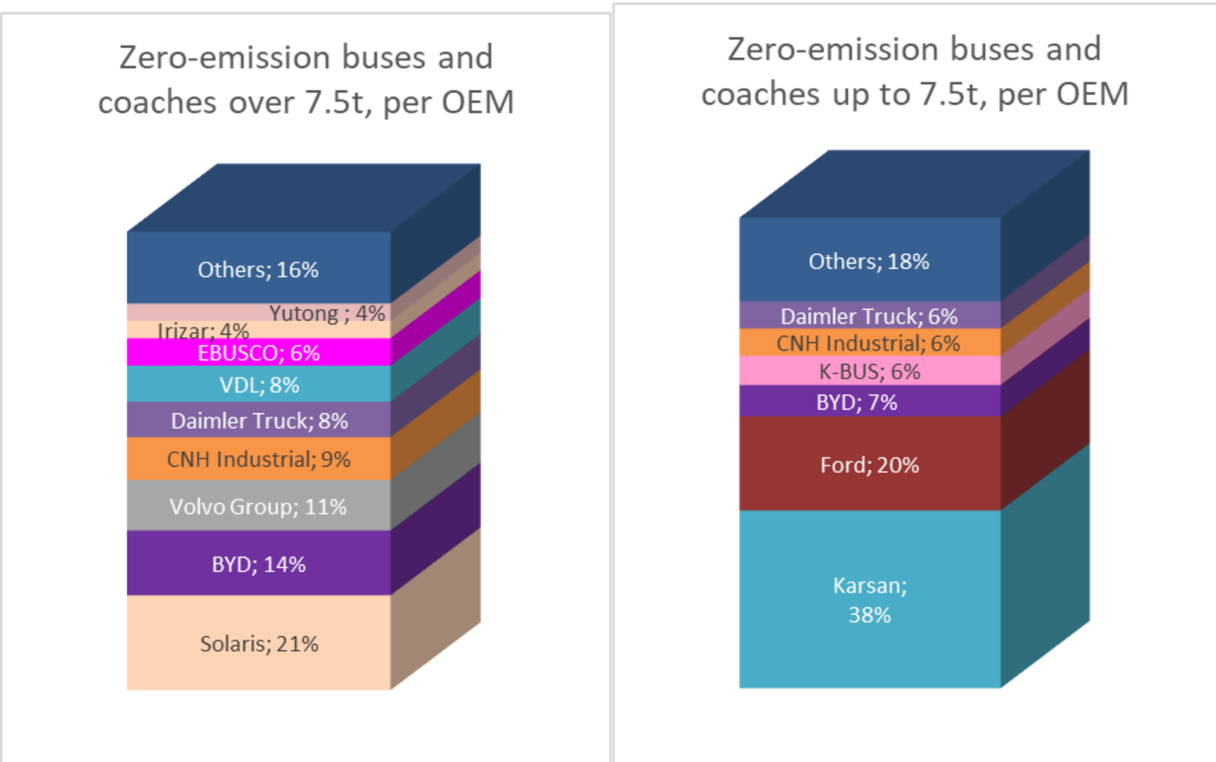
[60] https://www.dw.com/en/ford-deutsche-post-kick-off-streetscooter-xl-production/a-45810020

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

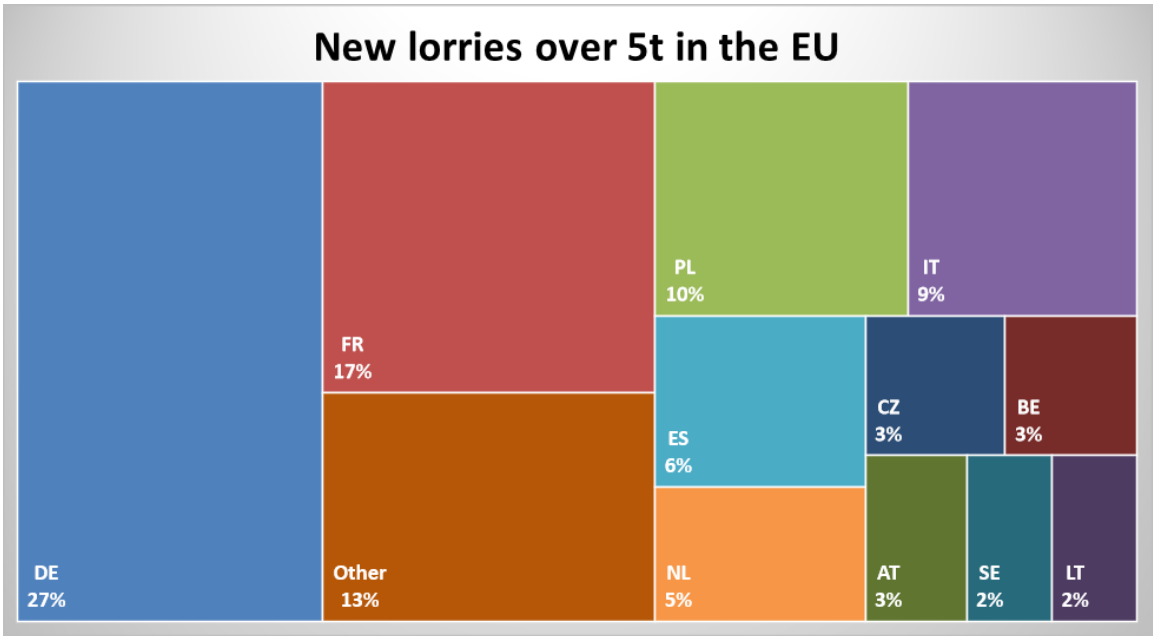


Figure 10. New lorries (over 3.5t) - registration percentage per Member State along 2020 and first half of 2021

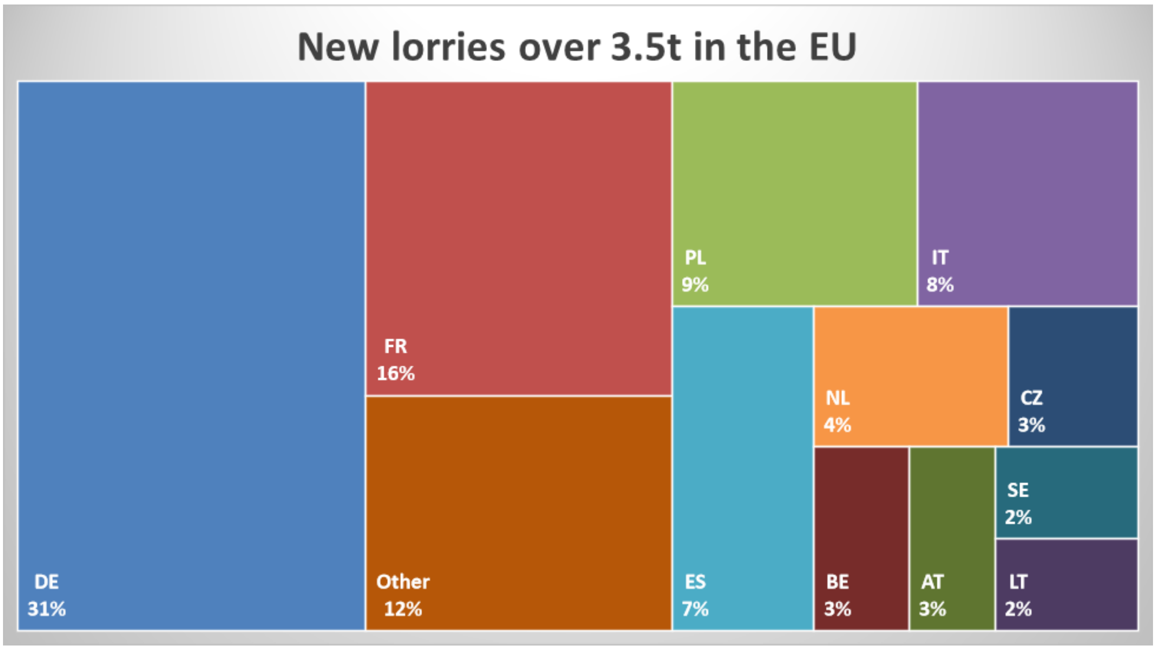


Figure 11. New buses and coaches over 7.5t - registration percentage per Member State along 2020 and first half of 2021

