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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) 2019/631 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition

{COM(2021) 556 final} - {SEC(2021) 556 final} - {SWD(2021) 188 final} - {SWD(2021) 614 final}

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Contents

Glossary

Term or acronym	*Meaning or definition*
ACEA	European Automobile Manufacturers Association
AFID	Alternative Fuels Infrastructure Directive 2014/94/EU
BEV	Battery Electric Vehicle
CNG	Compressed Natural Gas
CTP	Climate Target Plan
CO_2	Carbon dioxide
ESR	Effort Sharing Regulation
EED	Energy Efficiency Directive
EIB	European Investment Bank
EU ETS	EU Emission Trading System
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 (vehicles of more than 3.5 tons)
ICEV	Internal Combustion Engine Vehicle(s)
IEA	International Energy Agency
JTF	Just Transition Fund
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)
LPG	Liquefied Petroleum Gas
LNG	Liquefied Natural Gas
NEDC	New European Driving Cycle
NO_x	Nitrogen oxides (nitric oxide (NO) and nitrogen dioxide (NO_2))
PHEV	Plug-in Hybrid Electric Vehicle(s)
PM	Particulate Matter
RED	Renewable Energy Directive

RFNBO	Renewable Fuels of Non-Biological Origin
R&D	Research and Development
TCO	Total cost of ownership
TEN-T	Trans-European Transport Network
TFEU	Treaty on the Functioning of the European Union
UNFCCC	United Nations Framework Convention on Climate Change
WLTP	Worldwide Harmonised Light Vehicles Test Procedure
ZEV	Zero-Emission Vehicle(s)
ZLEV	Zero- and Low-Emission Vehicle(s)

1 INTRODUCTION: POLITICAL AND LEGAL CONTEXT

1.1 Overall context

The **European Green Deal**[1] puts climate action at its core, by setting an EU climate neutrality objective by 2050. With its **Communication on stepping up Europe's 2030 climate ambition**[2], the Commission proposed to raise the EU's ambition on reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030. The European Council endorsed this ambitious target, and the EU formally submitted it as its updated nationally determined contribution to the UNFCCC Secretariat. The **European Climate Law**, as agreed with the co-legislators, will make the EU's climate neutrality target legally binding, and raise the 2030 ambition by setting the target of at least 55% net emission reduction by 2030 compared to 1990.

In order to follow the pathway proposed in the European Climate Law, and deliver this increased level of ambition for 2030, the Commission has reviewed the climate and energy legislation currently in place that is expected to only reduce greenhouse gas emissions by 40% by 2030 and by 60% by 2050.

This 'fit for 55' legislative package, as announced in the Commission's Climate Target Plan, is the most comprehensive building block in the efforts to implement the ambitious new 2030 climate target, and all economic sectors and policies will need to make their contribution, including road transport.

Through the revision of the CO_2 emission standards, **this impact assessment addresses the necessary contribution of passenger cars and light commercial vehicles (vans) to achieve the emission reduction target for 2030 and the climate neutrality objective.**

The CO_2 emission standards currently set out in Regulation (EU) 2019/631 will not deliver the emission reduction needed for road transport to contribute to the new 2030 emission reduction target and the climate neutrality objective.

The GHG emissions from road transport represent almost 20% of total EU GHG emissions and have significantly increased since 1990. Air quality continues to be impacted by traffic and congestion, leading to increasing number of cities introducing low and zero emission zones limiting local access to vehicles with internal combustion engines and certain Member States announcing phase-out of sales of internal combustion engine cars.

At the same time, the automotive industry is of key importance for the EU economy and accounts for over 7% of the EU's GDP. It provides jobs to 14.6 million Europeans - directly or indirectly, in manufacturing, sales, maintenance, construction and transport and transport services - representing 6.7% of total EU employment[3]. The EU is among the world's biggest producers of motor vehicles and demonstrates technological leadership in this sector[4]. EU automotive investment in R&D amounts to €60.9 billion annually[5], making it the largest private investor in R&D, responsible for 29% of total R&D spending in the EU.

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[1] COM(2019)640 final
[2] COM(2020)562 final
[3] https://www.acea.be/automobile-industry/facts-about-the-industry
[4] On automobile production plants in Europe, information is available at https://www.acea.be/statistics/tag/category/european-production-plants-map
[5] *idem*

The COVID-19 pandemic has had a severe impact on Europe's economy and automotive sector[6]. In 2020, the EU new passenger car market contracted by 23.7% to 9.9 million units, which is 3 million units less than in 2019[7]. At the same time, the market share of electric vehicles (EVs) surged spectacularly throughout the year 2020 in many countries. While in 2019 3.5% of the total new car sales were EVs, this increased to 10.5% in 2020. In terms of absolute numbers, new EV registrations almost tripled compared to 2019[8].

EU economic activity is forecast to moderately pick up again in the second and more vigorously in the third quarter of 2021, in light of the vaccination campaigns and the expected gradual relaxation of containment measures, the agreement reached with the UK on future cooperation, the endorsement of the Recovery and Resilience Facility and the overall resilience of the European economy[9]. Similarly, EU automotive manufacturing should continue to recover in 2021, provided that supply chains remain functional. A recovery of demand of new vehicles sales in the EU at the same level as 2019 is foreseen by 2023[10]. For an overview of the impacts of the COVID-19 crisis on the automotive industry, see Annex 6.

Member States and the Commission have announced a series of measures to support the economic recovery of the private sector, including the automotive segment. The **Next Generation EU**[11] sets the direction for Europe's recovery, including for sustainable mobility. Europe must invest in protecting and creating jobs and in the competitive sustainability of its transport sector by building a fairer, greener and more digital future for it. Measures are in place in a number of Member States to stimulate the recovery of the automotive sector, aimed in particular at demand and supply of zero- and low-emission vehicles and recharging infrastructure. These stimulus packages and recovery measures, alongside continued investments in battery and other zero emission technologies, have been instrumental for attenuating the negative economic impacts, have ensured that zero emission cars become increasingly price competitive compared to fossil fuelled cars and have contributed to the increase of the market for zero- and low-emission vehicles (see Annex 6).

At the same time, it is clear that the automotive sector is undergoing a significant **structural transformation**. This transformation includes changes in clean and digital technologies, in particular the shift from internal combustion engines towards zero- and low-emission technologies as well as increasingly connected vehicles. Alternative business models such as vehicle sharing and mobility as a service linking different travel options are also appearing on the market, as well as increasing efforts to develop other forms of mobility, be they public, or last mile individual, for passengers and for goods. All these trends are challenging the traditional business models of manufacturers, suppliers and service providers and increasing the need for more zero emission cars and vans entering the market. They offer business opportunities and benefits for early adopters.

As highlighted in the **New Industrial Strategy for Europe**[12], sustainable and smart mobility industries have both the responsibility and the potential to drive the twin green and digital

[6] SWD (2020) 98 final

[7] https://www.acea.be/press-releases/article/passenger-car-registrations-23.7-in-2020-3.3-in-december

[8] https://www.acea.be/press-releases/article/fuel-types-of-new-cars-electric-10.5-hybrid-11.9-petrol-47.5-market-share-f

[9] ECFIN winter 2020 economic forecast; it projects that the EU economy will grow by 3.7% in 2021 and 3.9% in 2022. The speed of recovery will vary across Member States. There projections, however, are subject to significant uncertainty and risks.

[10] BCG COVID-19's Impact on the Automotive Industry (December 2020)

[11] COM(2020)456 final

[12] COM(2020)102 final

transitions, support Europe's industrial competitiveness and improve connectivity. The **Energy System Integration Strategy**[13] also sets the framework for accelerating the electrification of energy demand, building on a largely renewables-based power system.

The Commission's **Strategy for Sustainable and Smart Mobility**[14] has put forward comprehensive and integrated measures to put European transport on track for the future. It addresses the broader challenges of the transition to zero-emission mobility and sets out a roadmap for putting European transport firmly on the right track for a sustainable and smart future. It aims to make sustainable alternatives widely available to enable better modal choices and put in place the right incentives. It puts forward a number of measures grouped under 10 flagships, many of which are aimed at reducing GHG emissions in the road transport sector. The Strategy also sets out various milestones showing the European transport system's path towards achieving the objectives of a sustainable, smart and resilient mobility. It includes in particular the milestones that nearly all cars and vans will be zero-emission by 2050.

The Strategy's accompanying Action Plan includes policies aimed at boosting the uptake of zero-emission vehicles, renewable and low-carbon fuels and related infrastructure; addressing the sustainability of urban mobility; internalisation of externalities by pricing carbon; providing better incentives to users; boosting multimodality, including by making use of smart digital solutions and intelligent transport systems; and making mobility just and fair to all. The shift toward zero-emission vehicles will prevent pollution and improve the health of our citizens. This is also supporting the Zero Pollution Ambition of the European Green Deal as articulated in the recently adopted Zero Pollution Action Plan.

The **CO_2 emission standards for light-duty vehicles** are key drivers for reducing CO_2 emissions in the sector, as also shown in the Communication on stepping up Europe's 2030 climate ambition. This impact assessment will focus on specific issues linked to the CO_2 emissions standards of new cars and vans. Further policies envisaged by the Strategy for Sustainable and Smart Mobility will address broader sustainability issues of the transport sector, at the EU, international, national and local levels. The revision of the CO_2 emission standards for heavy-duty vehicles will be proposed by the Commission in 2022 as foreseen in this legislation and in view of the need to review and extend, as a prerequisite, the underlying legislation on the certification of CO2 emissions and fuel consumption of heavy-duty vehicles.

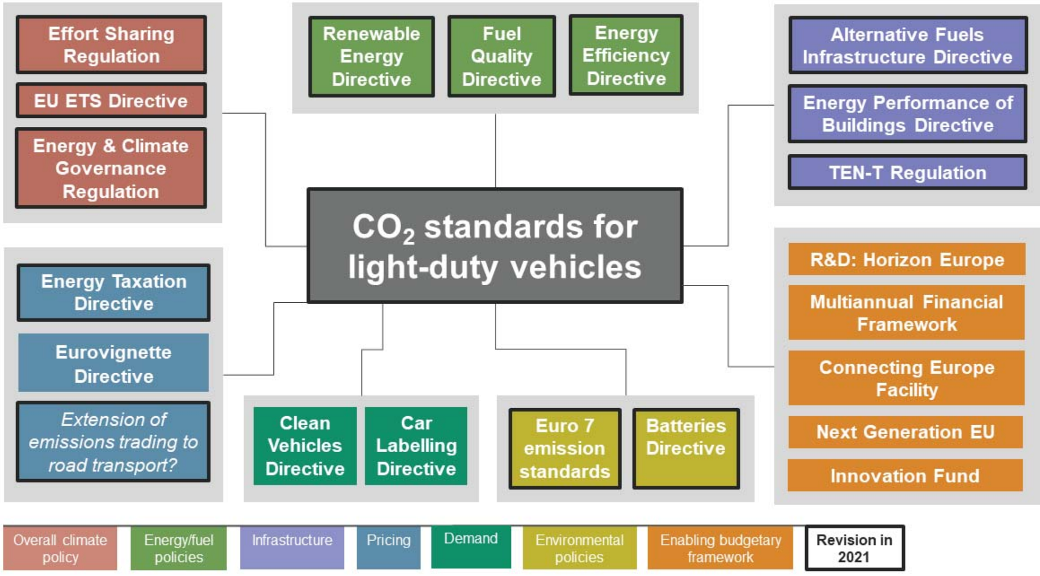
1.2 Interaction between CO_2 emission standards for cars and vans and other policies to deliver increased climate ambition in the road transport sector

The policy measures to deliver on the increased climate ambition interact in many ways, and should be seen in combination.

As displayed in **Figure 1**, the CO_2 emission standards for new cars and vans addressed by this impact assessment interact with several other EU legislative instruments and policies. Many of these policies are also revised as part of the 'Fit for 55 Package'.

Figure 1: Policy context and overview of interactions

[13] COM(2020) 299 final
[14] COM(2020)789 final



The interactions can be summarized along the following lines:

- Overall climate policy: this concerns in particular the Effort Sharing Regulation (ESR)[15] which sets binding greenhouse gas emission reduction targets per Member State. The current ESR covers emissions of road transport and the CO_2 emission standards for vehicles help Member States meeting their ESR targets. Under the Energy and Climate Governance Regulation, Member States have to adopt National Climate and Energy Plans which, inter alia, cover the policies and measures aiming at reducing emissions from light-duty vehicles.

- The EU ETS caps emissions from the sectors within its scope, including power generation, and therefore ensures (i) that the additional electricity consumption from the zero-emission vehicles does not lead to additional upstream emissions, and (ii) that the electricity used in zero-emission vehicles is decarbonised over time. Depending on the carbon price, the EU ETS can impact the operating cost for zero-emission vehicles. Emissions trading for building and road transport would further internalise climate externalities and provide incentives for consumers to reduce emissions. Therefore it can be a complementary demand-side action to the CO_2 emission standards.

- Energy and fuels policy: the Renewable Energy Directive as well as the Fuel Quality Directive set obligations on the supply of liquid renewable transport fuels and on the reduction of the GHG emission intensity of liquid transport fuels. The CO_2 emission standards for cars and vans ensure the increased supply and affordability on the market of new efficient and zero-emission vehicles, and therefore they are the key policy-driver for the transition towards zero-emission mobility in road transport. Fuels related legislation provides an additional contribution by incentivising the use of renewable and low carbon fuels in existing vehicle fleets that are not zero-emission. As zero emission vehicles, in particular battery electric vehicles, provide significant energy efficiency gains compared to fossil fuelled cars, the CO_2 emission standards also contribute to achieving the targets set in the Energy Efficiency Directive (EED) and wider benefits of the Energy System

[15] Regulation (EU) 2018/842

Integration Strategy which will help to maximize the use of renewable electricity and keep energy system costs down. The uptake of zero-emission vehicles will contribute to accelerating the electrification of energy demand and, through smart charging, can also contribute to balancing the electricity grid. The EED is an enabler of achieving reductions of GHG emissions including in transport by providing a framework for stimulating the uptake of specific transport policies such modal shift and urban mobility planning. The Governance Regulation requires to implement energy efficiency measures first, whenever cost-effective.

- Infrastructure policy: the Alternative Fuels Infrastructure Directive (AFID), the TEN-T Regulation, as well as the Energy Performance of Buildings Directive incentivise the rollout of recharging and refuelling infrastructure and thus contribute to facilitating the uptake of zero-emission vehicles. The European Green Deal has at this stage set the indicative target of 1 million public recharging and refuelling points by 2025 and 3 million by 2030. The Impact Assessment for the AFID will provide an analysis on the numbers and types of recharging and refuelling points that are needed.

