EUROPEAN
COMMISSION

Strasbourg, 14.2.2023
SWD(2023) 88 final

PART 1/2

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Part 1

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}

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT 1
1.1. Overall context 1
1.2. Description of the heavy-duty vehicles sector 2
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 3
1.4. Legal context 5
1.5. Evaluation of the implementation 5
2. PROBLEM DEFINITION 6
2.1 What are the problems? 6
2.2 What are the problem drivers? 11
2.3 How is likely the problem to persist? 16
3. WHY SHOULD THE EU ACT? 16
3.1 Legal basis 16
3.2 Subsidiarity: Necessity of EU action 16
3.3 Subsidiarity: Added value of EU action 17
4. OBJECTIVES: WHAT IS TO BE ACHIEVED? 17
4.1 General policy objectives 17
4.2 Specific objectives 17
5. WHAT ARE THE VARIOUS OPTIONS TO ACHIEVE THE OBJECTIVES? 19
5.1 What is the baseline from which options are assessed? 19
5.2 Description of the policy options 21
6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS? 28
6.1 Introduction 28
6.2 Extension of the scope 30
6.3 CO_2 emission targets and their timing 32
6.4 Target levels for the energy efficiency of trailers 41
6.5 Target timing (TT) 43
6.6 Use of the revenues from excess emissions premiums (fines) 43
6.7 Incentive scheme for zero-emission vehicles 44
6.8 Mechanism to account for renewable and low-carbon fuels when assessing vehicles manufacturers compliance with the CO_2 standards 45
6.9 Governance provisions 48
6.10 Overall costs and benefits and CO2 emissions of the most relevant combinations of options 50
6.11 One in, One out 59
7. HOW DO THE OPTIONS COMPARE? 59
7.1 Extension of the scope 59
7.2 CO_2 emission targets and their timing 60

7.3 Use of revenues from excess emissions premiums (fines) 62
7.4 Incentive scheme for zero- and low-emission vehicles 62
7.5 Mechanism for renewable and low-carbon fuels accounting 63
7.6 Governance provisions 64
8. PREFERRED OPTION 65
8.1 Methodological approach 65
8.2 REFIT (simplification and improved efficiency) 69
9. HOW WOULD IMPACTS BE MONITORED AND EVALUATED? 69
9.1 Indicators 69
9.2 Operational objectives 70

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.

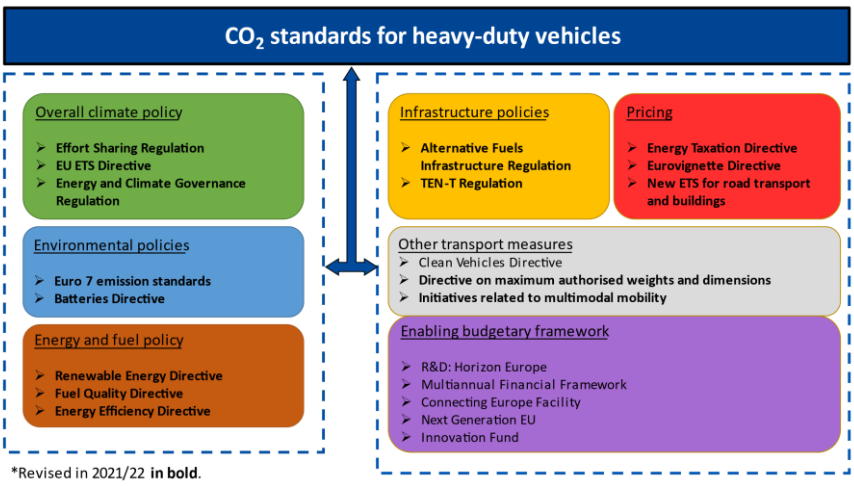
At the same time, the traditional competitive advantage of the EU heavy-duty vehicles industry is being challenged by the development of foreign competitors, mainly from China and the USA, currently investing largely in zero-emission technologies. More information on the zero-emission regulatory status 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.