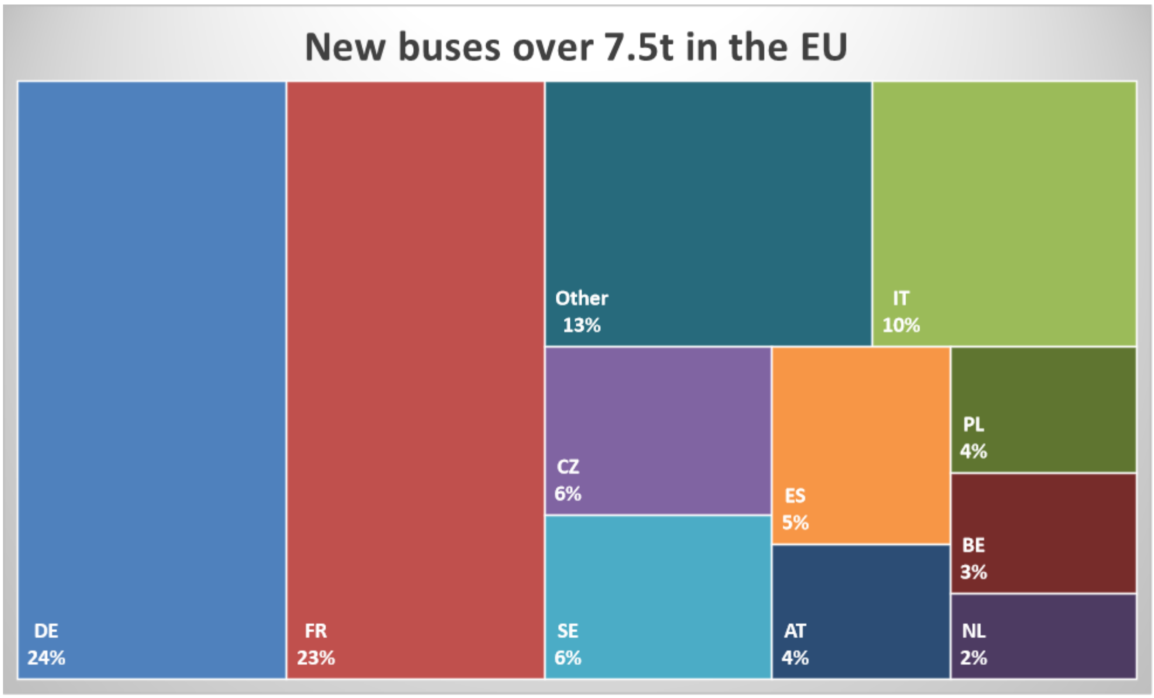
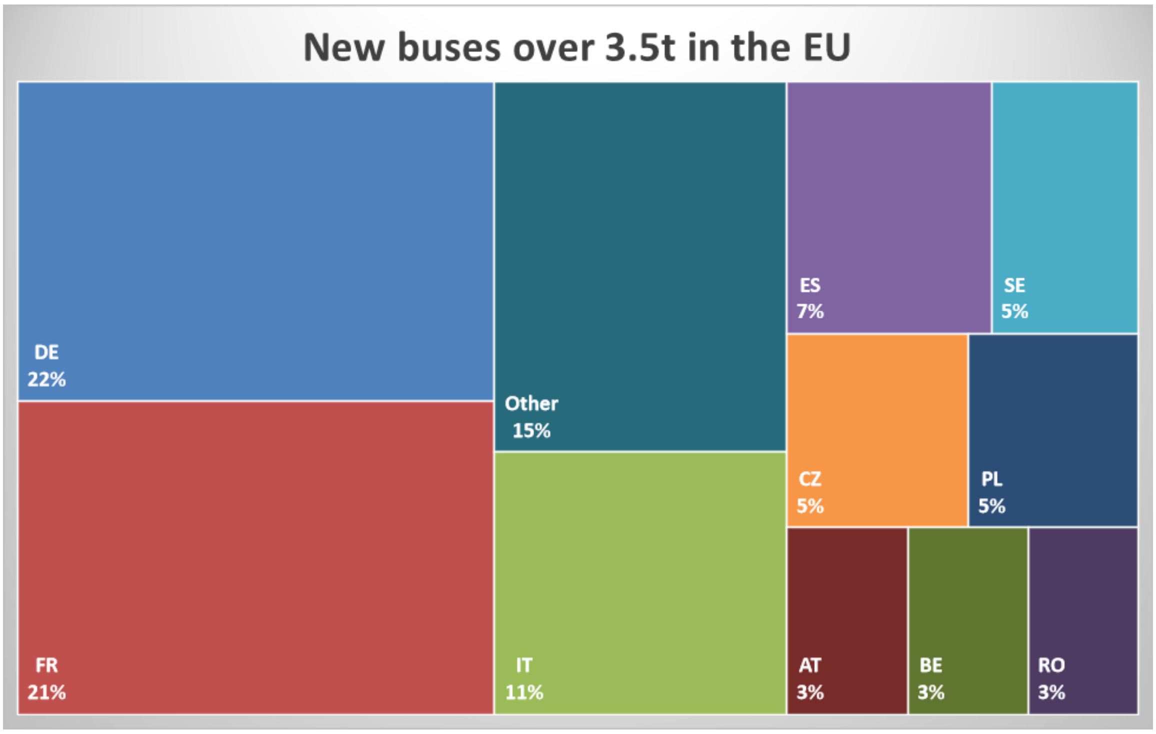


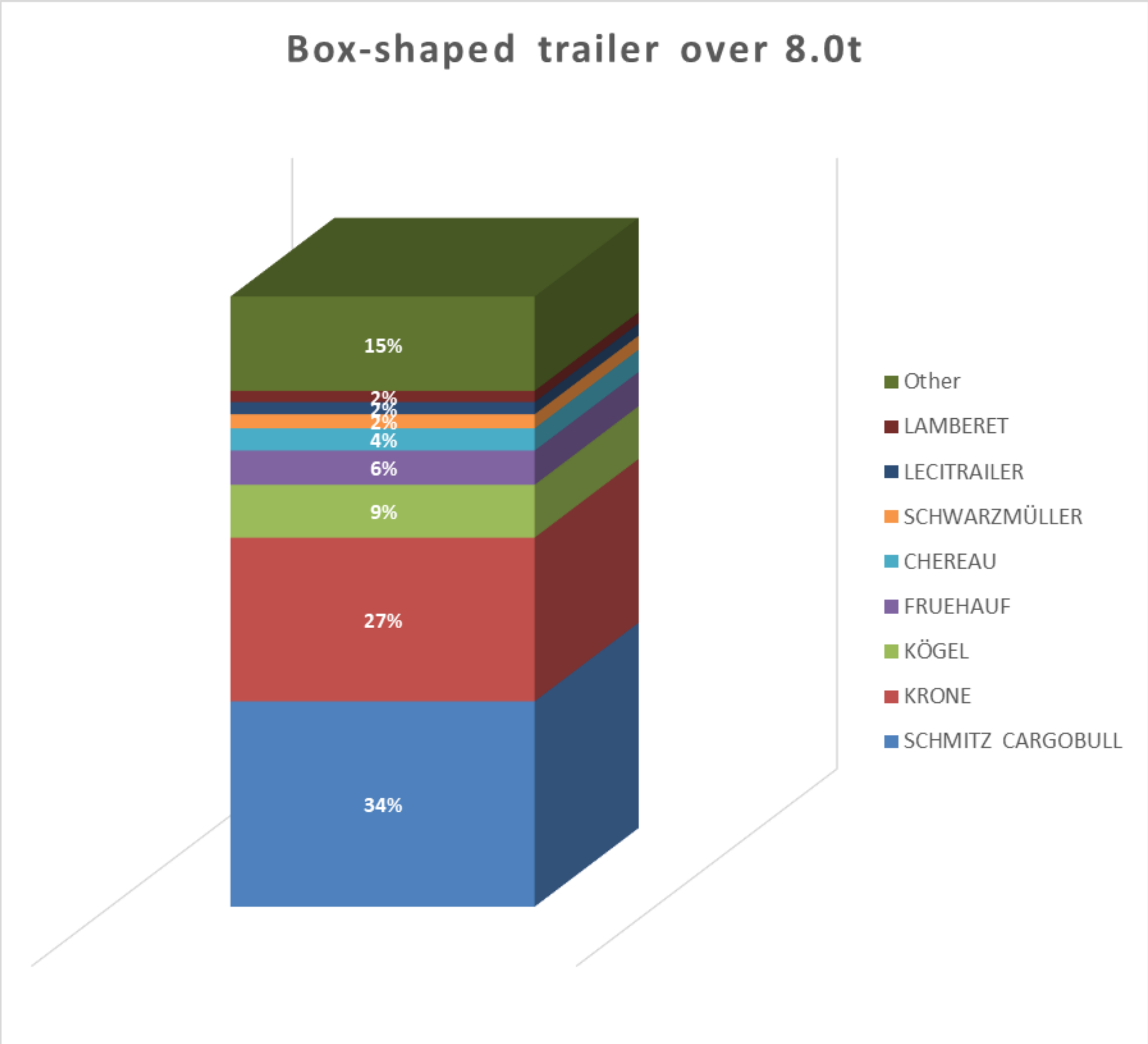
Figure 12. New buses and coaches (over 3.5t) - registration percentage per Member State along 2020 and first half of 2021



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.

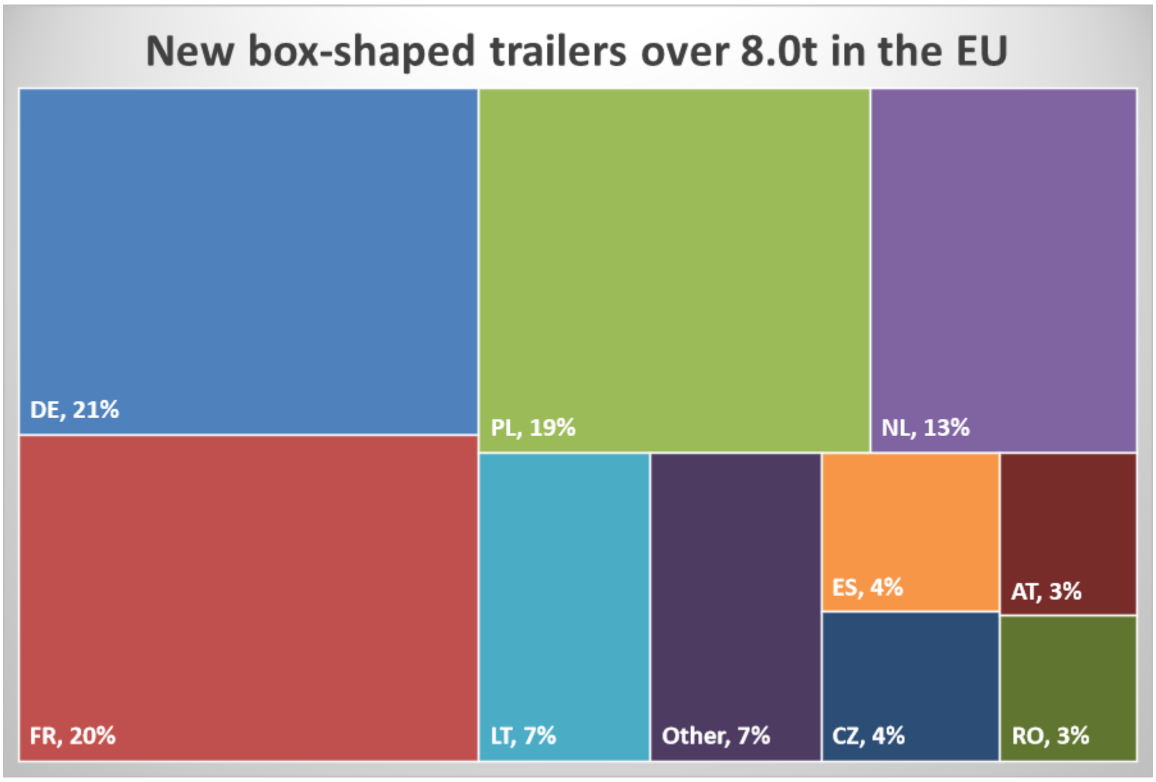
Figure 13. EU Market share per manufacturer (OEM) - newly registered box-shaped trailers along 2020 and first half of 2021.



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

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[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.