- Other pricing policies: the Eurovignette Directive and the Energy Taxation Directive may support the decarbonisation of road transport by contributing to the internalisation of the climate externality. The revised Eurovignette Directive will most likely include the option for Member States to vary road charges based on the environmental performance, including the CO2 emissions of light-duty vehicles.

- Policies addressing demand: The Clean Vehicles Directive promotes clean mobility solutions and supports the demand for zero- and low-emission vehicles through public procurement. The Car Labelling Directive requires EU countries to ensure that information on emissions is provided to consumers.

- Other environmental policies: air pollutant emission standards ensure the placing on the market of clean internal combustion engine vehicles with respect to NO_x, particles and other pollutants. The European Green Deal roadmap includes a proposal for more stringent air pollutant emissions standards for combustion engine vehicles by 2021 (Euro 7). While the CO_2 emission standards incentivise the market deployment of zero-emission technologies, the Euro 7 standards will aim at further reducing the pollutant emissions from internal combustion engine vehicles, which will still be used until nearly all cars and vans on the road will be zero-emission. Most pollutants covered by Euro 7 are also regulated under the National Emission reduction Commitments Directive (NECD), which requires Member States to reduce their emissions of main air pollutants for the periods 2020-29 and more drastically after 2030. The European Green Deal also commits the Commission to a revision of ambient air quality legislation, notably to align air quality standards more closely with the World Health Organization recommendations. Furthermore, the proposed Batteries Regulation[16] addresses the sustainability of batteries and sets requirements for the collection, treatment and recycling of waste batteries. It will also help addressing the issue of availability of raw materials for batteries, such as lithium, cobalt, and natural graphite, which are critical raw materials (see Annex 7 for details).

- The budgetary framework with the Multiannual Financial Framework and the Next Generation EU, including funding instruments for infrastructure investments (Connecting Europe Facility, Cohesion and Structural Funds, InvestEU, blending with EIB instruments), for the demonstration of innovative low-carbon technologies (Innovation

[16] COM(2020) 798

Fund) and for research and development (Horizon Europe, Battery Alliance) are also important components of the enabling framework for clean vehicles and technologies.

In light of the above, the revision of CO_2 standards for cars and vans needs to be viewed in the broader policy context of the planned revision of all the key legislation for delivering the 'fit for 55% package'.

The interactions between this impact assessment and the impact assessments supporting the revision of the EU ETS, the Renewable Energy Directive, the Effort Sharing Regulation, the Energy Efficiency Directive, the Alternative Fuels Infrastructure Directive and the Energy Taxation Directive are most relevant in this context. This impact assessment is therefore building on the analytical work of the Climate Target Plan, which takes into account the interaction and combination of the various policies. The interactions are further explored and assessed in the next sections.

1.3 Legal context

Based on Article 192 of the Treaty on the Functioning of the European Union (TFEU) (Title XX on Environment), the EU has adopted legislation setting mandatory CO_2 emission targets for new passenger cars and vans, since 2009 and 2011, respectively.

On 17 April 2019, the European Parliament and the Council adopted Regulation (EU) 2019/631 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, replacing and repealing the previous Regulations (EC) No 443/2009 (cars) and (EU) No 510/2011 (vans). Regulation (EU) 2019/631 maintained the existing EU fleet-wide CO_2 emissions targets that entered into force on 1 January 2020 and added new targets that apply from 2025 and 2030 respectively. The applicable EU fleet-wide CO_2 targets are defined as a percentage reduction from the EU fleet-wide target in 2021, as shown in the below table (**Table 1**).

Table 1: Current EU fleet-wide CO_2 targets in 2025 and 2030

EU fleet-wide CO_2 targets (% reduction from 2021 starting point)		
	2025	**2030**
Passenger Cars	15%	37.5%
Vans	15%	31%

Each year, a specific emission target is set for each manufacturer on the basis of the applicable EU fleet-wide target and taking into account the average mass of the manufacturer's fleet of new vehicles registered in that year. If the average specific emissions of a manufacturer exceed its specific emission target in a given year, an excess emission premium is imposed.

Additional details on targets and the way compliance is assessed, the incentive mechanism for zero- and low-emission vehicles (ZLEV)[17], as well as further elements of Regulation (EU) 2019/631 and its implementation are outlined in Annex 5.

[17] '*Zero- and low-emission vehicle'* (ZLEV) means a passenger car or light commercial vehicle with tailpipe emissions from zero up to 50 g CO_2/km, i.e. battery electric vehicles (BEV), fuel-cell electric vehicles (FCEV) and certain plug-in hybrid electric vehicles (PHEV).

No evaluation of the new obligations that were introduced in Regulation (EU) 2019/631 was carried out as they have not yet entered into application, in particular with regards to the new targets and the incentive mechanism for zero- and low-emission vehicles. For the other elements of the Regulation, the conclusions of the 2015 evaluation study[18] reflected in the 2017 impact assessment[19] remain valid.

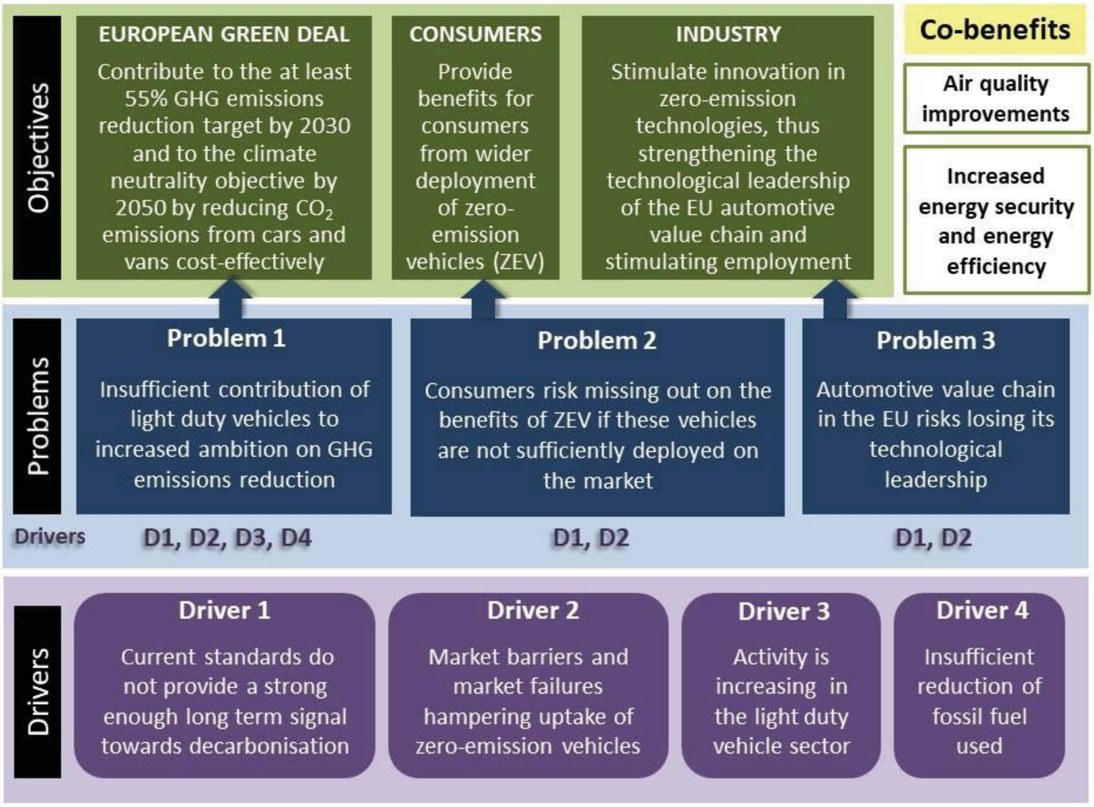
The issue of the growing discrepancy between emissions measured with the former NEDC laboratory test and the real world CO_2 emissions, which was identified in the 2017 impact assessment as a driver of the growing 'emissions gap'[20] has been addressed by the introduction of a new test procedure (WLTP), the revision of the type approval framework and through specific governance provisions in Regulation (EU) 2019/631. Implementing legislation to operationalise these provisions has been put in place[21] and will be further developed. In particular, the monitoring and reporting of the real-world CO_2 emissions of cars and vans, which will start from 2021 onwards, will ensure a more robust and effective implementation of the legislation. Furthermore, the Commission plans to amend the type approval legislation[22] to better reflect the real-world CO_2 emissions of PHEVs under the WLTP test procedure. More information can be found in Annex 5.

[18] https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/evaluation_ldv_co2_regs_en.pdf
[19] SWD(2017) 650 final
[20] The main concern is that a growing gap, which was not anticipated in the policy design, would undermine the effectiveness of the CO_2 targets. By monitoring the evolution of the gap based on data from on-board fuel consumption monitoring, as foreseen under the Regulation, the Commission will be able to mitigate this impact in case it would materialise.
[21] Commission Implementing Regulation (EU) 2021/392 of 4 March 2021, see Annex 5
[22] Amendment of the WLTP Regulation (EU) 2017/1151 setting out the CO_2 emission test procedure for light duty vehicles

2 PROBLEM DEFINITION

The drivers and problems that are relevant for the revision of CO_2 standards for cars and vans, the co-benefits and the objectives pursued are presented in **Figure 2.**

Figure 2: Drivers, problems, objectives



2.1 What are the problems?

Three key problems have been identified.

2.1.1 Problem 1: Insufficient contribution of light-duty vehicles to increased ambition on GHG emissions reduction

While this problem is not entirely new, and it was one of the problems tackled in the current legislation setting CO_2 emission standards for vehicles, its relevance and importance have been enhanced in view of the higher climate ambition for 2030 and 2050, as set out in the European Climate Law. This new context also underpins the continued relevance of the other two problems described below.

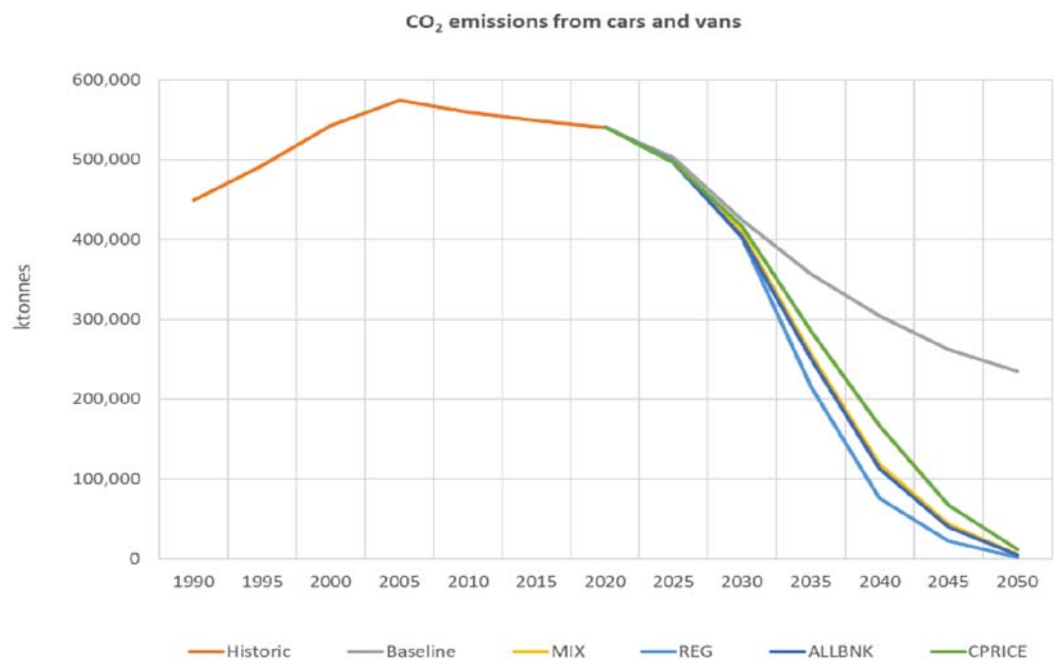
Overall transport GHG emissions (including international aviation and international maritime) represented 27% of total EU emissions in 2018, with road transport accounting for around 70% of transport emissions. Within road transport, emissions of cars and vans in turn represented around 70%. Carbon dioxide contributes around 99% of the total amount of greenhouse gases emitted by cars and vans, with methane and nitrous oxide emissions only playing a minor role. Measures tackling those other GHG emissions, which are also pollutants that pose a threat to human health, will be considered in the context of the impact assessment supporting the revision of the air pollutant emission standards.

The CO_2 standards for cars and vans set in Regulation (EU) 2019/631 for the years 2020, 2025 and 2030 will stimulate the gradual uptake of more efficient vehicle technologies and of zero- and low-emission vehicles, making them more affordable through increased supply and will drive emission reductions in the sector to the benefit of society.

According to the findings in the Communication on stepping up Europe's 2030 climate ambition, with the standards of Regulation (EU) 2019/631, CO_2 emissions from road transport would diminish by around 16% by 2030 and by 44% by 2050 compared to 2015, with emissions diminishing by 23% by 2030 and 56% by 2050 for cars and by 13% and respectively 57% for vans.

In the scenarios of the Climate Target Plan, in order to reach the at least 55% emission reduction target by 2030 and climate neutrality by 2050, emissions of road transport would need to diminish by between 19% and 21% by 2030 and by between 98 and almost 100% by 2050. **Figure 3** shows the historic and projected evolution of CO_2 emissions of cars and vans in the EU.

Figure 3: Historic[23] and projected[24] CO_2 emissions (kt) from cars and vans under the scenarios of the Climate Target Plan



This shows that maintaining the CO_2 emission standards of Regulation (EU) 2019/631 would be insufficient to drive down emissions to the levels consistent with the 2030 at least –55% target and the 2050 climate neutrality objectives. 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. Early action also ensures a smooth

[23] EEA GHG data viewer (http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer), extracted on 06/10/2020

[24] Scenarios from the analysis of the Climate Target Plan - COM/2020/562 final and SWD(2020) 176 final

pathway towards the emission reductions for 2050 and no overly steep action with its socio-economic consequences being required in later decades.

2.1.2 *Problem 2: Consumers risk missing out on the benefits of zero-emission vehicles if these vehicles are not sufficiently deployed on the market*

As shown in the Climate Target Plan, over the coming decade a large deployment of zero-emission vehicles (ZEV) is necessary for significantly reducing the GHG emissions of light-duty vehicles and achieving the increased climate ambition.