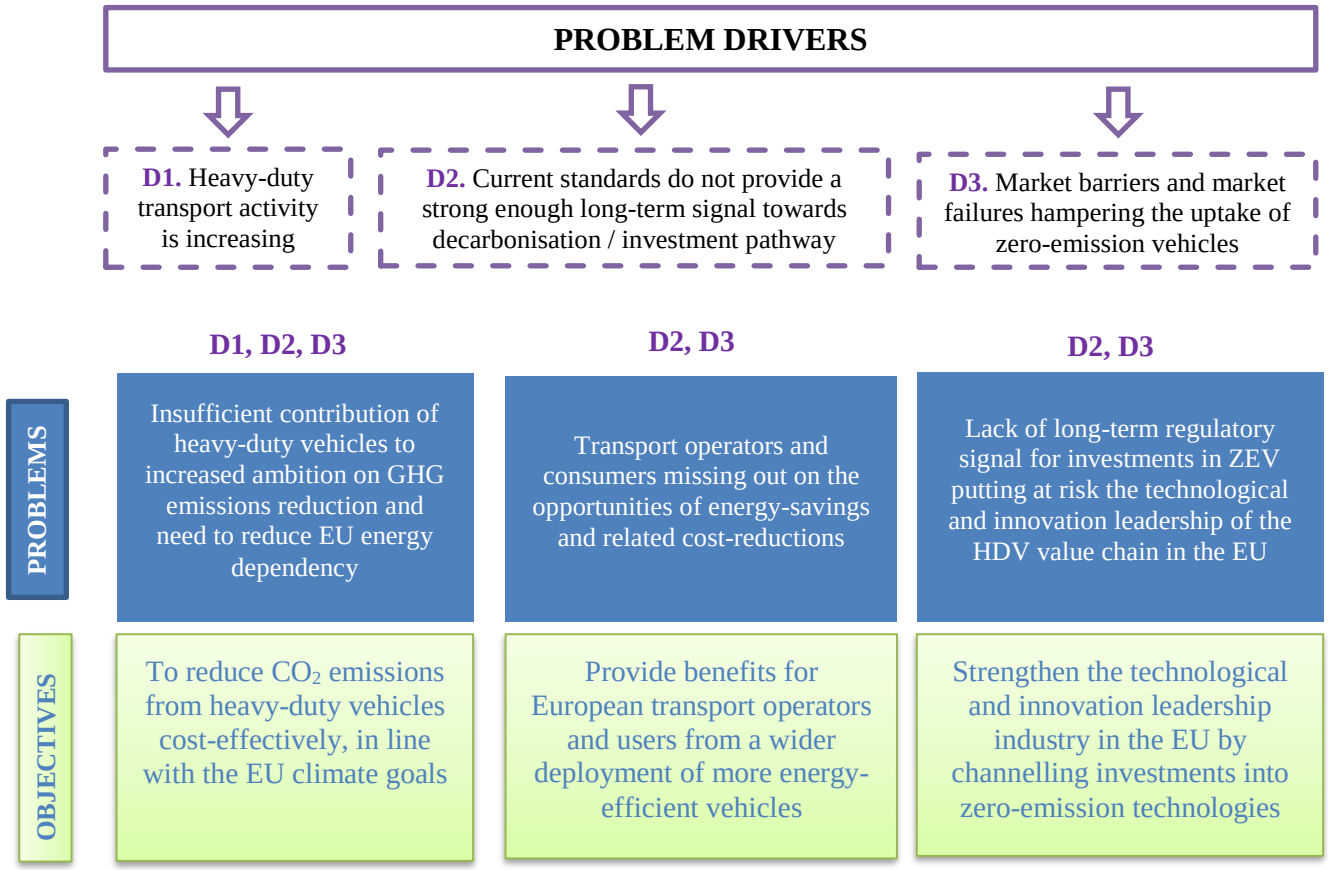
[8] Recital 5 of Regulation 2019/1242: "This Regulation […] contributes to the binding target of at least a 40% domestic reduction in economy-wide greenhouse gas emissions by 2030 compared to 1990 […]'

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).

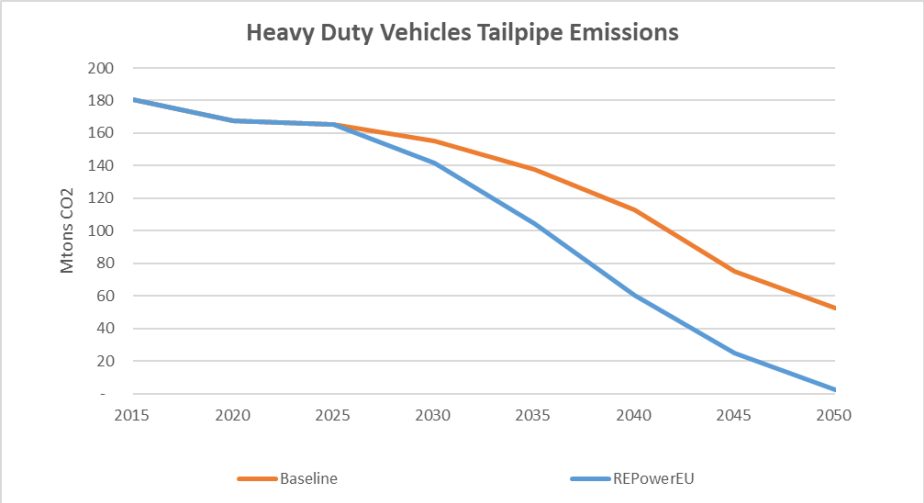
With the REPowerEU Plan and the need to end the EU's dependence on Russian fossil fuels while targeting the climate crisis, the Commission proposed, in May 2022, to increase the target in the Renewable Energy Directive to 45% by 2030, and the binding target in the Energy Efficiency Directive to 13% by 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.