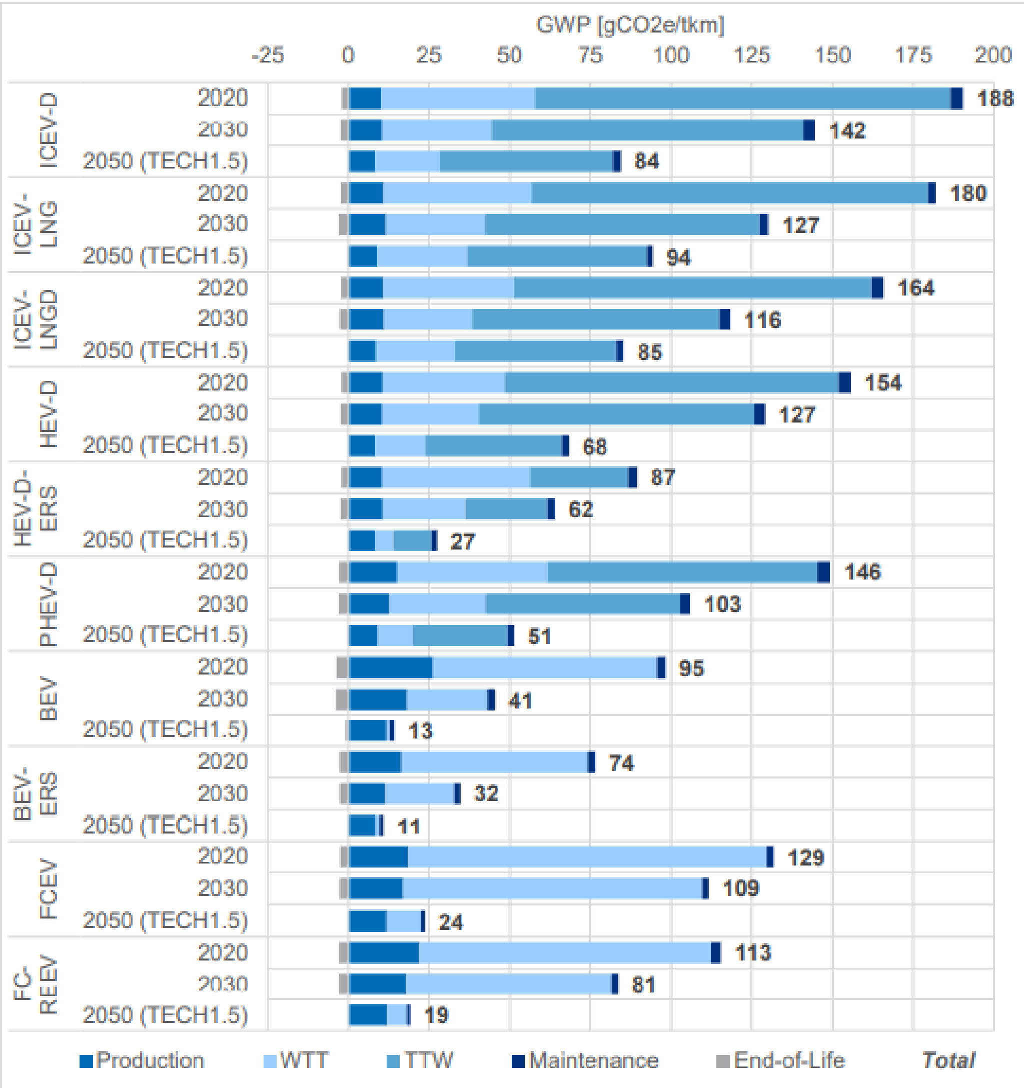
[86] Find all documents and datasets at DG CLIMA website: https://ec.europa.eu/clima/policies/transport/vehicles_en#tab-0-1

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)



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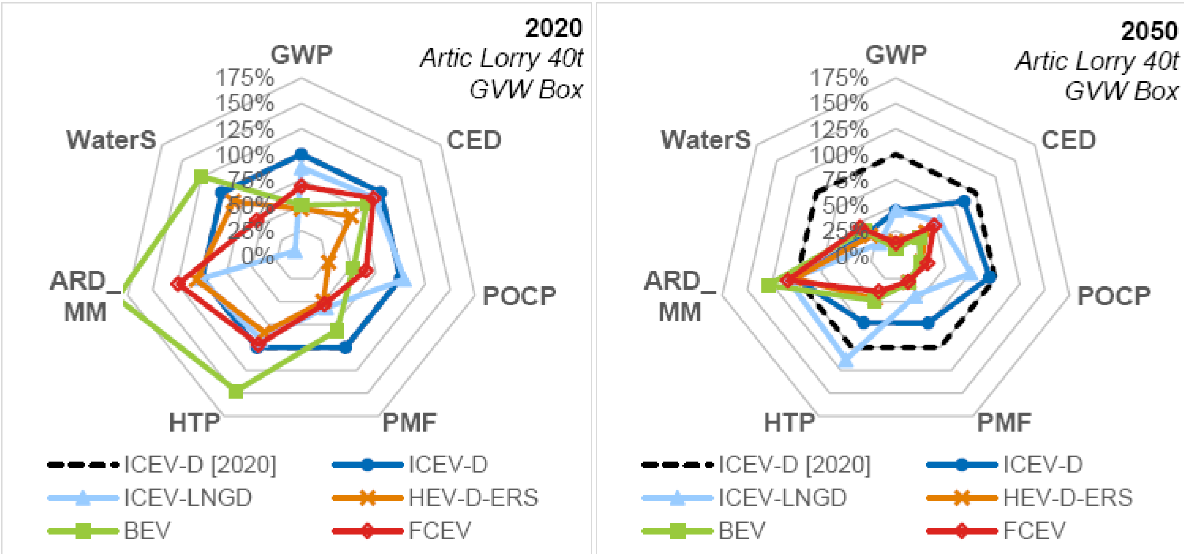
[87] The power sector is fully decarbonised in the "Policy scenarios for delivering the European Green Deal".

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]

[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.

[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

<table>
<tr><th>Vehicle category</th><th colspan="2">Attributed CO_2 emissions weight over HDV total (%)</th><th>Vehicle type</th></tr>
<tr><td>1 and 1s</td><td>0.29</td><td rowspan="7">13.94</td><td rowspan="7">Heavy lorry</td></tr>
<tr><td>2</td><td>1.51</td></tr>
<tr><td>3</td><td>2.63</td></tr>
<tr><td>11</td><td>3.07</td></tr>
<tr><td>12</td><td>0.83</td></tr>
<tr><td>16</td><td>5.21</td></tr>
<tr><td>Vocational vehicles</td><td>0.40</td></tr>
<tr><td>53</td><td>1.24</td><td rowspan="2">1.83</td><td rowspan="2">Medium lorry</td></tr>
<tr><td>54</td><td>0.59</td></tr>
<tr><td>P31</td><td>3.44</td><td rowspan="3">4.80</td><td rowspan="3">Heavy bus (low floor)</td></tr>
<tr><td>P33</td><td>0.37</td></tr>
<tr><td>P35</td><td>0.99</td></tr>
<tr><td>P32</td><td>3.04</td><td rowspan="2">4.14</td><td rowspan="2">Heavy bus (high floor)</td></tr>
<tr><td>P34</td><td>1.10</td></tr>
<tr><td>P37 and P39*</td><td>0.19</td><td rowspan="2">0.19</td><td>Heavy bus (low floor)</td></tr>
<tr><td>P36, P38 and P40*</td><td>0</td><td>Heavy bus (high floor)</td></tr>
<tr><td>TOTAL EMISSIONS SCOPE 1</td><td colspan="2">24.90%</td><td></td></tr>
</table>

** 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

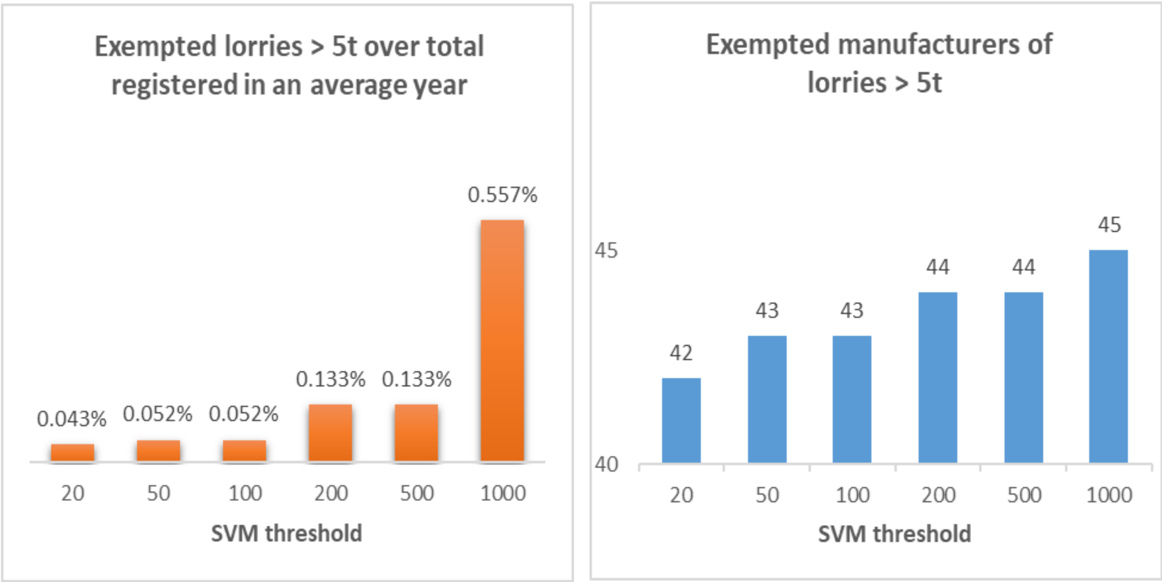
	Main OEM and subsidiaries	Special purpose manufacturers	Smaller manufacturers*
Registered vehicles on a normalized year	Over 250,000	Around 850	Less than 150
Identified manufacturers	11	13	**43**
Average yearly normalised production	ca. 23,000	Ca. 65	~ 3

* < 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

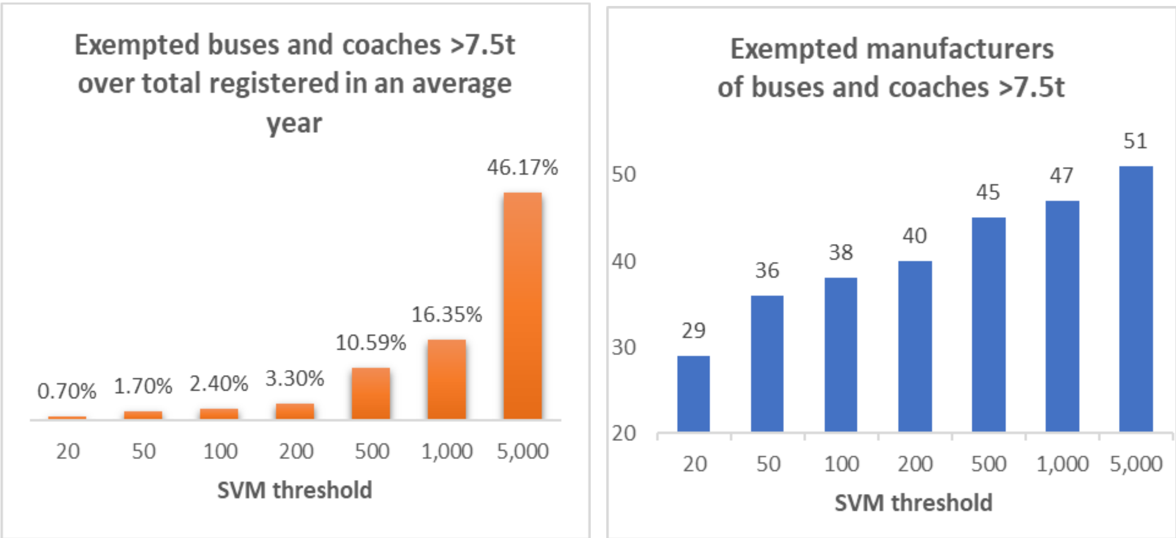
[95] Lorries with TPMLM over 5t from regulated groups 4, 5, 9, 10 and from currently unregulated groups 1, 2, 3, 6 and 11, 12, 16.