Such vehicles perform better from a life-cycle assessment perspective (see Annex 8). They do not only contribute to achieving Europe's climate objectives, but will also offer advantages to the consumers and companies buying and/or using them. Firstly, ZEV are cleaner as they do not have tailpipe emissions of air pollutants such as nitrogen oxides and particles. Secondly, as electric motors are more efficient than combustion engines, less energy is needed to drive an electric car and users may save on fuel/energy costs.

The implementation of the CO_2 emission standards of Regulation (EU) 2019/631 is projected to deliver around 25% battery electric vehicles in the EU new fleet by 2030 (see Table 4 in Section 6.1). Also globally, according to analysts, the market uptake of these vehicles is projected to further increase over the coming years[25, 26].

However, without further action, due to a number of market barriers and failures (see Section 2.2.2, driver 2), there is a risk that the scale of future uptake of ZEV may not reach sufficient levels so that all households and businesses could reap those benefits. In particular, in case the affordability of ZEV does not become comparable to that of internal combustion engine vehicles, zero-emission mobility would risk remaining accessible to too few consumers and companies. The role of CO_2 emission standards in incentivising the market uptake of ZEV to the benefits of consumers is key, as demonstrated by the surge in sales of zero-emission vehicles in 2020. While EV sales were growing slowly (by 1 percentage point or less) in the preceding years, they significantly increased from around 3% to 11% in one single year once the stricter 2020 targets came into force. This is a strong indication of the risk that, even if the ZEV share can be expected to continue to rise in the coming years, the steep increase in their uptake needed to reach climate neutrality in 2050 will not materialise without further action.

While it is not possible to predict the evolution of future consumers purchasing behaviours, there is strong evidence that a regulatory framework acting on the supply side is a key factor to increase the number of efficient and zero-emission vehicles models coming to the market. This framework can influence marketing strategies from manufacturers and, as a consequence, impact consumers demand, together with the necessary flanking measures, especially the availability of recharging infrastructure.

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[25] Source: IEA, Global EV Outlook 2020 (https://www.iea.org/reports/global-ev-outlook-2020). In the IEA's Stated Policies Scenario (illustrating the likely consequences of existing and announced policy measures and the expected effects of announced targets and plans from industry), the sales of so-called 'electric' LDV (light duty vehicle) - i.e. both BEV and PHEV - reach almost 25 million by 2030 (17% of total sales); 'electric' LDV stock would increase from 7.5 million vehicles in 2019 to almost 50 million by 2025 (3% of the total stock) and to 135 million by 2030 (120 million cars and 15 million vans; 8% of the total stock). In 2030, about two-thirds of the global 'electric' vehicle fleet are BEV.

[26] Source: Bloomberg, Electric vehicle outlook 2020 (https://about.bnef.com/electric-vehicle-outlook/). Sales of BEV and PHEV are expected to reach 10% of global passenger vehicle sales in 2025, rising to nearly 30% in 2030 and close to 60% in 2040; around three quarters of these sales in 2030 are BEVs and their share is expected to increase further in 2040.

2.1.3 *Problem 3: Automotive value chain in the EU risks losing its technological leadership*

Europe is a global leader in overall automotive R&D investment. Global automotive R&D is heavily concentrated in a few European countries, Japan and South-Korea, with these countries accounting for 70% of total R&D expenditure. At the same time, China's presence in automotive R&D is becoming more evident than before, especially due to their investments in developing EV technologies[27].

The EU automotive industry has traditionally led the way in technological developments for internal combustion engines. However, demand for new zero-emission powertrains, including electric ones, is surging globally as countries and companies are committing to decarbonise their economies, target climate neutrality and put forward actions to improve air quality. At the same time, the digital transformation and trends such as autonomous driving, car sharing and integration of road transport into digital multimodal and mobility as a service offerings also require a refocusing of R&D efforts.

Looking at the top players' patents of green, as well as green-digital technologies over the period of 2000-2008, European automotive companies have had a strong and dominant presence, followed by companies from Japan and the U.S. (see Annex 7)[28]. Over the past decade, world-wide patenting in green transportation technologies has continued to grow[29]. In the period 2005-15 the most important vehicle technologies all related to electrification, i.e. hybrid vehicles, charging stations for electric vehicles, and electric propulsion technologies with off-vehicle charging. Three countries, Japan, China and the U.S. accounted for 63% of all patent families in green transportation technologies in 2005-15. China has become a world leader in the patenting of green transportation technologies, in particular as regards charging stations.

The global market for ZEV specifically is growing rapidly, with electric car sales topping 3.1 million globally in 2020[30], with Europe, China and the United States accounting for over 90% of sales[31]. In 2020, Europe has emerged as a leading market for EVs, surpassing China in terms of market share of new electric vehicle registrations - around 10% of total sales in Europe[32] as compared to only 5.7% in China[33]. However, the global race to electrify light-duty vehicles will be a close one as China has the fastest growth of charging infrastructure, and a competitive advantage in EV battery production: in 2019, China produced above 1 million batteries for electric vehicles, whereas Europe produced just above 200,000, also falling behind the US producing almost 400,000 in the same year[34]. In terms of EV technology and battery capacity, the US is developing the fastest, followed by Europe that fluctuates around the global average[35].

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[27] https://www.eib.org/en/publications/investment-report-2020.htm
[28] https://www.eib.org/en/publications/investment-report-2020.htm
[29] WIPO, 2018, https://www.wipo.int/edocs/pubdocs/en/wipo_pub_econstat_wp_44.pdf
[30] IEA, Global Electric Vehicle Outlook 2021, https://www.iea.org/reports/global-ev-outlook-2021?mode=overview
[31] IEA, Global electric car sales by key markets, 2010-2020, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-electric-car-sales-by-key-markets-2015-2020
[32] https://www.acea.be/press-releases/article/fuel-types-of-new-cars-electric-10.5-hybrid-11.9-petrol-47.5-market-share-f
[33]. IEA, Global Electric Vehicle Outlook 2021, https://www.iea.org/reports/global-ev-outlook-2021?mode=overview
[34] https://theicct.org/publications/china-green-future-ev-jan2021
[35] *idem*

In 2020, a particularly strong surge in ZEV sales has been observed in Europe, mainly driven by the tighter CO_2 standards and in some cases also by financial incentives. This trend can be expected to continue with the application of stricter CO_2 emission standards (as described in problem 2).

The trend towards ZEV is creating new business opportunities for automotive manufacturers, which have already started adding a broader range of such vehicles to their portfolios. However, the mounting international competition in the development of ZEV risks negatively affecting the competitiveness of parts of the EU automotive industry.

As zero-emission technologies have developed rapidly, new players focusing on ZEV have emerged across the globe, some of which have started entering the EU market. Those particularly successful in taking up a share of the EU EV fleet have been achieving this by offering a combination of electric driving with innovative vehicle design and advanced data management. This showcases how an innovative approach in manufacturing, promoting and selling electric vehicles is important.

Policy developments towards lower carbon emissions have been a key driver for investments in zero emission technologies. During the years 2017-2018 when ambitious EV policies were adopted in China, investments in e-mobility were reported to be seven times higher in China (€21.7 billion) than in the EU (€3.2 billion). In 2019, with the forthcoming new CO_2 standards for 2020/21, the EU attracted large investments (around € 60 billion) in EV and batteries, nearly 20 times more than in 2017/2018 and 3.5 times more than in China[36].

Clear regulatory signals sent to the automotive industry have therefore proven to be crucial for delivering EV investment decisions. Without such clear signals, 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 necessary charging infrastructure for zero-emission vehicles.

Such delays could create a risk that the automotive industry in the EU could lose its technological leadership by not investing sufficiently rapidly and even lose market share in the EU market itself, and not be the front runner in the fast growing new market of zero-emission vehicles. As a result, the automotive industry value chain in the EU would risk not fully reaping the benefits of the economies of scale offered by its home market, which would otherwise increase its competitiveness also in global markets.

2.2 What are the problem drivers?

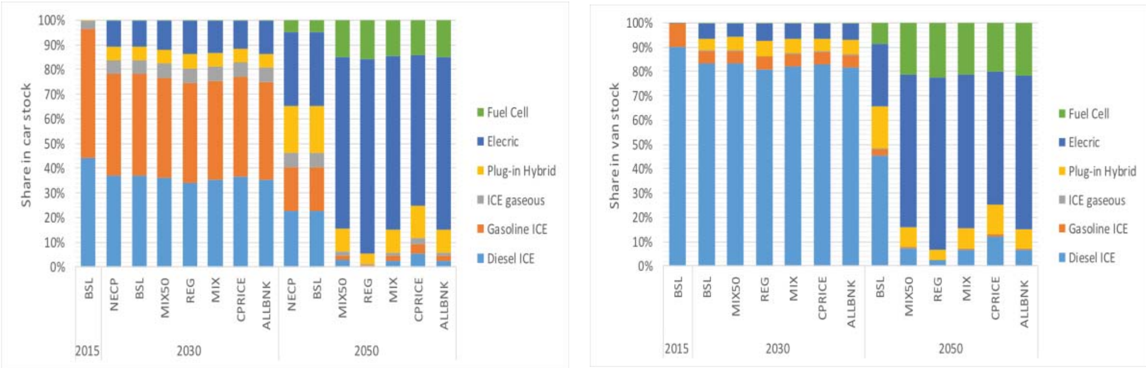
2.2.1 Driver 1: Current standards do not provide a strong enough long term signal towards decarbonisation

The analysis of the Climate Target Plan shows that with the current CO_2 emission standards of Regulation (EU) 2019/631, the share of zero emission cars and vans in the total vehicle stock is projected to be 11% and 7%, respectively, by 2030. With existing policies and targets reflected in the baseline (BSL), zero- and low-emission vehicles are projected to reach 54% of the stock in 2050, but internal combustion engine vehicles remain common in the fleet. However, to reach the climate neutrality objective, the analysis shows that by 2050, almost all

[36] https://www.transportenvironment.org/sites/te/files/publications/2020_05_Can_electric_cars_beat_the_COVID_crunch.pdf . The investments targeted mainly 8 countries, with €40 billion in Germany mainly from the VW Group, also investment made by Tesla. €6.6 billion also invested in the Czech Republic by VW Group

cars (between 88-99% of the vehicle stock) and almost all vans (between 87-97% of the vehicle stock) would need to be zero- or low- emission (**Figure 4**).

Figure 4: Car and van stock by type of drivetrain in 2030 and 2050 [37]



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 zero emission vehicles for the EU market to contribute to the new overall 55% GHG emission reduction target for 2030 and the 2050 climate neutrality objective.

This initiative will help address this driver.

2.2.2 Driver 2: Market barriers and market failures hampering the uptake of zero-emission vehicles

Market barriers

** Affordability*

Over the past years, the market for ZEV has steadily developed rapidly and costs of batteries have fallen faster than anticipated, by 87% in 2019 compared to 2010[38]. However, current prices of ZEV are still significantly above those of comparable ICEV and there is little offer at the lower end of the price range (see Annex 7).

According to the automotive market analyst JATO[39], in the first half of 2019, the retail prices for the five top selling ZEV models in Europe were all above the average new car retail price. While the interest rates for loans are historically low and new business models may help to lower the amount of upfront spending, e.g. by offering a lease contract for the battery, the affordability of ZEV risks continuing to be a barrier to their uptake, in particular in Member States with lower GDP per capita.

Furthermore, JATO[40] noted that ZEV retail prices have not been falling over the past years. As illustrated in Annex 7, battery electric cars became more affordable during the last decade only in China, mostly due to government incentives, and the launch of small and very cheap models. In Europe, the average Battery Electric Vehicles (BEV) price increased by more than 40% between 2011 and 2019 as manufacturers were focusing on premium and larger mid-size cars, leaving very few offerings in the entry-level segments. The average retail price

[37] Source: Climate Target Plan
[38] Bloomberg, 2019: Battery pack prices fall as market ramps up with market average at $156/kWh In 2019 https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/
[39] https://www.jato.com/electric-cars-cost-double-the-price-of-other-cars-on-the-market-today/
[40] https://www.jato.com/ev-prices-have-been-growing-during-the-last-8-years/

(excluding any kind of incentive) of BEV sold in Europe and the US in 2019 was 58% and 52% higher than in China, respectively.

With the production of ZEV increasing and zero emission technologies - in particular batteries - developing at scale, the production costs are expected to decrease over the coming years. Adding increased numbers of smaller models should thus make ZEV more affordable for more consumers.

Nevertheless, the trends seen in the past decade show that there is a risk that this may not fully materialise as anticipated and that the offer of ZEV which are affordable to a broad range of consumers may remain limited.

Also, while some analysts consider that ZEV could achieve cost parity with ICEV in the mid-2020s across most segments[41], the risk remains that this will not materialise so soon[42]. The evolution of the battery prices, which decreased dramatically over the last years, and which are projected to continue decreasing significantly, will have a positive impact on the production cost of vehicles, but there is a risk that this may not be fully reflected in the vehicle retail price, as manufacturers may aim to maximise their return on investments made for the development of conventional technologies and/or on their R&D expenditures for new technologies.

Up to now, most of the zero-emission vehicles put on the market have been in the higher segments, with however little choice amongst the more affordable models and segments. While this is changing as more and more manufacturers are starting to produce ZEV and broaden their ZEV portfolio, as shown by the market evolution in 2020, the regulatory framework will continue to play a key role in determining the speed by which the marketing of ZEV models will evolve in the future. All of this means that, even in case of reaching cost parity, there is no guarantee that access to individual zero-emission mobility will become affordable for all consumers, quickly enough to ensure the necessary uptake of ZEV in view of the increased climate ambition. The risk is highest for lower income groups, as they also have less access to financing possibilities. This puts at risks the milestone that by 2050 nearly all cars and vans on European roads will need to be zero-emission in order to reach climate neutrality, as highlighted by the Climate Target Plan. Achieving this milestone is premised on the need to ensure that such vehicles are supplied to the market and affordable for all EU citizens and businesses.

** Lack of information, uncertainties, lack of vehicle models*

Furthermore, when facing a shift to a new technology requiring to adapt long standing habits, the uncertainties faced may prevent consumers to make this switch. In the case of ZEV, they might have anxiety over its electric range and on where and how to recharge or refuel it *(see also below),* uncertainty on the battery life and on the resale value of the vehicle given expected further technical improvements[43]. Also, buyers may find it difficult to understand or quantify the benefits of using the technology, including the fuel or energy cost savings from ZEVs.