---

[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

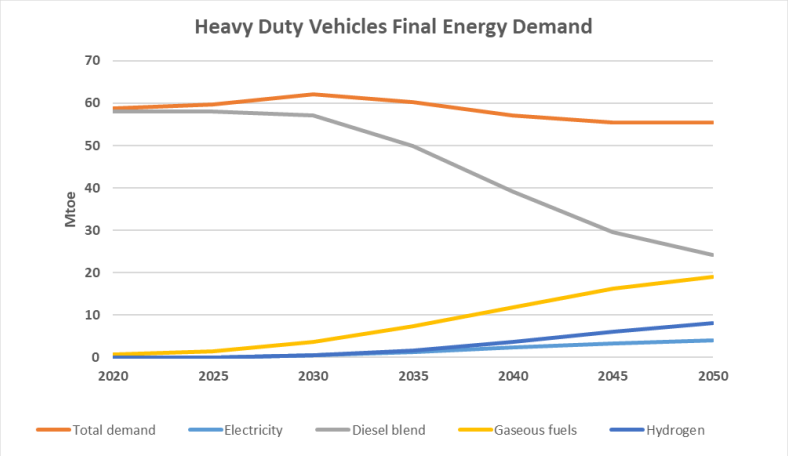


Table 1 shows the evolution of the fleet of new HDV in the baseline scenario. In line with the analysis presented above, it shows that only a limited share of the new fleet would be made of ZEV, with the current CO_2 standards. The analysis also shows that the current HDV standards would take time to 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)

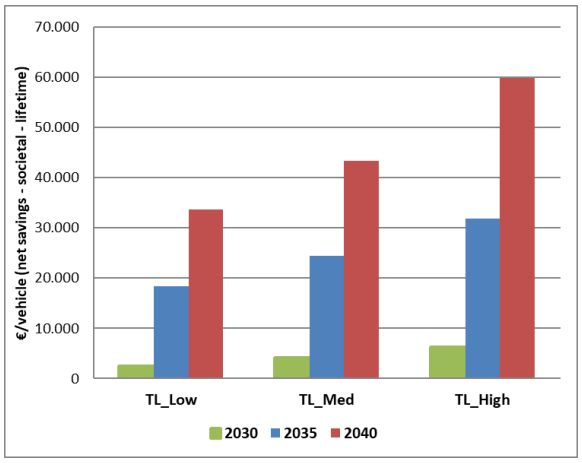
The below sections provide a summary of the main findings of the analysis.

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.



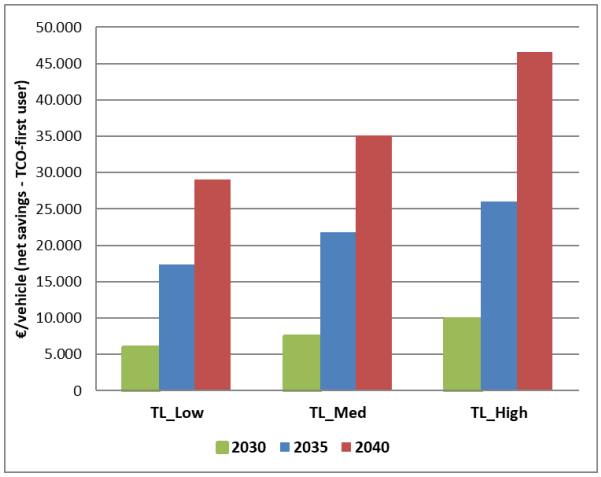
All three TL options lead to net savings, which increase with increasing target stringency.

- **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.