[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)

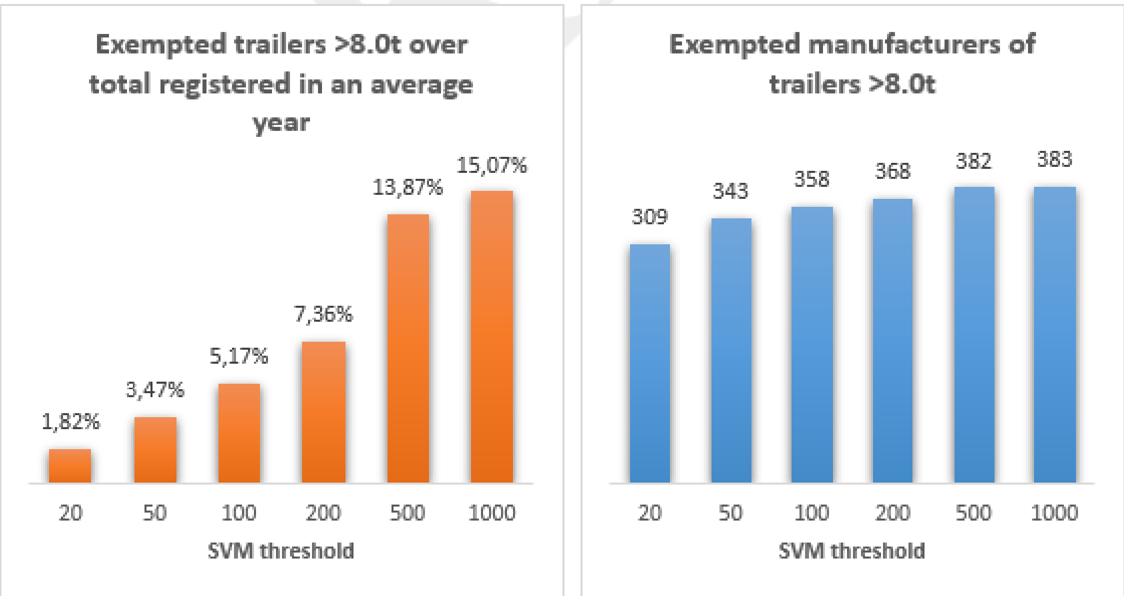
The analysis of the heavy trailer sector is limited to trailers above 8.0t with a box-shaped bodywork, which correspond to the scope of trailers to be included in option SCOPE 2. In a given year, a total of almost 65,000 heavy trailers were registered in the 19[98] EU Member States from which registration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

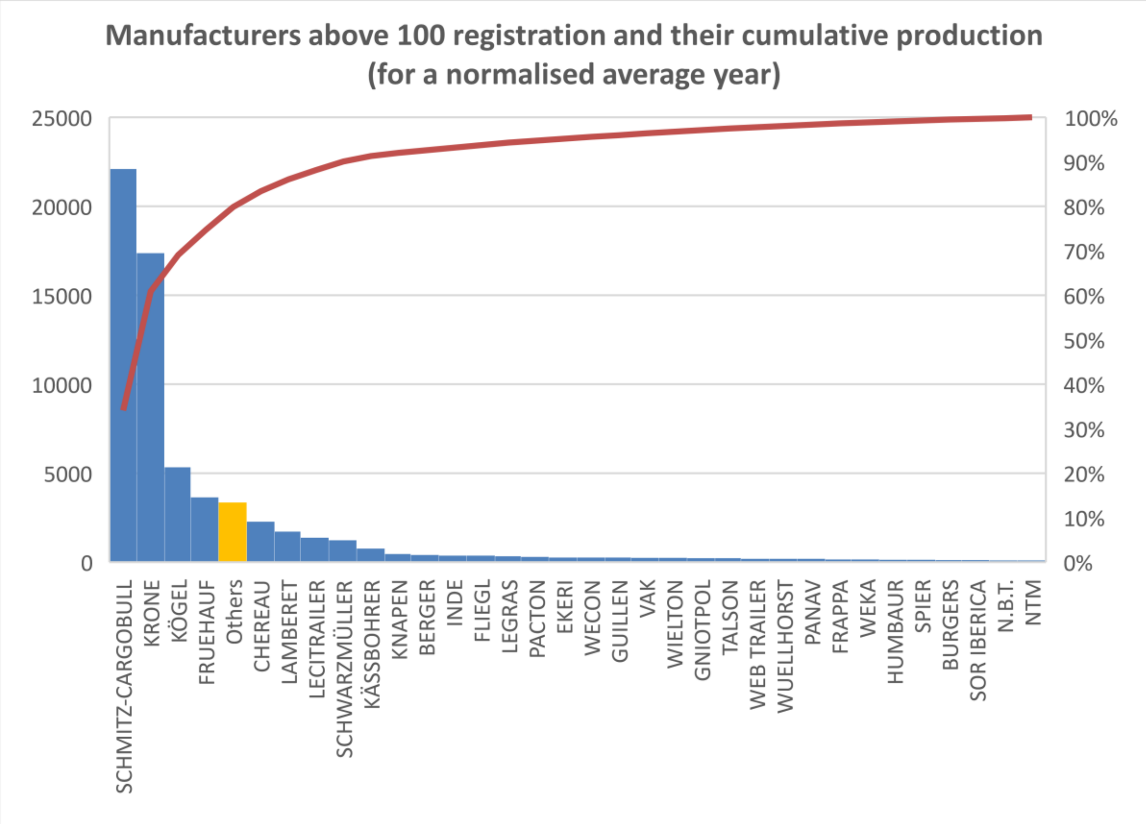
Figure 19. Exempted trailers and corresponding manufacturers across different threshold values.



[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)

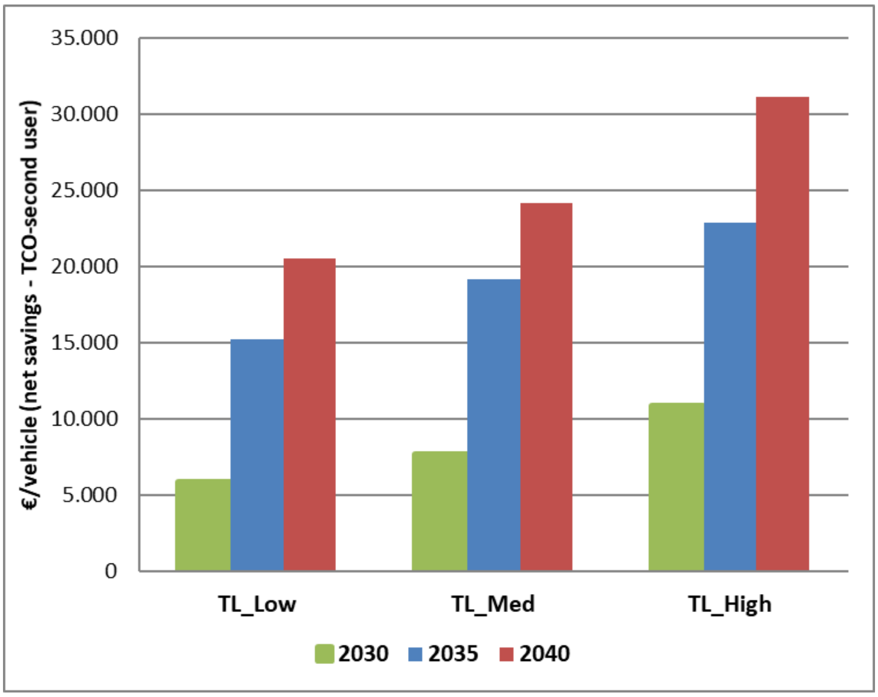
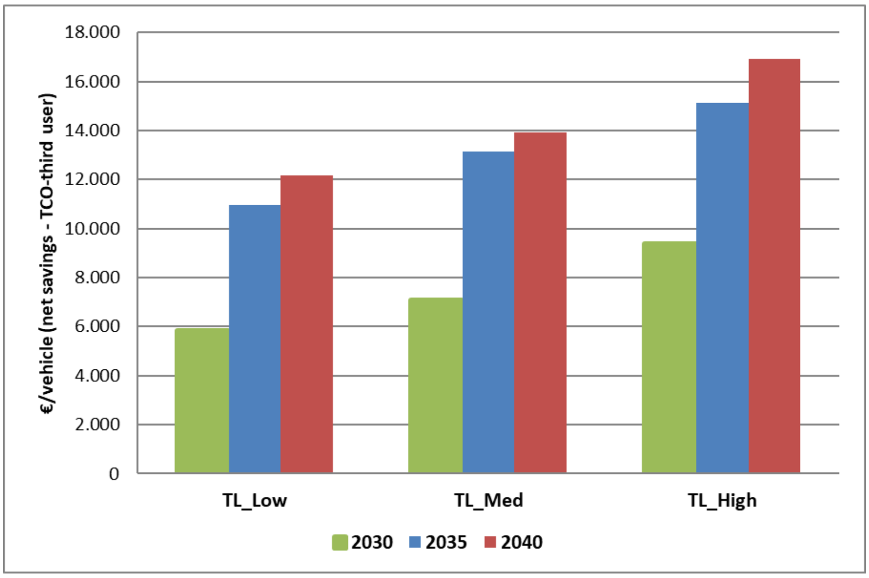


Figure 22. Average net economic savings from a TCO-third use perspective (EUR/vehicle)



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.