[41] Bloomberg, 2019: Electric Car Price Tag Shrinks Along With Battery Cost https://www.bloomberg.com/opinion/articles/2019-04-12/electric-vehicle-battery-shrinks-and-so-does-the-total-cost

[42] Fleeteurope, 2020: EV price parity may not arrive until 2030s https://www.fleeteurope.com/en/new-energies/europe/features/ev-price-parity-may-not-arrive-until-2030s?a=FJA05&t%5B0%5D=Electrification&curl=1

[43] European Environment Agency (2016): Electric vehicles in Europe, EEA Report No 20/2016

The smaller number of ZEV models on the market compared to their ICEV counterparts across the different segments and price categories may also create a barrier for consumers.

** Lack of recharging and refuelling infrastructure*

A particularly critical barrier to the market uptake and consumer acceptance of ZEV is the limited availability of infrastructure to recharge or refuel them, as the level of current infrastructure deployment is only sufficient to serve the rather low number of alternatively fuelled vehicles currently on the road[44]. While gas stations offering diesel and petrol are abundant across the EU, in many countries electric charging points have only started appearing recently in the public domain[45]. Furthermore, the infrastructure is not deployed evenly across the EU, leading to parts of the EU transport network being not sufficiently equipped while issues with regards to interoperability and user information persist. In view of the expected uptake of ZEVs by 2020 and beyond[46], the pace of recharging infrastructure roll-out needs to accelerate. Information on such market barriers and options for more binding roll out targets and targets that link the number of recharging and refuelling stations that are needed to the vehicle fleets that are likely to be in operation under initiatives such as the CO_2 standards, are considered in the Impact Assessment for AFID.

By acting on the supply of ZEV, this initiative will contribute to address the market barriers related to the availability of ZEV in various market segments and to their affordability. This initiative will also provide clear signals for investments in zero-emission technologies, thereby addressing the risks for industry in the EU of losing its technological leadership.

The upcoming revision of the Alternative Fuels Infrastructure Directive will be a key instrument to address shortcomings with regards to recharging and refuelling infrastructure. It complements the investment signals on infrastructure provided for by the CO_2 emission standards which act on the supply of vehicles.

Market failures

** Environmental externalities*

Even if the market was perfectly competitive and there was perfect information available to all agents, market forces would unlikely deliver the societal optimum in terms of CO_2 emissions. This is because vehicle manufacturers and purchasers do not directly experience this external environmental cost and therefore tend not to take it into account in their production and purchase decisions.

** Consumers undervaluing fuel savings*

Due to a lack of information and the challenge of making fully rational economic calculations, few consumers will consider the lifetime costs when purchasing a new car[47]. This is particularly the case for individual consumers. Users will tend to undervalue future cost savings in particular with regards to fuel consumption, as a result of which it may not appear

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[44] See impact assessment on AFID revision.

[45] https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats (at the end of 2020, around 225,000 public electric charging points were installed in Europe, up from around 48,000 in 2015)

[46] Commission Staff Working Document (2019), Report on the Assessment of the Member States National Policy Frameworks for the development of the market as regards alternative fuels in the transport sector and the deployment of the relevant infrastructure pursuant to Article 10 (2) of Directive 2014/94/EU.

[47] Eurobarometer survey on climate change in 2019 shows that around one in ten citizens (12%) say that low fuel consumption was an important factor in their choice of purchasing a car, https://ec.europa.eu/clima/sites/clima/files/support/docs/report_2019_en.pdf

attractive to pay more upfront for a more efficient vehicle[48]. This is also due to the uncertainty on the evolution of fuel and energy prices over the vehicle lifetime as well as regarding the period during which they intend to own and use the vehicle. As passenger cars generally have multiple owners over their lifetime, only a part of the fuel savings would be experienced by the initial purchaser.

** Split incentives*

Finally, a part of the cars and vans fleet is also affected by split incentives in the market, leading to a preference for purchasing less expensive vehicles over those with a more beneficial total cost of ownership. This is the case when the buyer of the vehicle is not bearing the fuel costs, for example in the case of rental cars. Depending on the fuel cost reimbursement policies and the purchase dynamics, this may apply for vans and for leased vehicles which have a share of around 30% of new registrations in the EU and of which most are company cars.

The initiative on the CO_2 emission standards will help address the market failures described above. At the same time, pricing policies such as the possible emissions trading for buildings and road transport as well as the revision of the Energy Taxation Directive and the Eurovignette Directive could act on these failures. However road transport fuels are already subject to high level of taxation and very high carbon prices would be required to have an effective impact on these market failures. These effects are further analyzed in their respective impact assessment reports.

2.2.3 Driver 3: Activity in road transport is increasing

As shown in the Climate Target Plan, despite profound shifts in mobility being underway, such as shared mobility services and easier shifts between modes, and policies aimed at increasing the efficiency of the transport system, EU light-duty transport activity is expected to continue to grow (see Annex 7).

The COVID-19 crisis and the subsequent lockdowns have led to a decrease in road transport activity. However, the short to medium-term effects of the COVID-19 crisis may also lead to increases in the road transport activity, in particular on the private use of cars as health concerns have induced some people to avoid the use of public transport and increase the use of private cars.

This initiative will not address this driver as CO_2 emission standards do not directly affect transport activity. This is addressed by policies targeting multimodal transport mobility as a service, low and zero emission zones for individuals or logistics, wider city planning initiatives including in the Renovation Wave and Bauhaus plans, and carbon pricing policies including the possible emissions trading for buildings and road transport.

2.2.4 Driver 4: Insufficient reduction of fossil fuel used

The EU-27 transport sector is currently relying very largely on fossil fuels as oil-derived fuels account for 93% of energy consumption in transport (with road transport depending on oil products of 94% of its energy use)[49]. After reaching its peak in 2007, oil consumption in transport (including international aviation and maritime) decreased by 12.2% during 2007-

[48] David L. Greene PhD, 2018. https://ww2.arb.ca.gov/sites/default/files/2018-10/10-21-2018_Greene_UTenn-Consumer_Behavior_Modeling.pdf

[49] SWD(2020) 331 final

2013 (-2.1% per year). Since 2014, oil consumption has been following an upward trend at an average rate of 1.9% per year. As a consequence, the total EU oil import bill is estimated at EUR 227.5 billion in 2018[50].

The road transport fossil fuel supply in 2018 was dominated by diesel (59.8%), followed by petrol (23.3%). Without further intervention, oil products would still represent about 89 % of the EU transport sector needs in 2030 and 77% in 2050[51]. Different reasons explain this situation.

Despite the current CO_2 emission standards for vehicles, the vehicle stock share of internal combustion engines powered cars and vans using diesel, petrol or gas is today almost 98-99%, and it is projected to remain significant by 2030, more than 80% both for cars and vans.

Despite the current renewable energy policies, sustainable renewable and low-carbon fuels for transport are available in limited amounts, with the total renewable energy share in transport reaching 8.3% in 2018. Sustainable advanced biofuels are barely starting to be produced at scale, while power-to-liquid and power-to-gas fuels as well as clean hydrogen from renewable sources are available only at demonstration scale. As a consequence of high production costs, including for feedstocks, and lower technology and commercial maturity, available volumes of these fuels are limited, and prices are not competitive with the fossil-based fuels.

The shares of renewable and low carbon fuels are projected to remain limited in 2030.

The current fiscal framework for fuels often does not take into account CO_2 emissions and it thus tends to be ineffective to shift away from fossil fuels. In addition, lack of harmonisation across Member States is also likely to hamper the development of an internal market of alternatives to fossil fuels at sufficient scale. This constitutes an inefficient use of a potentially important instrument to internalise the climate change externality.

The lack of an efficient/strong carbon pricing, through fiscal policies or market-based mechanisms, also does not incentivise behavioural changes that could potentially reduce fossil fuel use.

This impact assessment will look at how the CO_2 emission standards can address this driver, in particular in relation to the impacts on the deployment of zero emission vehicles and the use of electricity as fuels.

However, some of the underlying issues will also be tackled in other initiatives. The issue of promotion of renewable and low-carbon fuels will be looked at in the impact assessment for the Renewable Energy Directive. The issues of carbon pricing and taxation are assessed in the impact assessments for the revision of the EU ETS and the Energy Taxation Directive. Wider energy system integration and benefits of direct electrification for energy system efficiency will be pursued under Commission initiatives under the Energy System Integration Strategy.

2.3 How will the problem evolve?

According to projections, with the CO_2 emission targets set out in Regulation (EU) 2019/631, there will be a significant emissions gap both in 2030 and in 2050 that will need to be closed, in order to ensure a sufficient contribution to the increased 2030 climate ambition, as well as by the objective of climate neutrality by 2050.

[50] SWD(2020) 951 final.
[51] Reference Scenario 2020

The baseline for this impact assessment is the Reference Scenario 2020, which models the existing 2030 climate and energy legislative framework, as further referred to and elaborated on in Section 5.1.

In the Reference Scenario 2020, without further policy action, the CO_2 emission standards currently set out in Regulation (EU) 2019/631 would remain applicable after 2030. As a consequence, the Reference Scenario 2020 shows that emissions from cars and vans in 2050 would only decrease by around 39% as compared to 2005, giving raise to the problem described in section 2.1.1. One of the main reasons is related to the limited penetration of zero-emission vehicles, which are necessary to ensure higher emissions reduction, as shown in the scenarios analysed in the Climate Target Plan.

Without further strengthening of the CO_2 emission standards, the shares of zero-emission cars and vans circulating on the roads in 2050 would remain limited to around 44% and 42% respectively. Even when considering a scenario with all the policies included in the MIX scenario except the strengthening of the CO_2 emission standards, the shares of zero-emission cars and vans on European roads in 2050 would be around 60% and 54% respectively, and emissions from cars and vans in 2050 would decrease by around 50% as compared to 2005. This is largely insufficient for reaching the climate neutrality objective.

As a result, the analysis of the evolution of the problem highlights the need to strengthen the CO_2 emission standards currently set out in Regulation (EU) 2019/631 despite the fact that this legislation came recently into force.

Full details are available in the publication related to the Reference Scenario. In addition, Section 6 presents the different impacts of the baseline scenario, as relevant.

3 WHY SHOULD THE EU ACT?

3.1 Legal basis

Title XX (Environment) of the Treaty on the Functioning of the European Union (TFEU), in particular 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 cars and vans through Regulation (EC) 443/2009 and Regulation (EU) 510/2011, which were repealed and replaced by Regulation (EU) 2019/631, currently effective since 1 January 2020.

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.

In light of the ambitious emission reduction target for 2030 in the perspective of the climate neutrality objective, stronger EU action is needed to ensure a sufficiently high contribution of the road transport sector standards. As underlined in the Climate Target Plan, Regulation (EU) 2019/631 therefore needs to be revisited and strengthened to ensure a clear pathway towards zero emissions mobility.

3.3 Subsidiarity: Added value of EU action

Although initiatives at the national, regional and local level can create synergies, alone they will not be sufficient. Lack of coordinated EU action via the strengthening of CO_2 emission standards would translate into a risk of 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, therefore, an EU wide approach is needed to drive industry level changes and to create economies of scale.

Market fragmentation would potentially translate to competitive distortions, a risk of tailoring national legislation to suit local industry, and compliance costs (passed on to consumers) 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.

Furthermore, while national, regional or local fiscal incentives play a role to incentivise the market uptake of zero-emission vehicles, they are easily reversible, and therefore they do not provide the needed long-term market signal and predictability. Coordinated EU action through the strengthening of 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

General policy objective

The general objectives of this initiative are to contribute to achieving climate neutrality by 2050 (i.e. achieve net zero GHG emissions by 2050) and to this end, in line with the 2030 Climate Target Plan, to contribute to reaching at least 55% net greenhouse gas emission reductions by 2030 compared to 1990 This articulation of targets and objectives requires a coherent strengthening of the policy architecture for climate, including the Regulation on CO_2 emission standards for cars and vans.

Specific objectives

1. Contribute to the 2030 at least -55% net GHG emissions target and to the climate neutrality objective by 2050 by reducing **CO_2 emissions** from cars and vans cost-effectively and thereby supporting Member States in meeting their target under the ESR, in case of a continued ESR scope.;
2. Provide benefits for **consumers and citizens** from wider deployment of zero-emission vehicles;
3. Stimulate **innovation in zero-emission technologies**, thus strengthening the **technological leadership** of the EU automotive value chain and stimulating employment.

The first specific objective concerns the contribution of cars and vans to the **increased overall climate ambition** for 2030 and 2050. With road transport causing 20% of EU GHG emissions in 2018, improving the CO_2 efficiency of new cars and vans is of key importance.

The majority of industry representatives, public authorities, and other stakeholders responding to the public consultation considered this objective important. More than half of responding citizens saw it as important or somewhat important (more information provided in Annex 2).

Considering that the effect of the CO_2 emission standards on the reduction of emissions from the running stock of vehicles is not immediate, and considering the dynamics of the fleet renewal, early action is important to ensure the achievement of the long term objective.

The second specific objective is related, in line with the European Green Deal, to **providing benefits to consumers** from a wider deployment of zero-emission vehicles. Policy action on CO_2 emission standards should aim at incentivizing the market supply of zero-emission vehicles, which provides (i) air quality benefits, in line also with the "zero pollution ambition" of the European Green Deal and the Commission's Communication on a Pathway to a Healthy Planet for All[52], and (ii) reduction of energy consumption, lowering energy bills, in line with the "just transition" objective of the European Green Deal. This aspect is specifically important in a context where policies on fuels could increase the energy prices for consumers and business. Providing benefits for the consumers is also essential to create buy-in for climate-related action.

These benefits for consumers and citizens were highlighted in the responses to the open public consultation on this initiative. Most responding public authorities, citizens and other stakeholders considered air pollution as an important or somewhat important co-benefit. Furthermore, the majority of all stakeholder categories considered that reducing the total cost

[52] COM(2021) 400 final

of ownership is an important objective. The European Consumer Organisation (‘BEUC’, which is an umbrella group for European consumer organisations) rated this objective as highly important.

The third specific objective relates to **innovation, technological leadership and employment**. This objective is strongly rooted in the European Green Deal as a new growth strategy, which aims at transforming the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy.

This objective was the one most supported by all stakeholder categories among respondents to the public consultation (80% of public authorities, 78% of industry respondents, 72% of other stakeholders and 69% citizens).

The Commission Communication “A New Industrial Strategy for Europe”[53] states the need for an industrial policy, fit for the ambitions of today and the realities of tomorrow. At the heart of this is the ability of Europe’s industry to lead the twin transitions and drive its competitiveness. It cannot afford to simply adapt, it must become the accelerator and enabler of change and innovation. The Strategy also highlights that the EU must leverage the impact, the size and the integration of its single market to set global standards. By providing a common regulatory space and scale, the single market is the driver of competitiveness. This is particularly important for the transport sector, where the green transition offers great opportunities for European industry across the value chains to modernise, create high-quality jobs, develop new products and services, and strengthen competitiveness.