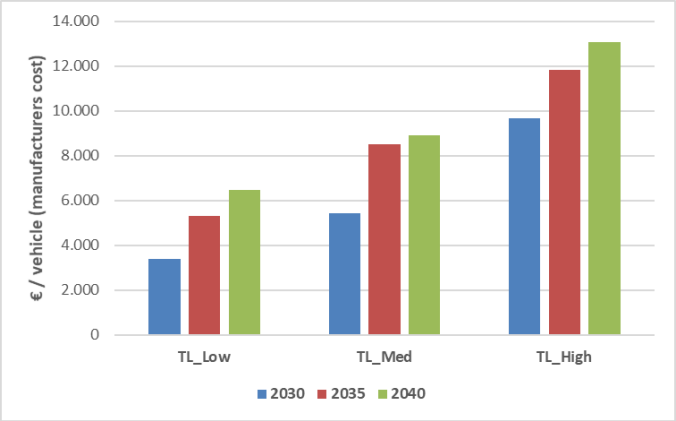
- **Sensitivity analyses**

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.

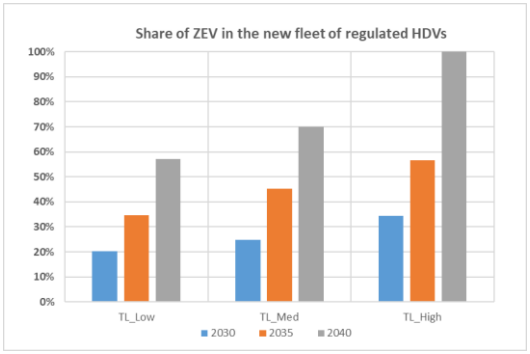
6.3.1.1.6 Innovation and competitiveness

[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

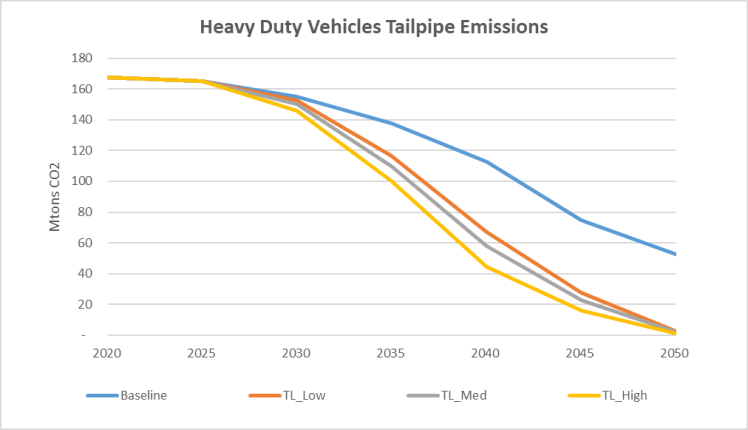
Cumulative discounted health benefits would sum up to EUR 7 to 14 billion between 2031 and 2050. More details are presented in section 6.10. Additional results in terms of the reduction of air pollutants emissions are presented in Annex 9.

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 1st, 2nd and 3rd 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.

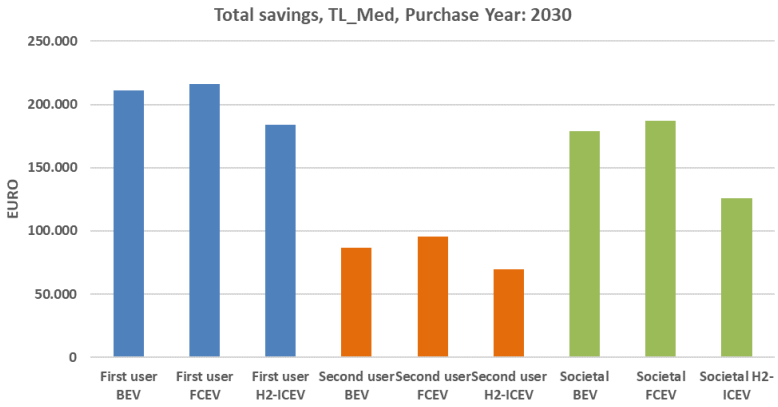
Route	Fuel/ZEV technology	2030	2035
(i)	BEV, vehicle group 5-LH	108	101
	FCEV, vehicle group 5-LH	90	56
(ii)	LCF bio-diesel	261	186
	LCF e-diesel	259	171

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 €)**		
Scenarios	**Capital costs**	**Other costs (AFI, maintenance, tolls, etc)**	**Fuel costs**	**Total costs (bn€)**	**CO_2 emiss.**	**Air pollution**	**Total impact (bn €)**
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 €)		
Scenarios	**Capital costs**	**Other costs (AFI, maintenance, tolls, etc)**	**Fuel costs**	**Total costs (bn€)**	**CO_2 emiss.**	**Air pollution**	**Total impact (bn €)**
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 €)		
Scenarios	**Capital costs**	**Other costs (AFI, maintenance, tolls, etc)**	**Fuel costs**	**Total costs (bn€)**	**CO_2 emiss.**	**Air pollution**	**Total impact (bn €)**
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