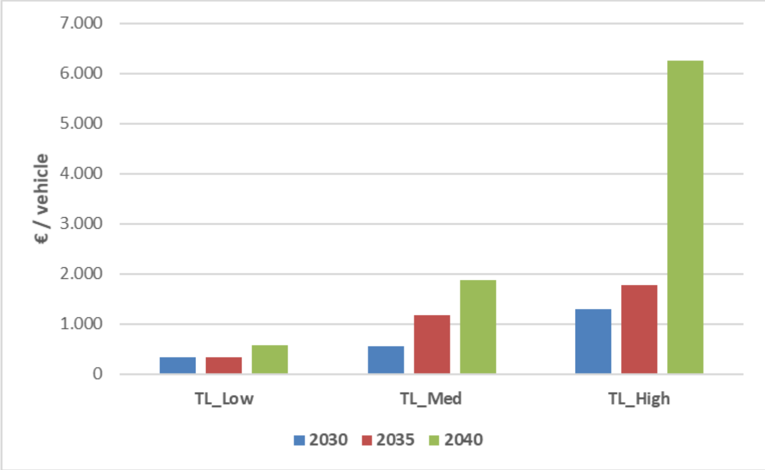
One should also be aware that the figures for 2040 have to be considered with some care as the Eurovignette provisions are likely to be amended at the background of a high uptake of ZEV. The savings from road charges for new HDVs after 2040 will gradually shrink and converge to 0 when ZEV shares in the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

[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.

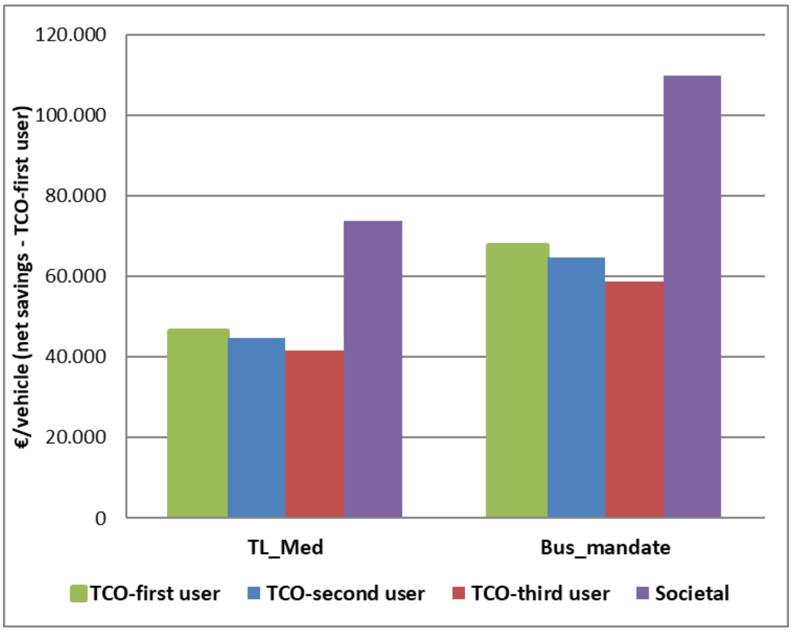
Figure 23. Vehicle lifetime discounted average road charge savings compared to the baseline (EUR/vehicle).



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

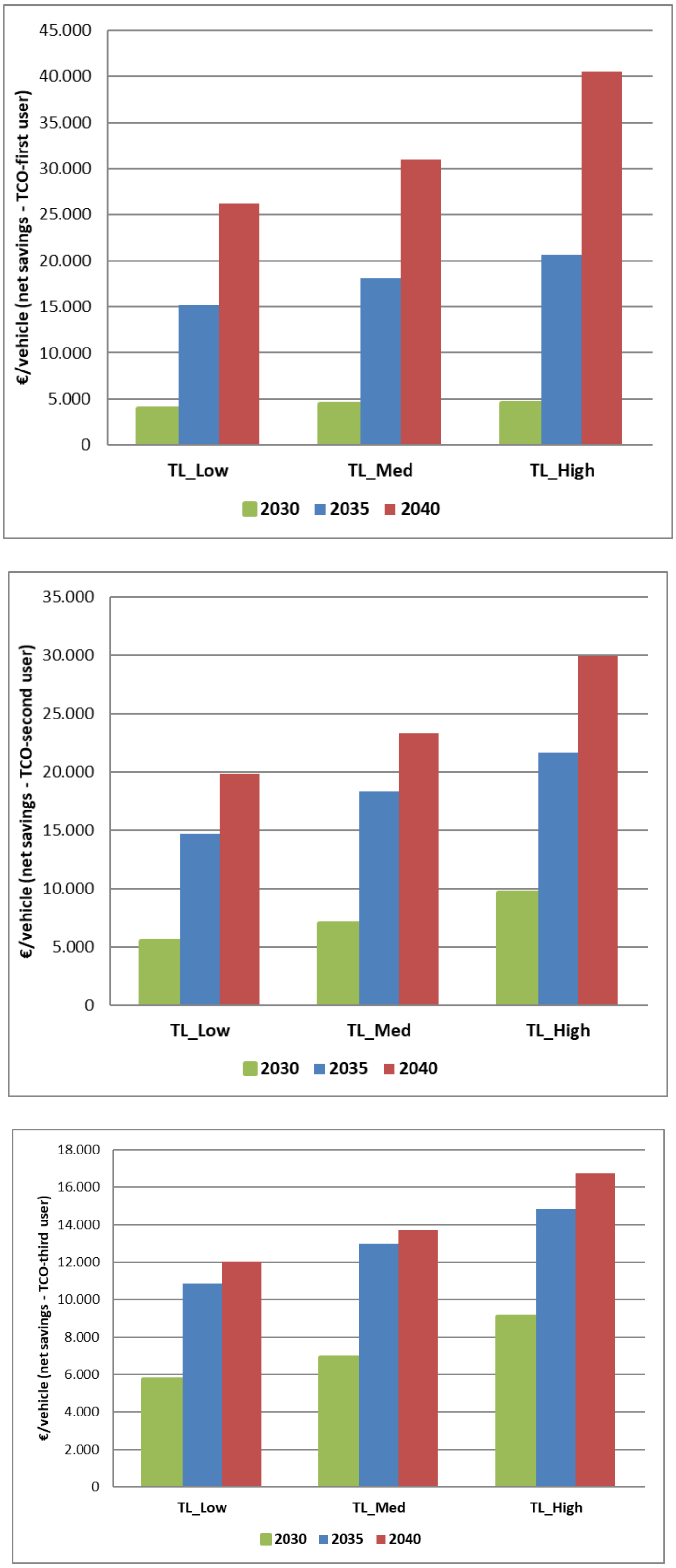
The net economic savings from different perspectives have also been subject to two sensitivity analyses.

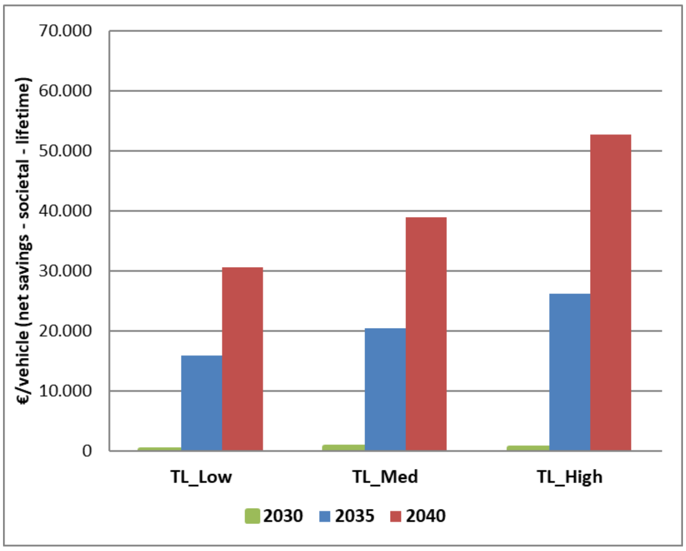
The first captures the uncertainty related to the projected evolution of zero-emission technologies (and PHEV) in case their costs decrease at a lower rate than assumed[101] and

[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.

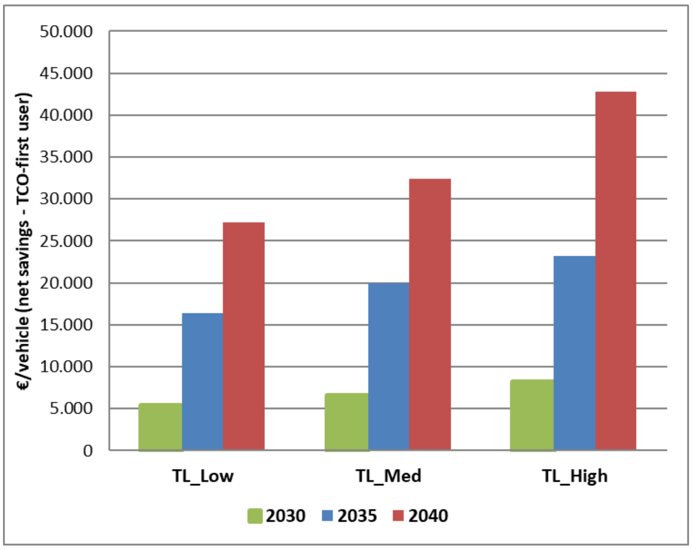
Figure 25. Average net savings over the vehicle lifetime from different perspectives for a new average heavy-duty vehicle registered in 2030, 2035 or 2040, assuming higher ZEV costs.