While the EU automotive sector has been successful in developing and manufacturing advanced internal combustion engine vehicle technologies and marketing them world-wide, it will need to adapt to the ongoing global transition towards zero- emission mobility and increasingly channel investments in zero emission technologies.

By providing a clear regulatory signal for industry to develop and invest in zero-emission vehicles, the objective is to foster innovation and thereby to maintain the technological leadership of the EU automotive value chain and stimulate employment in these new technologies.

The three specific objectives are all linked to the necessary increasing share of zero-emission vehicles on the EU market which will reduce CO_2 emissions from light-duty vehicles, provide benefits to consumers in terms of air quality (especially in urban areas) and energy savings, and strengthen the technological leadership of the EU automotive value chain. Additional co-benefits are expected to be the **increased energy efficiency and energy security** as the demand for imported oil will decrease.

[53] COM(2020) 102 final

5 WHAT ARE THE AVAILABLE POLICY OPTIONS?

This Section describes the options identified to address the problems listed in Section 3 and to achieve the objectives defined in Section 4. It sets out the rationale for their selection and design, taking into account the public consultation, additional stakeholder input as well as internal and external study reports.

The options explored reflect the outcome of the open public consultation and are grouped into the following categories:

(i) CO_2 emission targets for cars and vans (levels, timing, modalities);

(ii) specific incentives for zero- and low-emission vehicles (ZLEV);

(iii) a mechanism to take into account the potential contribution of renewable and low-carbon fuels for the purpose of target compliance assessment.

5.1 What is the baseline from which options are assessed?

The baseline for the assessment is built on the EU Reference Scenario 2020, which reflects the provisions laid down in the current Regulation (EU) 2019/631 and in particular the CO_2 emission targets set out therein[54], as summarised in **Table 2**.

Table 2: EU fleet-wide target levels in the baseline scenario (TL_0), i.e. as set out under the current Regulation (EU) 2019/631 (2020 targets in g/km NEDC; 2025 and 2030 targets as % reduction compared to 2021 WLTP baseline)

	2020	2025	2030
Cars	95 g/km	15%	37.5%
Vans	147 g/km	15%	31%

5.2 Description of the policy options

5.2.1 CO_2 emission targets for cars and vans

5.2.1.1 Target levels (TL)

Since the specific WLTP emission target values for 2021 (in g/km) will only be determined in 2022, the new emission targets should be defined as a reduction percentage compared to the 2021 starting point defined in Annex I of the Regulation.

The options for the EU-wide fleet average target levels for cars and for vans set out in this Section are defining the target trajectory over the period 2025-2040 in five-year steps, without prejudging the levels of the targets applicable in the intermediate years. Options as regards these intermediate targets are set out in Section 5.2.1.2.

Table 3 summarises the EU fleet-wide CO_2 emission target levels under the three options considered, reflecting Low, Medium (Med) and High emission reduction percentages. These target levels are consistent with the levels in the scenarios of the Climate Target Plan, and

[54] A detailed explanation on the transition from NEDC to WLTP based targets and on the definition of the 2021 WLTP baseline is given in Annex 5

they are embedded in the core policy scenarios described in Annex 4. Annex 9 provides a description of the main findings of the Climate Target Plan.

Table 3: Target levels under the options considered (% reduction compared to 2021 starting point)

	2025		2030		2035		2040	
	Cars	**Vans**	**Cars**	**Vans**	**Cars**	**Vans**	**Cars**	**Vans**
TL_Low	15%	15%	40%	35%	60%	55%	80%	80%
TL_Med	15%	15%	50%	40%	70%	70%	100%	100%
TL_High	15%	15%	60%	50%	100%	100%	100%	100%

During the open public consultation, vehicle manufacturers and respondents representing the fossil fuel industry supported no or limited change in the current ambition level while public authorities and environmental NGOs called for the most ambitious levels, including an increase of the 2025 emission targets. The higher ambition option received certain support across stakeholder categories as part of the public consultation. For public authority, environmental and consumer organisation respondents, the preferred year for a 100% reduction target for both new cars and vans was 2035. Around 13 % of industry respondents and 10% of responding citizens also considered 2035 the date by when all new cars and vans should be zero-emission. Some environmental NGOs even call for more ambition. The European Consumer Organisation (BEUC) also supported the high ambition option. Some Member States already made announcements for the phase-out of combustion engines in the period between 2030 and 2040.

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

Manufacturer specific target levels

Starting from the EU fleet-wide targets set out in it, Regulation (EU) 2019/631 defines the specific emission targets for individual manufacturers using a limit value curve, based on the average mass of a manufacturer’s new vehicle fleet in a given year.

During the stakeholder consultation, manufacturers supported maintaining the current regulatory approach while environmental NGOs called for removing the use of the limit value curve.

The current approach recognises that heavier vehicles require more energy for their propulsion. The Regulation foresees that the slope of the limit value curve will become lower over time as the EU-fleet wide targets become stricter. This means that the effect of the average vehicle mass on a manufacturer’s target will diminish and the manufacturer specific targets will equalize over time. Furthermore, from 2025 onwards, the adjustment of the reference vehicle mass, which should ensure that the average of the manufacturer’s specific targets does not deviate from the EU fleet-wide targets, will take place every two years instead of three-yearly as is currently the case. In this way, the limit value curve should better reflect trends in fleet mass.

It therefore does not appear necessary to look at options to change the methodological approach for the calculation of the manufacturers' specific targets.

The approach of setting fleet-wide CO_2 emission targets provides manufacturers with flexibility in their fleet composition. Compliance can be achieved by increasing the share of zero- and low-emission vehicles and/or by improving the average efficiency of the ICEV fleet. Some environmental NGOs have remarked that, as ZLEV shares increase, the fleet-wide targets may no longer require the ICEV fleet efficiency to improve and they recommended introducing a CO_2 emissions target for the ICEV fleet to prevent that its average emissions would increase over time.

However, it was acknowledged that the risk of such increase is limited as long as appropriate fleet-wide CO_2 targets are set, which reflect the market uptake of ZLEV. As the fleet-wide CO_2 targets become stricter over time, the share of ICEV in the fleet will shrink and the impact of these vehicles on the overall emissions will diminish.

Adding an ICEV fleet target to the Regulation would require an in-depth consideration of the appropriate reference level, of how it would apply across different manufacturers, which vehicles it should cover and its interaction with the overall CO_2 targets, with the provisions on pooling and on eco-innovation credits and with the ZLEV incentive mechanism. It would also require defining the level of fines to be imposed in case of non-compliance. An additional ICEV target would thus unduly add complication to the regulation for an uncertain added value.

In view of the above elements, the option of introducing an additional CO_2 emission target for ICEV is not taken forward.

5.2.1.2 Timing of targets

Regulation (EU) 2019/631 sets out annual EU fleet-wide CO_2 targets. The stringency of these targets increases in five-year steps. The targets which start applying in 2020 remain applicable until 2024. As of 2025 the targets become stricter and stay at these levels until 2029. Finally, the stringency of the targets is further increased as of 2030, and manufacturers will have to continue to comply with them in the period post-2030.

In the past, manufacturers have anticipated the 2015 EU fleet-wide targets for cars and the 2017 targets for vans and those targets had even been met a few years ahead of the deadlines. However, in the last years, ahead of the stricter targets applying from 2020, while the EU average emissions remained significantly below the applicable target levels, less anticipation was observed. Since 2017 for cars, and since 2018 for vans, average EU fleet-wide emissions even increased on a year-to-year basis[55].

A way to ensure a steady decrease of emissions over time, would be to set stricter targets more frequently, for example annually or for an intermediate year. This option is supported by environmental NGOs which call more specifically for an interim target in 2027. Manufacturers supported the continuation of a 5-year steps approach.

The following options will be considered for defining the year(s) for which stricter targets are set. These options apply both for passenger cars and vans.

- Option TT 0: Target decreasing in 5-year steps

  New CO_2 targets start applying every 5 years

[55] https://www.eea.europa.eu/data-and-maps/data/co2-cars-emission

- Option TT 1: Targets decreasing in less-than-5-year steps.

  New CO_2 targets start to apply annually or in some of the intermediate years. This could possibly be combined with some degree of flexibility as regards compliance by manufacturers, such as through a banking mechanism.

The majority of industry representatives responding to the public consultation stressed the need that targets should remain applicable for five years before being strenghtened, as in Option TT 0. This was supported in particular by automotive manufacturers and respondents representing the fossil fuel industry. Public authority respondents environmental organisations and the European Consumer Organisation (BEUC) largely supported strenghtening targets every year as in Option TT 1.

5.2.1.3 Use of the revenues from excess emissions premiums

Excess emission premiums are imposed on manufacturers in accordance with Article 8 of Regulation (EU) 2019/631, if their average specific emissions exceed their specific emission targets in a given calendar year. The amounts of the premiums shall be considered as revenue for the EU general budget. Such revenue decreases the Member States' own contributions to the EU budget.

The co-legislators have requested the Commission in Article 15(5) of the Regulation to assess the possibility to assign the revenue to a specific fund or programme, notably "*with the objective to ensure a just transition towards a climate-neutral economy as referred to in Article 4.1 of the Paris Agreement, in particular to support re-skilling, up-skilling and other skills training and reallocation of workers in the automotive sector in all affected Member States and in particular in the regions and the communities most affected by the transition*". Using the possible revenues for reskilling and upskilling objectives was specifically supported by manufacturers during the public consultation.

The following options will therefore be considered:

- 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
- Option REV 2: Consider the revenue as "own resources", within the meaning of Article 311 of the Treaty. Under this option the revenue would be considered reducing specifically the part of the own resources that are based on the gross national income of the Member States and would therefore have to be redistributed to ensure that the equity between Member States' contributions is maintained.

Public authorities and NGOs (including environmental and consumer organisations) responding to the public consultation were of the view that revenues from excess emission premiums should be allocated to a fund to support the just transition to a climate-neutral economy, in particular to support the automotive workers (REV 1). Most of industry respondents and citizens called for allocating them to funds serving other purposes, from supporting the decarbonisation efforts of the industry to climate mitigation efforts in general.

5.2.1.4 Derogations for small volume manufacturers

Regulation (EU) 2019/631 acknowledges that CO_2 targets should be determined differently for smaller manufacturers as compared to larger ones, taking account of their more limited possibilities to reduce average CO_2 emissions of their vehicle fleet.

The evaluation study of the former Regulations[56] identified the small volume derogation option[57] as a potential weakness, although its negative impacts had been relatively small. As part of the public consultation, manufacturers indicated their preference for maintaining this derogation. An option setting a phase-out date beyond 2030 is discarded. With a later phase-out date, the difference in terms of stringency would increase even further between manufacturers benefitting or not from a derogation. As a result, the emission reduction efforts for small-volume manufacturers would become too severe to catch up and meet a non-derogated target and ultimately zero-emission cars also in this market segment.

Taking into account the above, the following options will be considered:

- Option SVM 0: maintain the 'small volume manufacturers' derogations
- Option SVM 1: Remove the possibility for small volume manufacturers to be granted a derogation target from 2030 on. The choice of the date allows concerned manufacturers enough time to programme and adapt to the new regulatory requirements. It is also consistent with the application date of the strenghtened targets under the options presented in Table 3

Around a third of respondents to the public consultation supported revising the provision on the ‘small volume manufacturers’ derogations. However, manufacturers were generally against revising this provision. Public authorities’ and NGOs’ opinions were rather mixed or neutral.

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

5.2.2.1 Context

Since 2009, the Regulation setting CO_2 emission performance standards for cars has included a mechanism, in addition to the CO_2 targets, aimed to incentivise the uptake of vehicles with zero or low emissions. In a first phase, the incentive took the form of “super-credits”[58]. In the current Regulation (EU) 2019/631, super-credits can be obtained by car manufacturers for the years 2020 to 2022[59]. From 2025 on, a new “bonus-only” incentive scheme will apply, covering both cars and vans and targeting zero- and low-emission vehicles (ZLEV). ZLEV are defined as vehicles with CO_2 emissions of not more than 50°g/km (WLTP).

This new scheme aimed to incentivise the uptake of ZLEV beyond a given level without undermining the CO_2 targets. It intends to facilitate a smooth transition towards zero-emission mobility and should provide a strong and credible signal for the development, deployment and marketing of such vehicles[60].

Regulation (EU) 2019/631 sets out benchmarks for the share of ZLEV in a manufacturer’s fleet of new vehicles registered in a given year. If that ZLEV benchmark is exceeded, the specific CO_2 emission target (in g CO_2/km) of a manufacturer will be relaxed by up to 5%.

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[56] Evaluation of Regulation 443/2009 and 510/2011 on the reduction of CO_2 emissions from light-duty vehicles (Ricardo-AEA and TEPR, 2015) https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/evaluation_ldv_co2_regs_en.pdf

[57] This derogation option applies for “small volume” manufacturers responsible for less than 10 000 new cars or 22 000 new vans registered per year

[58] The term “super-credits” refers to a system where vehicles with low CO_2 emissions (below 50 g/km) are counted multiple times when calculating the average specific emissions of the manufacturer concerned.

[59] The super-credit multiplier was 2 in 2020 and decreases to 1.66 in 2021 and 1.33 in 2022. The total amount of super-credits is limited to 7.5 g CO_2/km per manufacturer (or pool) over the whole period (2020-2022).

[60] Regulation (EU) 2019/631, Recitals 20-21

Accounting rules apply for calculating the ZLEV share of a manufacturer's fleet: the lower its emissions, the more a vehicle gets counted.

The "bonus-only" approach means that there are no direct consequences for a manufacturer not meeting the ZLEV benchmark level.

During the public consultation, manufacturers expressed the view that a ZLEV incentive scheme should be maintained in its current form up to 2030 and that it should focus on zero-emission vehicles only beyond 2030. They stressed the need to include low-emission vehicles in the incentive scheme until 2030 so as to further incentivise their contribution to the decarbonisation in a transitional period.

Environmental NGOs, on the other hand, are calling for removing the incentive scheme, as soon as the share of electric vehicles reaches a certain level. They argue that the benchmark is a temporary incentive to kick-start the EV market, and therefore it is no longer justifiable after a certain point. They also stress that benchmarks weaken the Regulation by allowing the manufacturers to get a bonus on the overall target. They also highlight that only zero emission technologies, which are future-proof, should be incentivised.

The main issues to be considered in this respect are: (i) the incentive type and (ii) the targeted vehicles and their accounting.