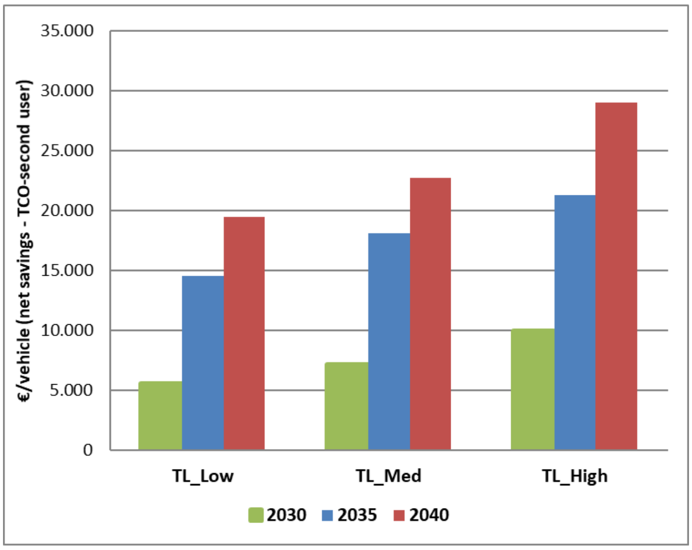


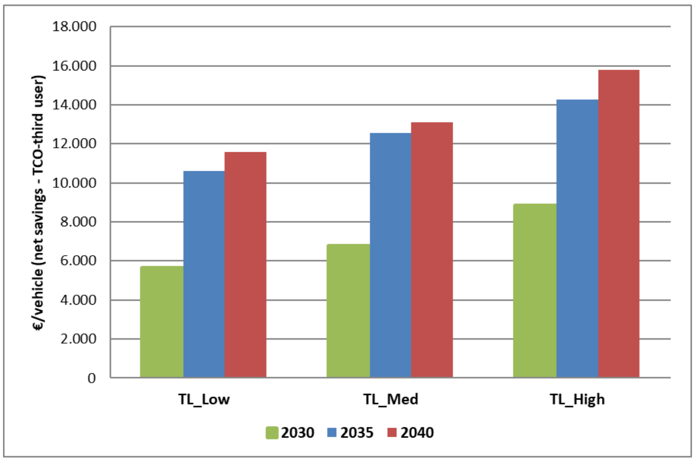


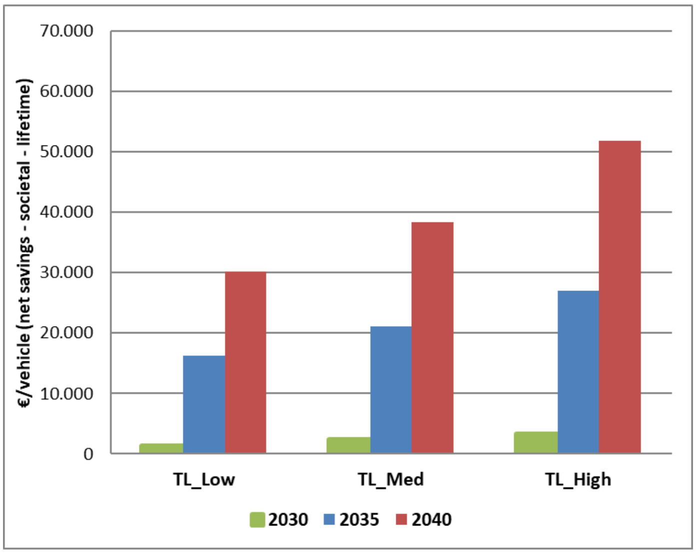
The second assumes electricity and hydrogen prices which are 10% higher than those presented in Section 13.1.4. As for the sensitivity on technology costs, it shows that, even when the price of such fuel increases compared to the main scenario runs, savings would still occur for all users and for the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

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[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.

[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**	**Mediu m**	**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%

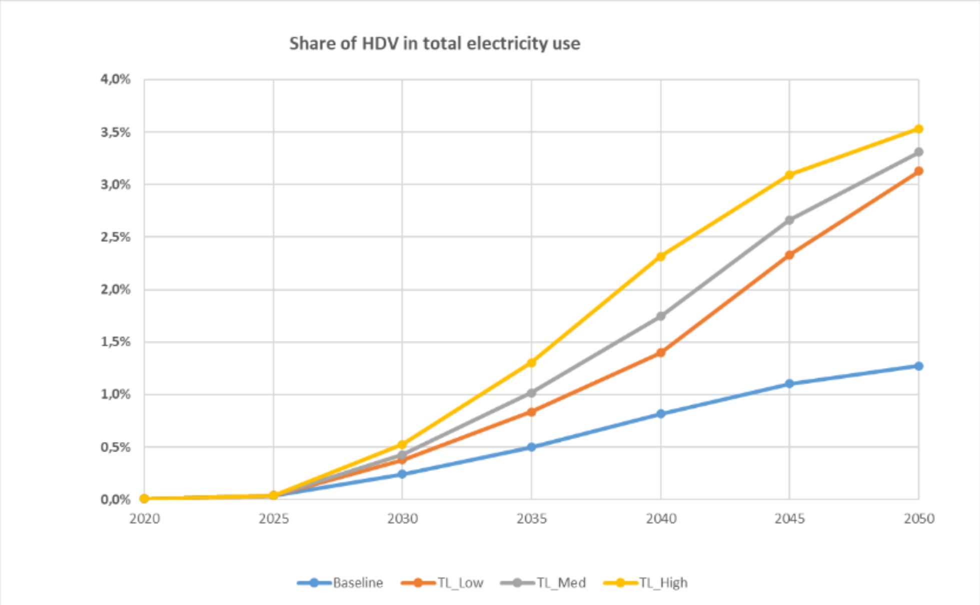
2040					
Baseline	44%	23%	4%	22%	7%
TL_Low	24%	9%	10%	46%	12%
TL_Med	16%	6%	8%	57%	14%
TL_High	0%	0%	0%	78%	22%

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.

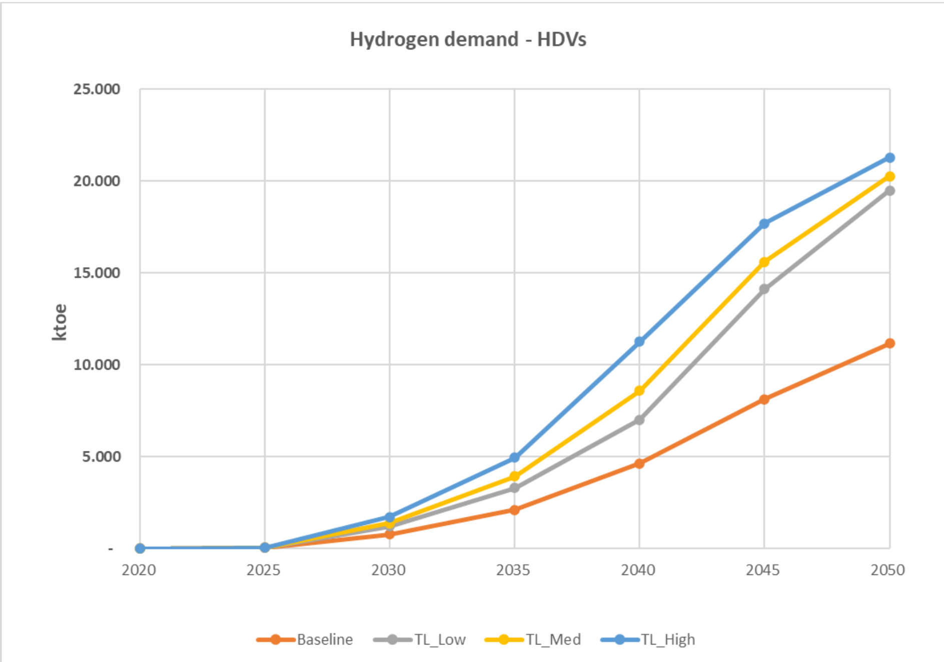
Figure 27: Electricity consumption by HDVs as a percentage of total electricity consumption (EU-27) under different TL options



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.

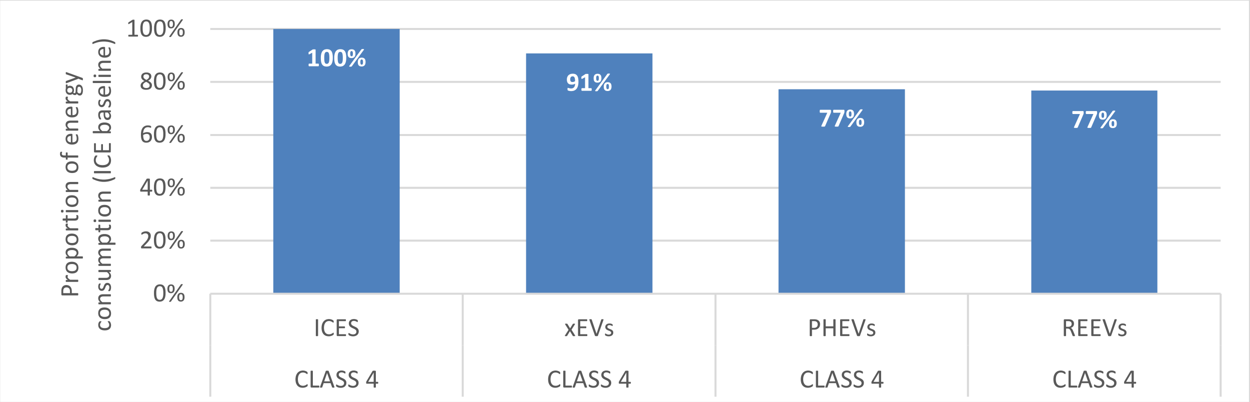
Table 26: Vehicle powertrains mapping to trailer cost curve group

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

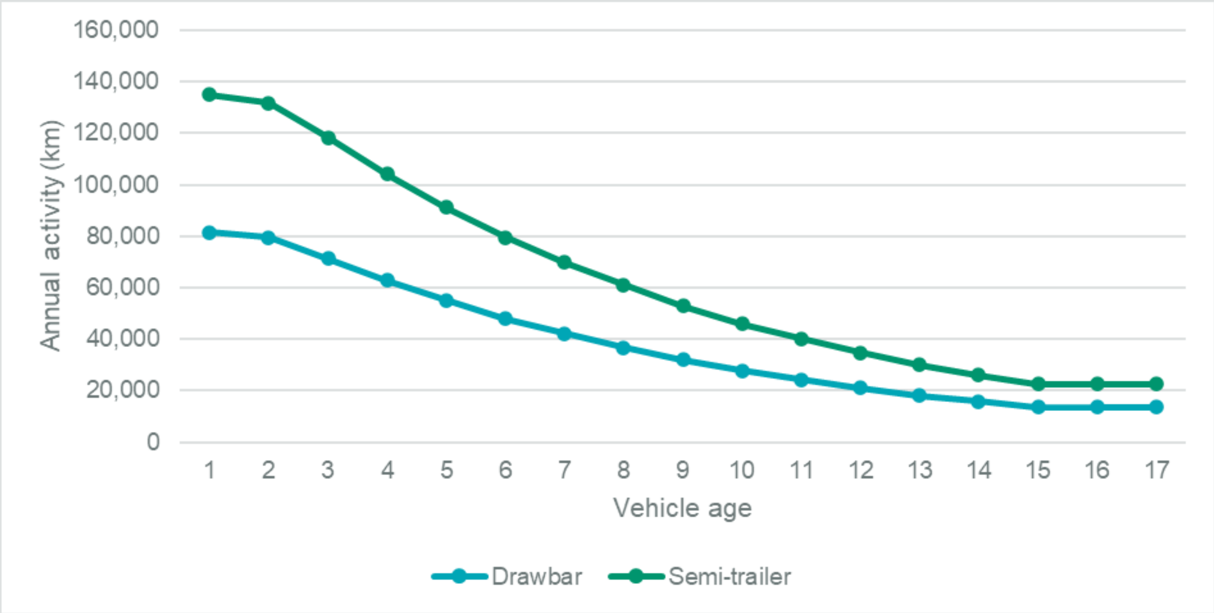
Annual trailer mileage profiles are shown in