5.2.2.2 Incentive type

The following options are considered as regards the ZLEV incentive types[61]:

- Option ZLEVT_no: no ZLEV incentive mechanismOption ZLEVT_B: bonus-only system

  This option maintains the "bonus-only" crediting system under Regulation (EU) 2019/631, with adjusted CO_2 targets and ZLEV benchmarks.

- Option ZLEVT_BM: bonus/malus system

  Same as option ZLEVT_B, except for the addition of a "malus" mechanism, which means that a manufacturer not meeting the ZLEV benchmark level would have to comply with a stricter specific CO_2 target.

- Option ZLEVT_M: ZLEV mandate

  Each manufacturer's new vehicle fleet would have to include at least a given share of ZLEV and manufacturers not meeting this mandate level would have to pay a penalty.

5.2.2.3 Targeted vehicles

Under the options where a ZLEV incentive mechanism would be maintained, the types of vehicles to be targeted and the accounting rules need to be assessed, in particular in light of the objectives described in Chapter 4 to ensure a cost-effective CO_2 emission reduction, provide benefits for consumers and stimulate innovation in zero-emission technologies, as well as the recent developments on the deployment of ZLEV and the new options for the CO_2 target levels considered (Section 5.2.1.1).

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[61] The same types have been considered in the impact assessment supporting the 2017 Commission Proposal for a Regulation setting CO_2 emission performance standards for cars and vans (SWD(2017)650 final of 8 November 2017).

The ZLEV incentivised by the complementary mechanism should be those that have the greatest potential contribution to reducing the CO_2 emissions of the new car and van fleet in real-world conditions. The types of vehicle most relevant in this respect are battery electric vehicles (BEV) and fuel cell electric vehicles (FCEV), both having zero tailpipe CO_2 emissions. These vehicles will be key for the transition to zero-emission mobility.

In addition, it should be considered which plug-in hybrid electric vehicles (PHEV) should be further incentivised and to what extent.

In the current Regulation, the accounting of a ZLEV under the incentive scheme is based on its CO_2 emissions. In this way, the incentive is targeted towards vehicles having near-zero emissions and avoids over-incentivising PHEVs with a short electric range. For cars, two multipliers were introduced by the co-legislators to give a greater weight to PHEVs, and, up to 2030, to ZLEV registered in Member States with the lowest ZLEV uptake.

In view of the above, the following options will be considered as regards the type of vehicles to be covered by the incentive scheme and the accounting rules:

- Option ZLEVAC_0: change nothing
- Option ZLEVAC_1: only zero-emission vehicles are eligible
- Option ZLEVAC_2: ZLEV with emissions from 0 to 25 g CO_2/km are eligible, with a linear accounting according to their emission level.

5.2.3 *Mechanism for renewable and low-carbon fuels accounting*

Under Regulation (EU) 2019/631, compliance of a manufacturer with its specific emission target is assessed against the tailpipe CO_2 emissions of its fleet as measured under the test cycle laid down in type approval legislation (WLTP). While fuels policy is an important aspect of road transport decarbonisation, so far, the EU legal instruments in place are regulating the GHG emissions of vehicles and transport fuels separately.

Some stakeholders, in particular fuel producers and some automotive and component manufacturers, expressed the view that compliance assessment under Regulation (EU) 2019/631 should take into account emission reductions due to the use of renewable and low-carbon fuels, which have lower life-cycle emissions.

This would contribute to one or a combination of the following objectives: (i) to provide fuels suppliers with additional incentives to invest in the development, production and marketing of renewable and low-carbon transport fuels; (ii) to provide vehicle manufacturers with additional options for complying with their specific CO_2 emission targets, and consequently avoiding possible inefficiencies.

During the public consultation, environmental NGOs have argued against the introduction of such a mechanism, thereby pointing at a possible increased complexity of the approach, with a risk of creating loopholes and double counting as well as delaying the introduction of zero-emission vehicles. Vehicle manufacturers indicated that the Commission should consider to increase the contribution of renewable and low-carbon fuels by an ambitious revision of the Renewable Energy Directive.

The following options will therefore be considered on this issue:

- Option FUEL0: change nothing
- Option FUEL1: application of "carbon correction" factors to the type-approved emissions of the vehicles, to reflect the carbon intensity and share of the eligible fuels.

- Option FUEL2: the introduction of a 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[62].

For both options FUEL1 and FUEL2 the focus should be on those fuels which need additional support to come to the market and have the greatest potential in sustainably reducing emissions in the light-duty vehicle segment without additional environmental effects.

[62] Options for such a possible crediting mechanism were outlined for example in the study "Crediting system for renewable fuels in EU emission standards for road transport" commissioned by the German Federal Ministry for Economic Affairs and Energy (BMWi) (Frontier Economics Ltd. and Flick Gocke Schaumburg, May 2020 (https://www.frontier-economics.com/media/3937/crediting-systems-for-renewable-fuels-in-eu-emission-standards-for-road-transport-en.pdf).

6 WHAT ARE THE ECONOMIC/EMPLOYMENT, ENVIRONMENTAL AND SOCIAL IMPACTS OF THE DIFFERENT POLICY OPTIONS AND WHO WILL BE AFFECTED?

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 baseline used for the assessment is the Reference Scenario 2020 (REF), consistent with the other initiatives for the 'fit for 55 package'. Some options regarding specific design elements, in particular the ZLEV incentive system and issues related to fuels, complement the CO_2 emission targets for vehicles. Therefore it is considered more appropriate to assess their impacts within the context of a policy environment achieving CO_2 targets compatible with the overall 55% emission reduction objective rather than comparing with the Reference Scenario 2020. This policy context is mainly represented by the MIX policy scenario.

As explained in Section 1, the CO_2 emission standards interact with a number of other policies part of the 'Fit for 55%' package. In order to capture the impacts of the CO_2 emission standards in a policy context where these other policies are represented, the MIX policy scenario context is used to assess the three different levels of the CO_2 emission standards TL_Low, TL_Med and TL_High.

This means that the policies and drivers described in Annex 4 for the climate initiatives of the package are included in the analysis, and they are kept at the same level as in MIX policy scenario to ensure the comparability of the results. In particular, this ensures that the contribution of carbon pricing is duly taken into account, with the same carbon price under the three different levels of the CO_2 emission standards. Where relevant, the contribution of the CO_2 emission standards alone is also singled out in the analysis.

Detailed information on the methodological approach, on the key assumptions and on the MIX and core policy scenarios can be found in Annex 4, and some additional results of the analysis in Annex 8.

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 cars and vans, which is one of the main drivers for the other impacts described in this chapter. The impacts of the different target levels on the fleet composition are shown in **Table 4**. It shows that the implementation of more ambitious targets levels leads to higher penetration of zero emission vehicles (i.e. BEV and FCEV) in the fleet of new vehicles in particular year.

Table 4: New cars and vans powertrain composition in 2030, 2035 and 2040 under different target levels (TL) options

	Cars				Vans			
2030	ICEV*	PHEV	BEV	FCEV	ICEV*	PHEV	BEV	FCEV
TL_0	61,5%	13,3%	24,5%	0,6%	71,6%	14,7%	13,4%	0,3%
TL_Low	56,1%	12,8%	30,5%	0,6%	66,9%	13,6%	18,9%	0,7%
TL_Med	48,0%	16,1%	35,1%	0,8%	61,9%	16,0%	21,3%	0,7%
TL_High	39,4%	14,3%	45,3%	1,0%	51,3%	13,3%	34,7%	0,7%
2035								
TL_0	56,0%	16,8%	25,3%	1,8%	58,2%	18,4%	22,0%	1,3%
TL_Low	38,7%	20,1%	38,8%	2,4%	43,4%	21,2%	32,7%	2,6%
TL_Med	28,0%	21,8%	46,8%	3,4%	28,7%	21,8%	47,4%	4,2%
TL_High	0,0%	0,0%	90,2%	9,8%	0,0%	0,0%	94,2%	5,8%
2040								
TL_0	46,7%	17,6%	32,4%	3,2%	50,1%	20,8%	26,8%	2,3%
TL_Low	18,5%	19,2%	55,1%	7,2%	17,7%	22,9%	52,3%	7,2%
TL_Med	0,0%	0,0%	87,0%	13,0%	0,0%	0,0%	85,6%	14,4%
TL_High	0,0%	0,0%	89,9%	10,1%	0,0%	0,0%	93,0%	7,0%

* including HEV and gas fuelled vehicles

6.2 CO_2 emission targets for cars and vans

6.2.1 Target levels (TL)

6.2.1.1 Economic impacts (including employment)

6.2.1.1.1 Introduction

Different types of economic impacts of the different TL options are considered.

(i) Net economic savings from societal and end-user perspectives (Sections 6.2.1.1.2 to 6.2.1.1.3)

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 cars and vans registered in 2030, 2035 or 2040. The total costs include the capital costs, the fuel or electricity costs, and the operation and maintenance (O&M) costs of the vehicles. For the societal perspective, they also include the external cost of CO_2 emissions[63]. The end-user perspective is presented for the first user (first 5 years after first registeration) and the second user (years 6-10).

(ii) Costs for automotive manufacturers (Section 6.2.1.1.4)

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 cars and vans registered in 2030, 2035, 2040.

(iii) Energy system impacts (Section 6.2.1.1.6)

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

In view of the links between the CO_2 standards for cars and vans and the energy system, impacts of the TL options on the latter have been analysed, also considering the links with the revision of the EU ETS as well as the Energy Efficiency and Renewable Energy Directives.

(iv) Investment in alternative fuels infrastructure (Section 6.2.1.1.7)

The investments needed for recharging and refuelling infrastructure have been analysed, to ensure consistency with the revision of the Alternative Fuels Infrastructure Directive.

(v) Macro-economic impacts, including employment (Section 6.2.1.1.8)

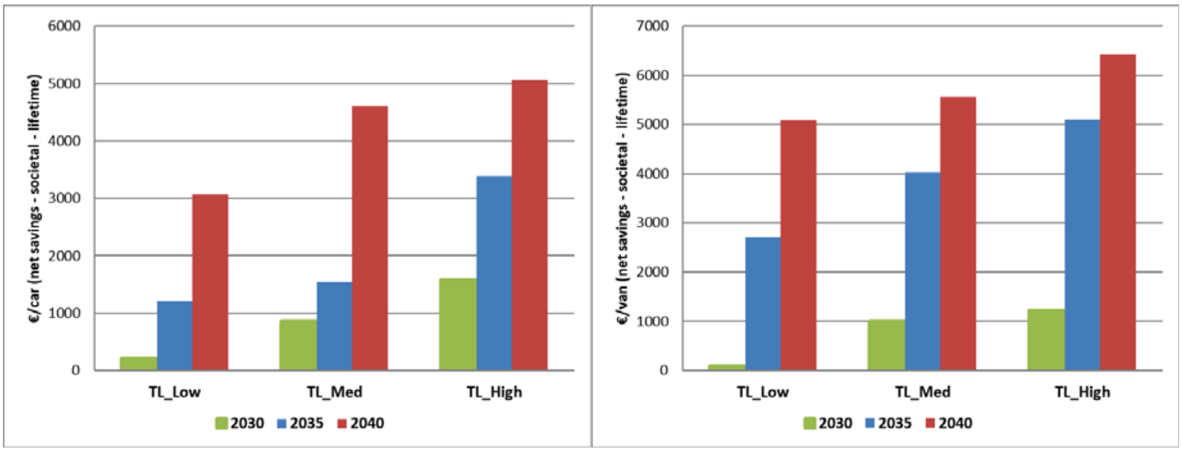
The below sections provide a summary of the main findings of the analysis.

6.2.1.1.2 Net economic savings over the vehicle lifetime from a societal perspective

Figure 5 displays the effect of the CO_2 emission standards only, for the three target level (TL) options, on the average net savings over the vehicle lifetime from a societal perspective for a new vehicle registered in 2030, 2035 or 2040, in a MIX policy scenario context.

For both cars and vans, all three TL options lead to net savings. These savings increase with increasing target stringency.

Figure 5: Average net savings over the vehicle lifetime from a societal perspective (EUR/vehicle) resulting from the CO_2 emission standards (in a MIX policy scenario context) (cars (l) and vans (r))

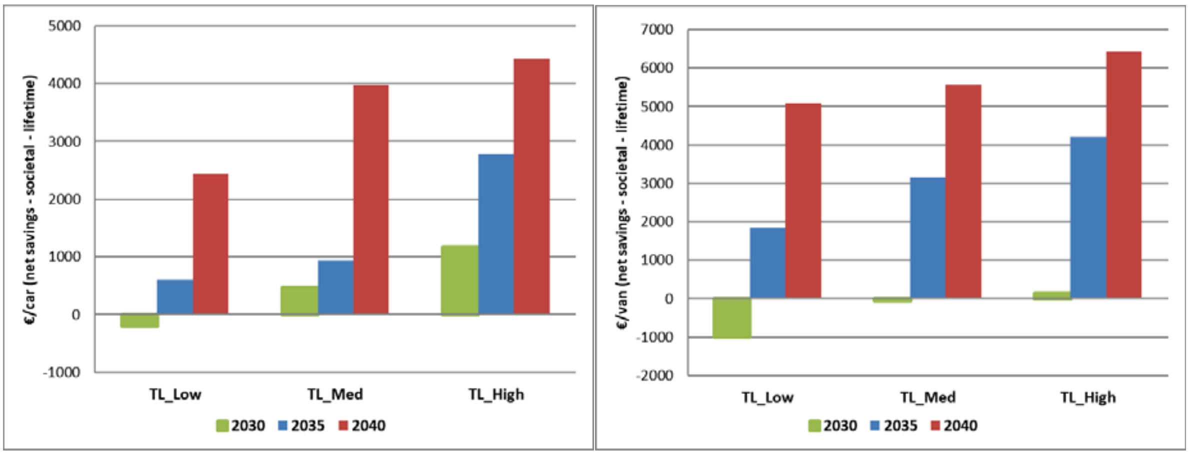


The CO_2 emission standards for cars and vans interact with other policies, which are part of the 'fit for 55 package' and which impact the average net economic savings. This concerns in particular (i) the strenghtening of the EU ETS and the possible emissions trading for buildings and road transport, which impact the fuels and electricity prices, as projected in the MIX policy scenario; (ii) the increased use of renewable fuels in road transport required under the Renewable Energy Directive, which also impacts the fuel prices; (iii) the preparation of stricter Euro 7 pollutant emission standards, which lead to additional capital costs for vehicles powered by internal combustion engines.

Figure 6 shows the net savings over the vehicle lifetime from a societal perspective when the effects of those policies are taken into account, so that the costs considered also reflect the changes resulting from those policies. Two major effects contribute to the differences as compared to Figure 5: on the one hand a decrease in the energy savings due to higher electricity and fuel prices; on the other hand an increase in avoided CO_2 emissions due to the combination of policies.