[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)

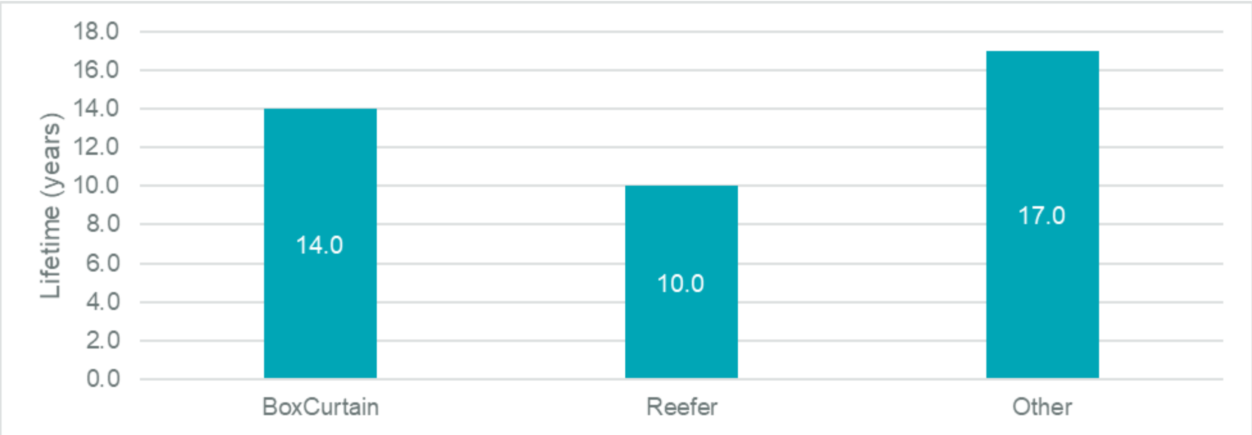
Figure 30 below as a function of the trailer/vehicle age. Vehicles pulling drawbar trailers (group 4, group 9) have a lower annual activity compared to vehicles pulling semi-trailers (group 5, 10, 12). Trailer mileage was aligned to vehicle mileage for drawbar trailers, as there are more vehicles (group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

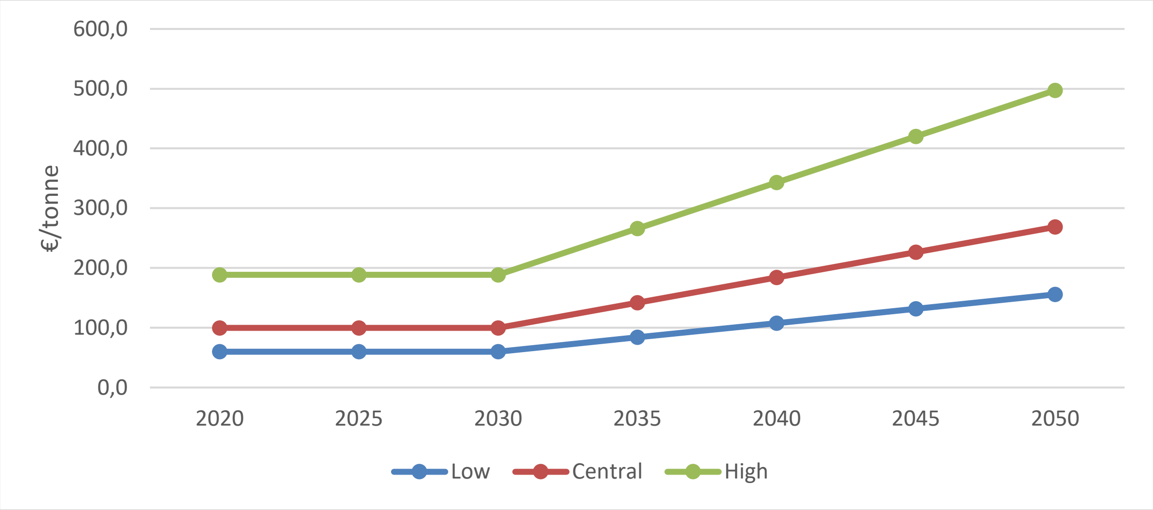


Source: Bodies and trailers – development of CO2 emissions determination procedure; Procedure no: CLIMA/C.4/SER/OC/2018/0005

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)]

<u>Marginal TCO assumptions</u>

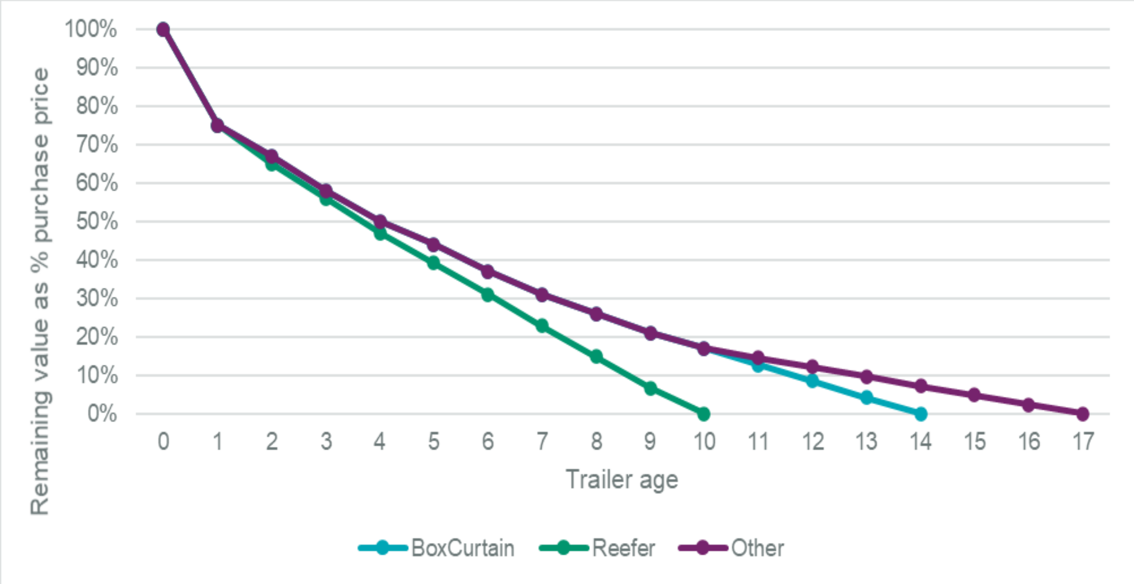
The marginal TCO calculations include the same vehicle segments and trailer groups as the fleet impacts analysis. The results are provided for new trailers across their lifetime for each powertrain type, and from two aspects:

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

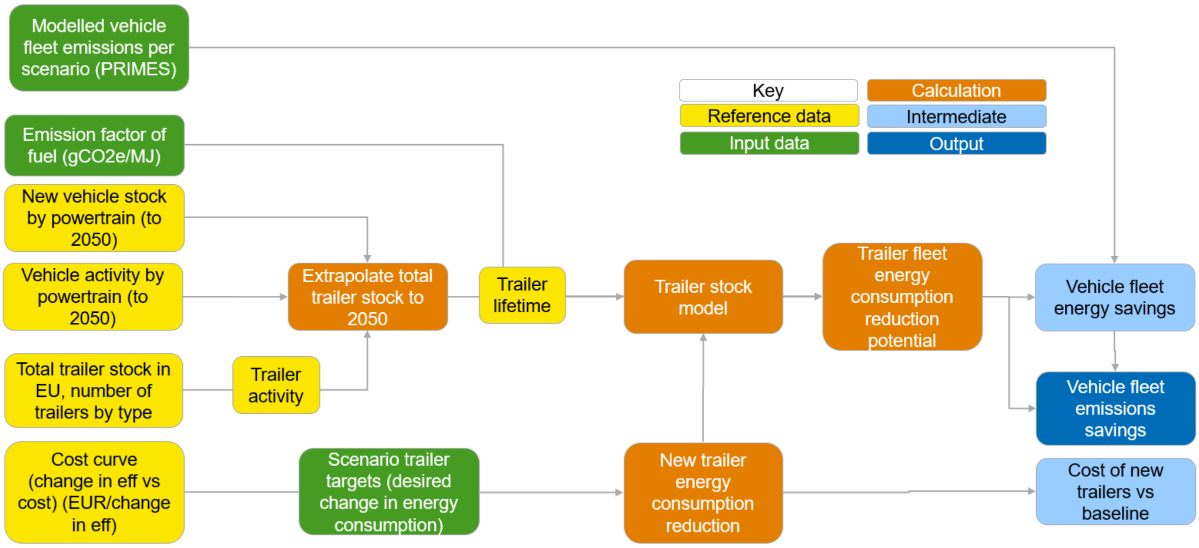
1.42. 18.4.1.3.1 HDV fleet impact analysis

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

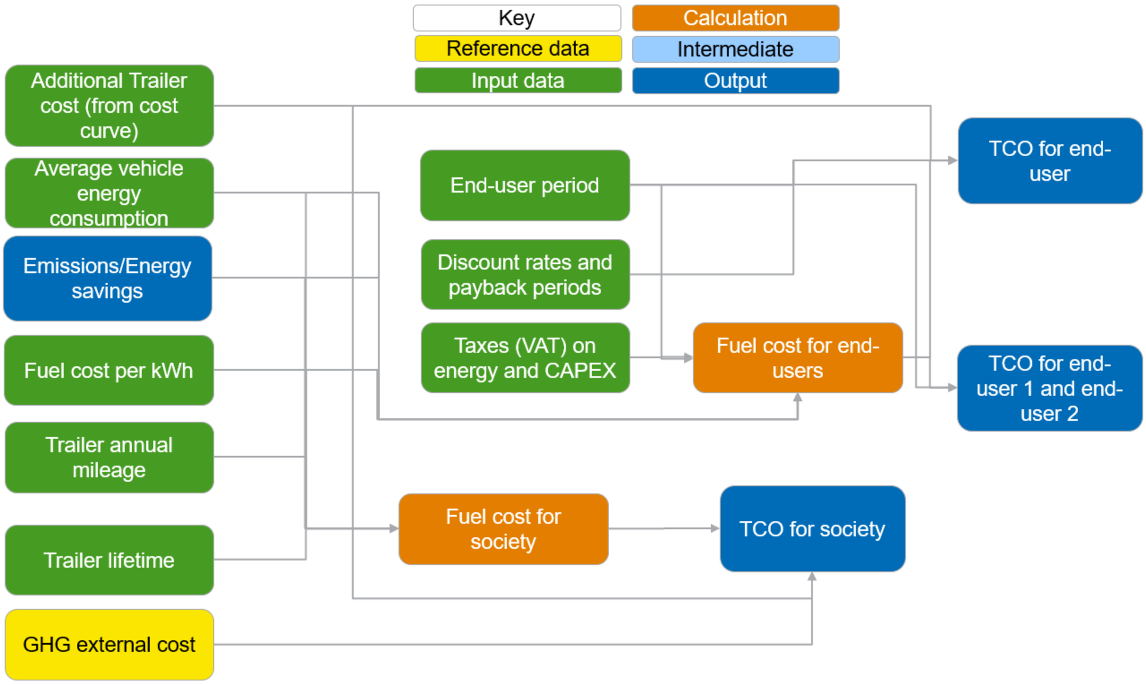


1.43. 18.4.1.3.2 Marginal TCO analysis

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)