This analysis shows that higher levels of the CO_2 targets for cars and vans result in higher societal benefits also when considering the combined effect of the CO_2 standards and the other policies as projected in the MIX scenario.

Figure 6: Average net savings over the vehicle lifetime from a societal perspective (EUR/vehicle) resulting from the combination of policies (cars (l) and vans (r))



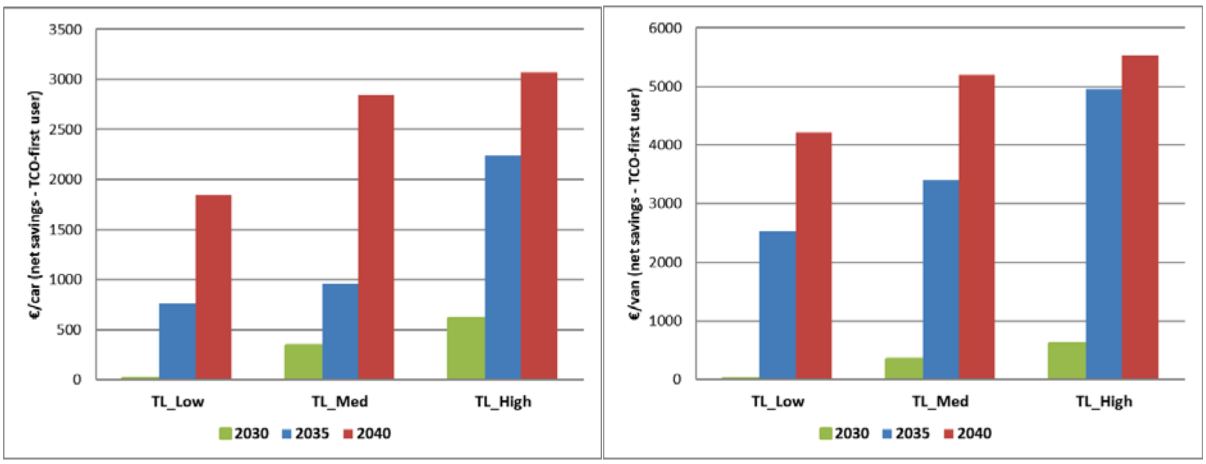
6.2.1.1.3 TCO-first user and TCO-second user

<u>First user perspective</u>

Figure 7 shows the average net savings (EUR per vehicle) resulting from the CO_2 emission standards from a first end-user perspective considering the first five years of a vehicle's lifetime under the three TL options for a new vehicle registered in 2030, 2035 and 2040.

Overall, the factors determining the net savings are the same as under the societal perspective, apart from the CO_2 externalities. 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.

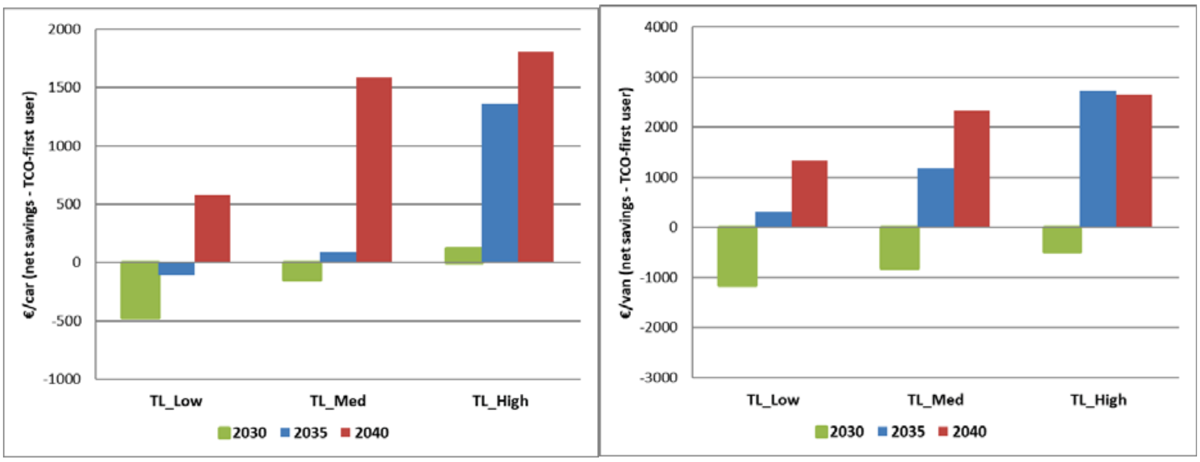
Figure 7: Average net economic savings from a TCO-first user (first 5 years) perspective (EUR/vehicle) resulting from the CO_2 emission standards (in a MIX policy scenario context) (cars (l) and vans (r))



The effect of the interaction with the other policies of the ‘fit for 55%’ package, in particular the EU ETS and RED, is shown in **Figure 8**. The policy interaction changes the outcome as compared to the case illustrated in **Figure 7**. The increase of fuel prices leads to a decrease of the fuel savings for consumers, up to the point that over the period of their vehicle use, overall losses can be experienced by the first users instead of savings.

However, the analysis shows that the CO_2 targets for cars and vans mitigate the effect of the higher fuel prices due to the other policies. Considered together with those policies, the strenghening of the CO_2 target levels leads to lower costs, except in the case of TL_Low option.

Figure 8: Average net economic savings in TCO-first user (5 years) (EUR/vehicle) resulting from the combination of policies (cars (l) and vans (r))



<u>Second user perspective</u>

The economic impacts of stricter CO_2 targets under the different TL options on buyers of second hand vehicles were also looked at. It is considered that second users on average purchase the vehicle after 5 years of use and resell it after 10 years.

The results of the analysis are similar as for the first-user (see Annex 8). Both for cars and vans, when considering the effect of the CO_2 standards only, net savings occur under all options considered from 2030 onwards. The net savings increase with the stringency of the targets.

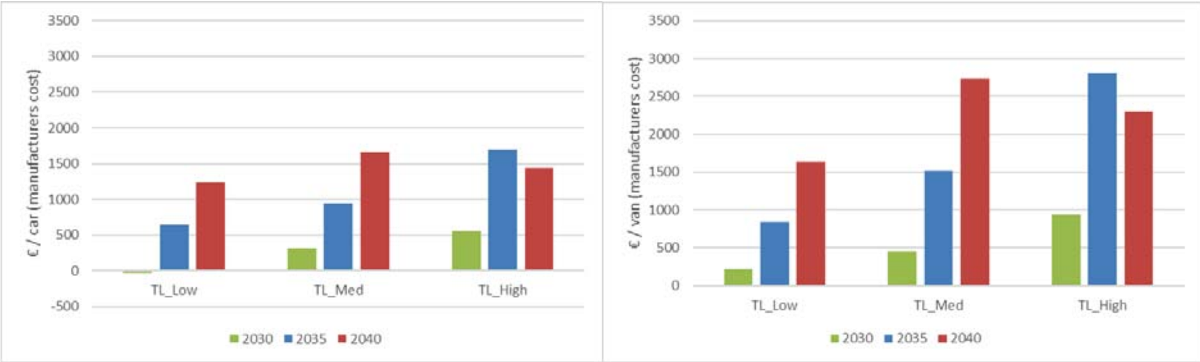
When considering the interaction with the other policies, stricter targets lead to net savings or to a reduction of the additional costs incurred.

6.2.1.1.4 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. These costs, averaged over the EU-wide new cars and vans fleet, are shown in **Figure 9**.

In general, the costs for manufacturers increase with stricter CO_2 emission targets. The situation is slightly different in the year 2040. This is due to a different distribution in 2040, in the three target options, between battery electric and fuel cell electric vehicles, reflecting different technology penetrations over time for reaching the zero-emission targets.

Figure 9: Average costs for automotive manufacturers resulting from the CO_2 emission standards (in a MIX policy scenario context) (cars (l) and vans (r))



In general, for all economic sectors, the investment challenge of the transition was already recognised in the European Green Deal, which stated that "*Delivering additional reductions in emissions is a challenge. It will require massive public investment and increased efforts to direct private capital towards climate and environmental action, while avoiding lock-in into unsustainable practices. […] This upfront investment is also an opportunity to put Europe firmly on a new path of sustainable and inclusive growth. The European Green Deal will accelerate and underpin the transition needed in all sectors.*" The Impact Assessment of the Climate Target Plan analysed and quantified the investment challenge in section 6.4.1.3, with table 12 showing the quantitative increase in investments in all sectors and in all scenarios, with the power and residential sectors facing the biggest challenge.

Also the automotive sector is projected to face additional investments[64] 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 5** for the different target level options. Over the period 2021 to 2040, they are estimated at around 4.6 billion euros annually for the option TL_Low. The additional investments become almost 3 times higher for option TL_Med, and around 4 times higher for option TL_High. For TL_Low, TL_Med and TL_High the additional annual investments represent an increase of around 1%, 3% and 4% compared to the annual investments needed to comply with the current CO_2 emission standards.

Table 5: Average annual additional investments over 2021-2030 and 2021-2040 for the different target level options

	Period 2021-2030 [billion €]	%	Period 2021-2040 [billion €]	%
TL_Low	0.27	0.1%	4.6	1%
TL_Med	1.2	0.3%	12	3%
TL_High	2.6	0.6%	19	4%

[64] 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.

Meeting the different target levels options depends on the ability to mobilise these investments, which represent a limited increase as compared to the investments needed to comply with the current CO_2 emission standards levels.

Significant investments in zero-emission vehicles are already taking place or have been announced. Many automotive manufacturers are setting up plans to reach high to very-high market shares of zero-emission vehicles. (see details in Annex 8).

Key investments necessary for the deployment of zero-emission vehicles needed to meet the CO_2 emission standards are related to investments in batteries, the core zero-emission technology for cars and vans. The European Battery Alliance is contributing to large investments in batteries in the EU, including through the European Investment Bank and the state aid instrument for Important Projects of Common European Interest (IPCEI), and through support to research and innovation programmes.

Recent announcements by major players in the market also confirm investments in battery technologies[65]. A study[66] found that: (i) "the European battery industry produces all chemistries and will meet demand thanks to lead-based and Li-ion batteries, comprising more than 90% of the total European battery market by 2030"; (ii) "Europe will retain its strong position in 2030 and remain very competitive, but ongoing investment is needed to maintain/improve production and for R&D"; (iii) "current/projected capacity will just meet current/projected demand"; (iv) on Li-ion batteries, there is a "ten-fold future growth potential and Europe is ready to meet demand, although currently heavily reliant on imports".

In addition, experience shows that the automotive industry was able to mobilise significant investments to drastically reduce emissions from cars as a result of the application of the stricter 2020 target. According to preliminary data, the share of BEV and PHEV increased from 3% in 2019 to 11% in 2020.

The different elements presented above show the feasibility of the different target level options. It is important that automotive investments are matched by investments in the necessary recharging infrastructure, a key flanking measure to remove one of the demand-side market barriers to the uptake of zero-emission vehicles. The investment needs related to infrastructure are estimated in paragraph 6.2.1.1.7, covering both public and private charging points.

6.2.1.1.5 Innovation and competitiveness.

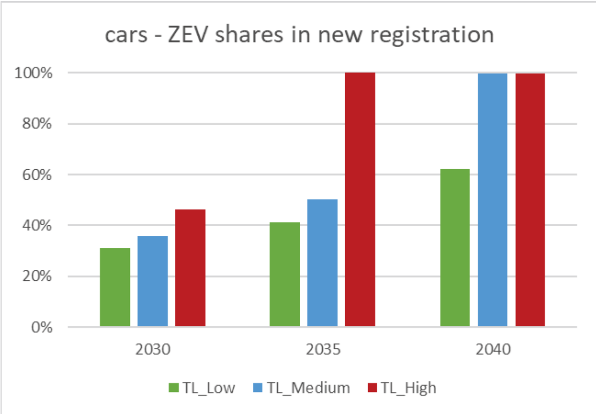
The different options considered for the target levels will have a positive impact on innovation. They are projected to incentivise the deployment of zero-emission technologies in the new vehicles fleet by requiring an increased supply of zero-emission vehicles to the market, which will spur innovation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

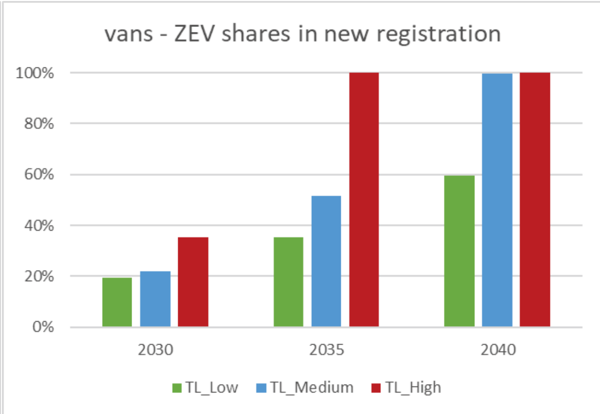
The projections on the penetration of zero-emission vehicles therefore serve as a quantitative proxy of the impacts on innovation. **Figure 10** presents the evolution of the projected penetration of zero-emission powertrains for new cars and vans over time, for the different options considered for the target levels.

Figure 10: Projected shares of zero-emission vehicles in the cars and vans fleet resulting from the CO_2 emission standards

[65] European Battery Alliance | Internal Market, Industry, Entrepreneurship and SMEs (europa.eu): https://ec.europa.eu/growth/industry/policy/european-battery-alliance_en

[66] The Rechargeable Battery Market and Main Trends 2011-2020 (eurobat.org)





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, with a steep increase between 2030 and 2035. Under the TL_Med options, the share of new zero-emission vehicles is projected to increase for cars to around 36%, 50% and 100% in 2030, 2035 and 2040 respectively, compared to around 6% in 2020. For vans, the share is projected to increase to around 22%, 52% and 100% in 2030, 2035 and 2040 respectively, compared to around 2% in 2020. Stimulating innovation in zero-emission technologies in the EU would also strengthen the technological leadership of the EU automotive value chain, as explained in Section 4.

In the global context, countries are stepping up their commitments to climate action. In particular, China recently pledged to achieve climate neutrality by 2060 and can be expected to continue to accelerate the deployment of zero-emission vehicles through regulatory action, also to tackle the serious air quality concerns in cities. The US has recently re-joined the Paris agreement and has announced ambitious action to reduce vehicle emissions, with California paving the way to a rapid transition towards zero-emission mobility through tightened legislation.