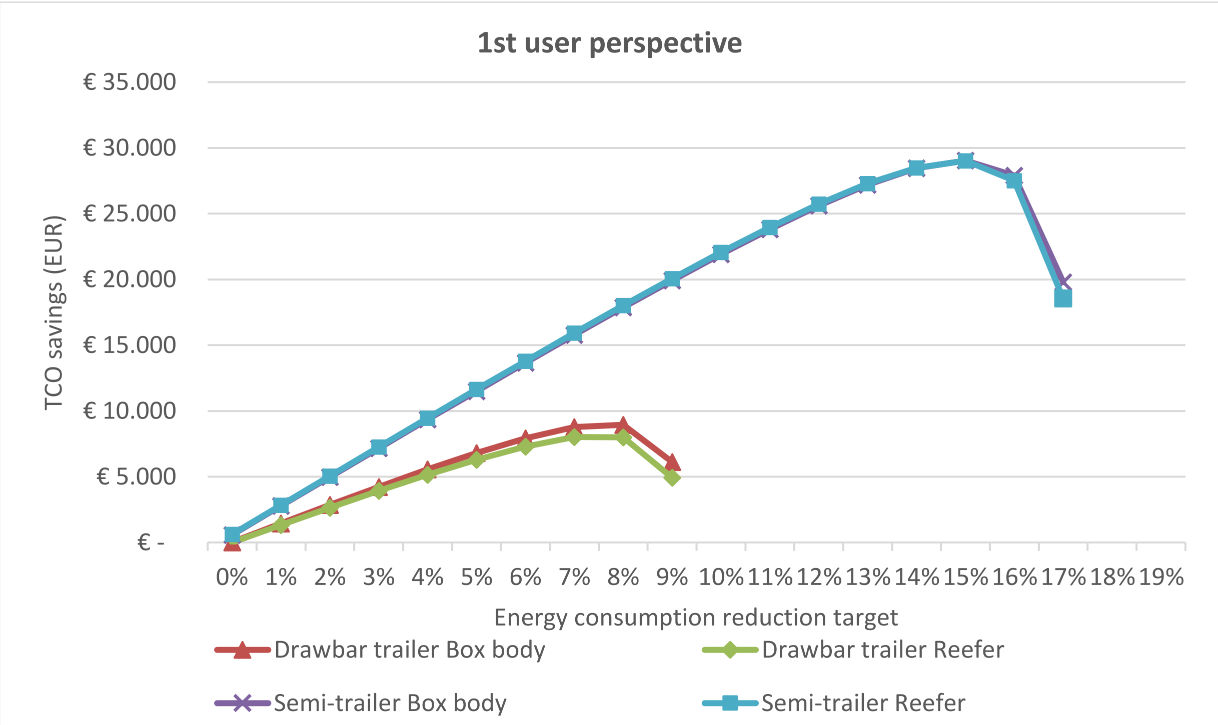


Figure 37. TCO savings from a societal perspective as a function of the energy consumption reduction target for trailers (for trailers registered in 2030).

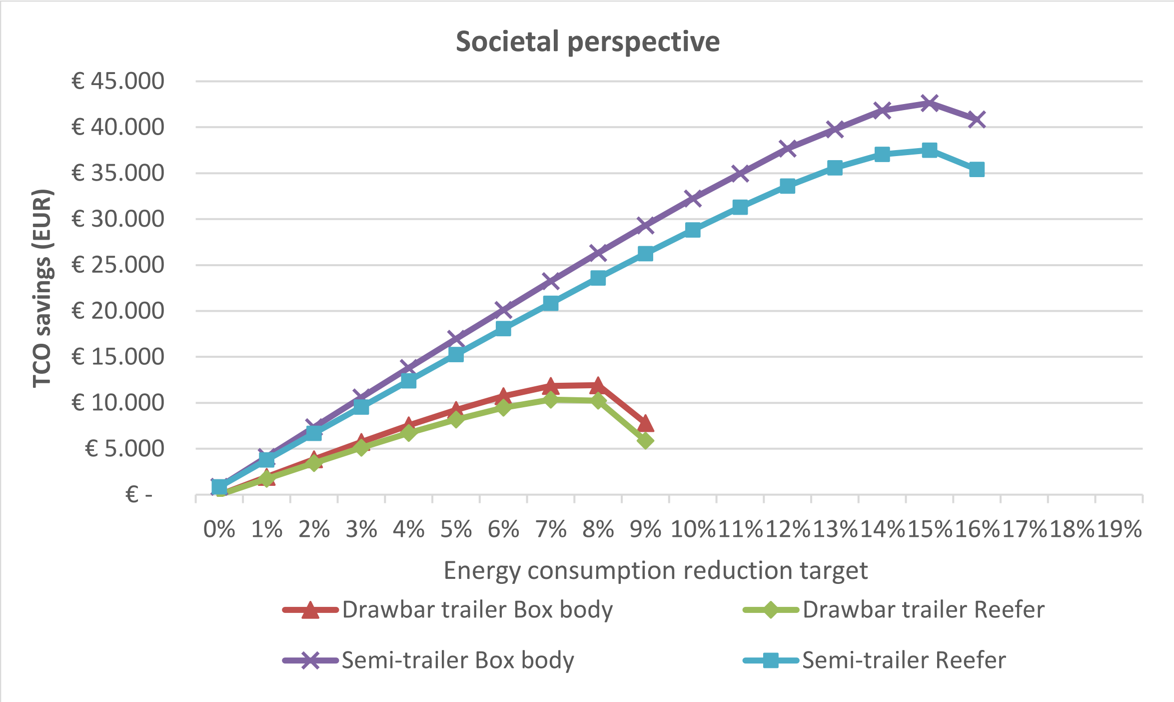


Table 27. and

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.

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[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.

<u>*Other assumptions*</u>

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,

[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.

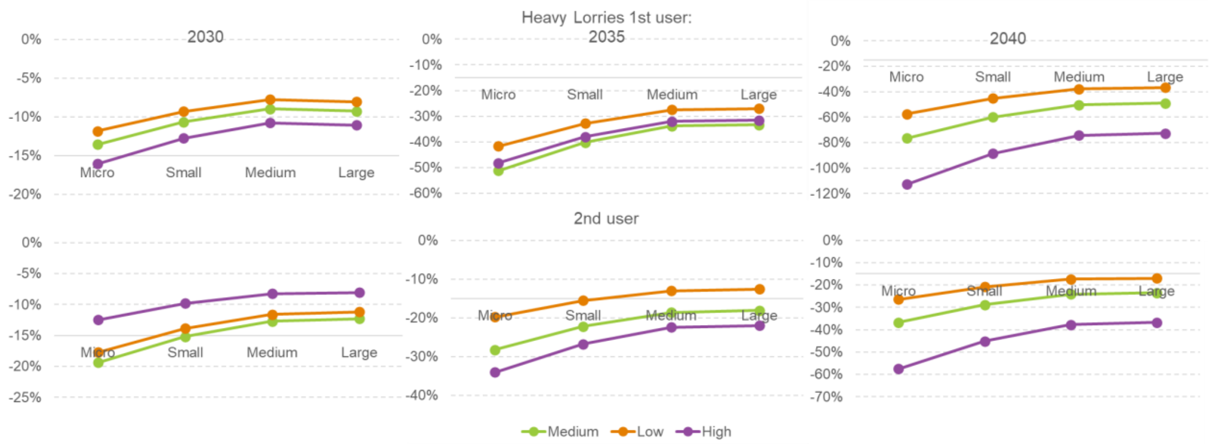
Subjective TCO

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.

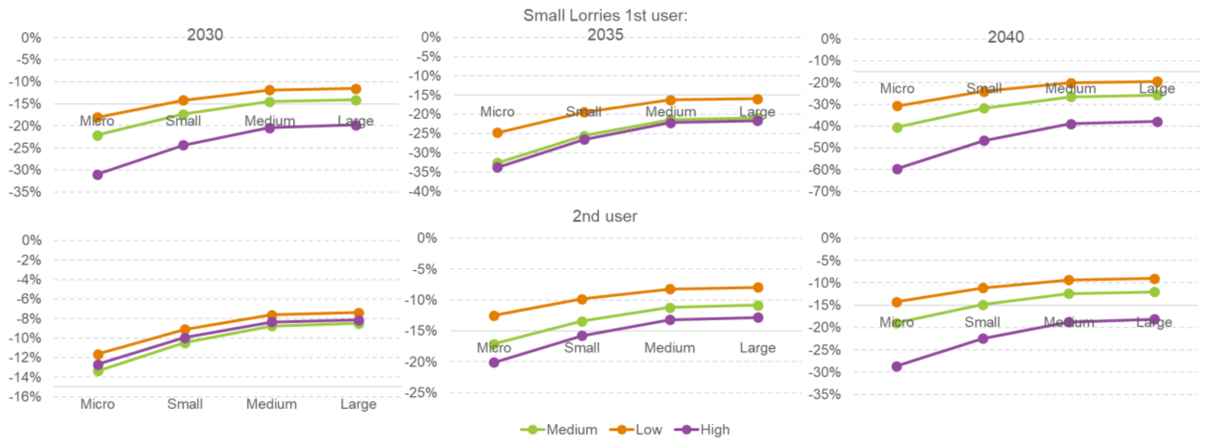
vehicles option per company size) divided by the average annual earnings per employee for different scenarios, as compared to the baseline. A negative value indicates cost savings.

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.