The US and China also represent the two biggest export markets for the EU automotive industry with 1 million and 460,000 cars exported in 2019 to the US and China respectively. This represents around 30% and 17% of EU export market value in these countries[67]. Stimulating innovation in zero-emission technologies is necessary in view of the importance of such markets, in light of the new climate commitments.

The International Energy Agency (IEA) foresees the electric light-duty vehicle stock to expand from about 10 million in 2020 to almost 140 million vehicles in 2030 (from less than 1% global stock share to 8% in 2030) according to the “Stated Policy Scenario”. The stock would possibly increase even further to 220 million electric light-duty vehicles in 2030 (corresponding to an almost 15% stock share) in the “Sustainable Development Scenario”[68]. This indicates that, with the global demand for zero-emission vehicles increasing, further investment in innovation is key for European manufacturers to maintain and reinforce the EU automotive industry’s competitiveness and market share on the global stage.

Stricter CO_2 emission standards provide certainty for the market deployment of EVs and a strong, long-term signal to automotive manufacturers to innovate. They can also drive

[67] Exports of passenger cars | ACEA - European Automobile Manufacturers' Association: https://www.acea.be/statistics/article/exports-of-passenger-cars

[68] https://www.iea.org/reports/global-ev-outlook-2021/prospects-for-electric-vehicle-deployment

innovation along the value chain, aiming at reducing the costs of production and securing availability of components..

If current CO_2 emission standards were to remain unchanged, manufacturers would be at risk of reduced competitiveness in other markets, as well as possibly lose market shares in Europe..

Drawing from the conclusions from GEAR 2030 on automotive competitiveness and sustainability[69], the evolution of the EU regulatory environment would influence the ability of automotive manufacturers to maintain and grow their future market shares both domestically and abroad.

European manufacturers are open to support current and even higher emission reduction targets under the condition that the required charging points and hydrogen stations are rolled out, as reported by the European Automobile Manufacturers' Association (ACEA)[70]. They are starting to shape up their future business strategies around zero-emission technologies, further underlining that their future competitiveness is linked to the development and marketing of these technologies.

Automotive manufacturers are announcing commitments to significantly increase their BEV and PHEV models in their portfolios over the next decade. 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[71], 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.

The effect of CO_2 emission standards in the automotive industry can also be observed in how the market values fully electric and most innovative automotive manufacturers. Already in 2021, relatively new purely EV brands are regarded as innovation leaders. They are at the top of the global ranking of automakers by market capitalization, and in some cases they have a market capitalisation greater than competitors[72], despite these competitors being much larger in terms of sales numbers and total revenues[73]. This indicates that the market views these EV brands as attractive options for investors, representing relatively low risk investment strategies and positive expectations for these companies in the future. This constitutes a strong signal for manufacturers on what the market is considering valuable for the future and further underlines that the transformation towards zero-emission mobility is also beneficial for manufacturers in the medium- and long-term.

[69] European Commission 2017. Report of the High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union (GEAR 2030): https://ec.europa.eu/growth/content/high-level-group-gear-2030-report-on-automotive-competitiveness-and-sustainability_en

[70] https://www.acea.be/press-releases/article/car-makers-open-to-higher-co2-targets-if-there-is-matching-infrastructure

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

[72] https://companiesmarketcap.com/automakers/largest-automakers-by-market-cap/ and https://www.visualcapitalist.com/worlds-top-car-manufacturer-by-market-cap/

[73] https://www.investopedia.com/articles/company-insights/091516/most-profitable-auto-companies-2016-tm-gm.asp

Finally, demand side considerations also impose additional pressure on the market, where manufacturers must supply what is demanded. Some cities[74] show support for restriction zones to non-zero emission vehicles and some Member States[75] are announcing plans for all new cars to be zero-emission vehicles by certain dates[76]. Both these findings further underline that demand is increasing for zero-emission vehicles and that the automotive industry will remain competitive on the market as long as it is able to offer zero-emission solutions to satisfy the increasing demand.

In light of the above, stricter CO_2 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 and competitiveness.

6.2.1.1.6 Energy system impacts

6.2.1.1.6.1 Final energy demand and fuel mix

Figure 11 shows the impact of the different TL options on the final energy demand for passenger cars and vans over the period 2015-2050.

Under the baseline, demand was 189 Mtoe in 2015. It decreased significantly in 2020 due to the effect of the COVID-19 pandemic but is projected to increase again to 174 Mtoe in 2025. 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 2030, 2040 and 2050, demand under the baseline is respectively 11%, 28% and 38% lower than in 2025.

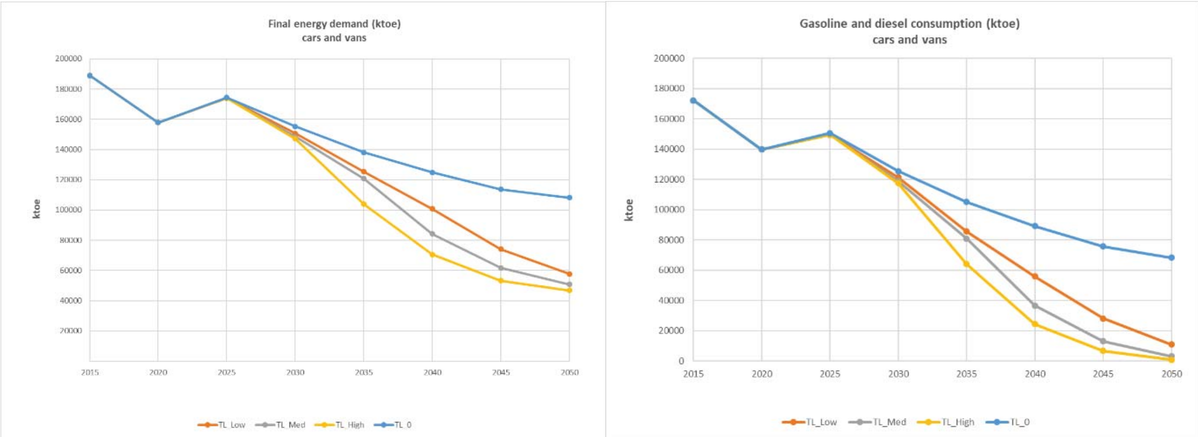
Under the different TL options, final energy demand decreases further and the effects of the more stringent CO_2 targets for cars and vans become more outspoken from 2035 on. While the stricter CO_2 emission targets in 2030 lead to a lower energy consumption already by 2030, their effect becomes stronger in the period post-2030 as a result of the fleet renewal. By 2040, demand is reduced by between 19%, 33% and 43% for the different TL levels, as compared to the baseline.

These results are built on the MIX scenario and therefore take into account the interaction with the other policies of the 'fit for 55% package' which have impacts on the energy system. This includes in particular: (i) the strenghtening of the EU ETS, and the emissions trading for buildings and road transport. They can both impact the energy consumption patterns due to carbon pricing on electricity, which becomes an important energy carrier for cars and vans, and on road transport fuels; (ii) the increased ambition on renewable energy and energy efficiency policies; (iii) policies to increase the efficiency of the transport sector[77].

It can be estimated that the vehicle CO_2 emission standards alone will contribute to the 2040 reductions of the final energy demand for cars and vans by 9, 24 and 36 percentage points for the three TL levels respectively. This contribution becomes more and more important over time in view of the delayed effect linked to the fleet renewal, as explained above. This will help contributing to the targets under the Energy Efficiency Directive.

[74] Such as Paris, Madrid, Strasbourg, Athens, Rome, Amsterdam, Brussels, Berlin and Stuttgart.
[75] Such as Denmark, Ireland, the Netherlands, Slovenia, Sweden, France, and Spain.
[76] https://theicct.org/blog/staff/global-ice-phaseout-nov2020
[77] This includes support for multimodal mobility and intermodal freight transport; deployment of infrastructure for smart traffic management and transport digitalisation, as well as fostering of connected and automated mobility; initiatives to increase and better manage the capacity of railways, inland waterways, supported by the TEN-T infrastructure and CEF funding; measures to reduce noise and air pollution in urban areas. A complete description is provided in the SWD(2020) 331 accompanying the Sustainable and Smart Mobility Strategy Communication.

Figure 11: Final energy demand (ktoe/year) and gasoline and diesel consumption (ktoe/year) for cars and vans under different TL options



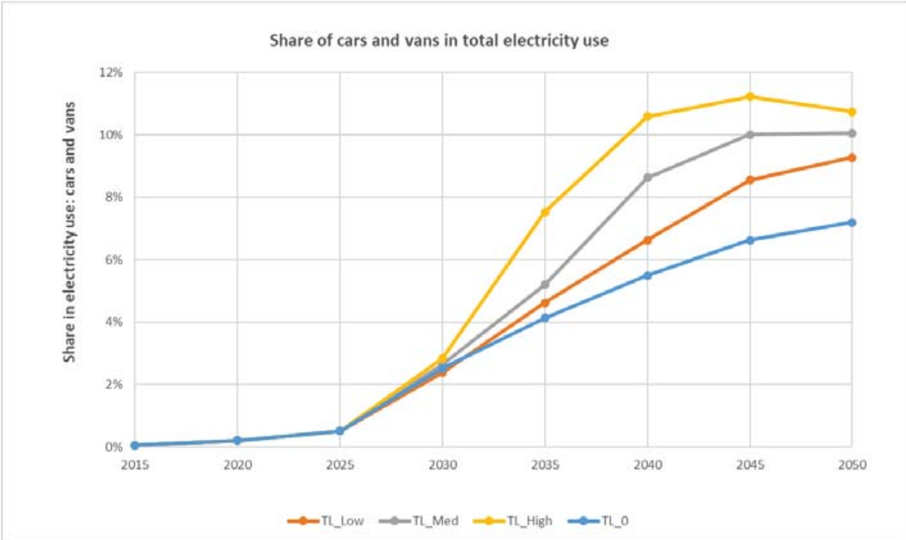
The CO_2 targets also have an impact on the demand per type of energy source for cars and vans. While diesel and gasoline remain the main fuels used in 2025 and 2030, there is a clear shift away from fossil fuels in the years thereafter. Over the period 2030 to 2050, the target level options TL_Low, TL_Med and TL_High would result in cumulative savings of diesel and gasoline with respect to the baseline of 685, 913 and 1100 Mtoe, respectively. This is equivalent to around 200-300 billion euros at current oil prices.

6.2.1.1.6.2 Electricity consumption

Figure 12 shows the share of the total EU-27 electricity consumption used by cars and vans (together) in 2030, 2040 and 2050 for the three TL options. It illustrates that, even with the strictest targets considered, the share of electricity used by light-duty vehicles up to 2030 is not more than 2.8 percent of the total electricity consumption. From 2030 onwards, the effect of more electric vehicles coming to the market becomes more evident, in particular under the most ambitious option TL_High, where electricity consumption of cars and vans makes up around 11% of the total by 2040. Electrification of end-user sectors, including building, industry and transport is one of the three key concepts of the Energy System Integration Strategy[78], which also tackles the issues related to grid infrastructure.

[78] COM(2020) 299 final

Figure 12: Electricity consumption by cars and vans as a percentage of total electricity consumption (EU-27) under different TL options



6.2.1.1.7 Investment in alternative fuels infrastructure

As the CO_2 emission standards will incentivise increasing shares of electric and hydrogen powered cars and vans in the market, the related minimum refuelling and recharging infrastructure will have to be provided.

The revision of the Alternative Fuels Infrastructure Directive (AFID) aims at defining the framework necessary for the roll-out of publicly accessible infrastructure, a key barrier to the market uptake and customer acceptance of zero-emission vehicles and hence an indispensable corollary to the roll-out of zero-emission vehicle fleets. The review of the Energy Performance of Buildings Directive aims at strengthening the framework necessary for the roll-out of recharging infrastructure in buildings. The Connecting Europe Facility, Regional and Structural Funds, the Renovation Wave and InvestEU/ blends with EIB instruments could assist in funding.

In order to support the market uptake of the zero-emission vehicles projected in the scenarios assessed (see Section 6.1), it is estimated that investments in public and private recharging infrastructure will amount to around €4 bn per year over 2021-2040 in TL_Low, around €5 bn per year in TL_Med and around €6 bn in TL_High. Additional information on recharging infrastructure is provided in the Impact Assessment for the revision of the AFID, including on the sufficiency levels for infrastructure coverage underpinning the above-mentioned investments estimate.

6.2.1.1.8 Macro-economic impacts, including employment

6.2.1.1.8.1 Introduction

The E3ME and GEM-E3 models are used to assess macro-economic and sectoral economic impacts. In particular, these models are used to quantify the impacts of the different CO_2 targets for light-duty vehicles on the wider economy, i.e. GDP, sectoral output and employment.

An analysis of the macro-economic impacts, including on employment, of meeting the overall 55% emission reduction target by 2030 is presented in the Climate Target Plan (CTP), to take into account the combined effect of different policies, including different levels of the CO_2 emission standards for vehicles[79]. The purpose of this analysis is to complement the CTP by focusing on the macroeconomic impacts of the CO_2 emission standards for cars and vans only. For this purpose, the MIX scenario context has been used both for the baseline and the policy scenarios. Different levels of CO_2 emission standards are also included, equivalent to TL_0 in baseline and TL_Low, TL_Med and TL_High in the policy scenarios.

6.2.1.1.8.2 E3ME modelling results

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

Table 6 shows the options for the target levels which were considered in the scenarios modelled by E3ME.

Table 6: Scenarios modelled with E3ME for assessing the macro-economic impacts of the TL options

E3ME scenarios	CO_2 target levels option (cars and vans)
Baseline	TL0
MIX55_LSTD	TL_Low
MIX55	TL_Med
MIX55_HSTD	TL_High

All the modelled scenarios estimate changes due to the new CO_2 target levels in order to isolate the macroeconomic effects of this specific policy. In all scenarios, government revenue neutrality from the associate reduction in fuel duty is imposed. The implementation of the new CO_2 targets reduces petrol and diesel consumption, which are commodities upon which taxes are levied in all Member States. The loss of fuel duty revenue due to lower petrol and diesel consumption is compensated, in all scenarios, by a proportional increase of VAT rates[80][81].

GDP and sectoral output

Table 7 shows the projected GDP impact for the EU-27 for the three scenarios compared against the baseline.

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[79] SWD(2020) 176 final

[80] As an example, in the scenario MIX55 modelled through E3ME, it is projected that fuel duty revenues in the EU-27 decrease by around 1,785 million euros in 2030, corresponding to a 2% decrease with respect to the baseline. The fuel duty revenue loss represents around 0.01% of the EU-27 GDP. To ensure revenue neutrality, VAT total revenues increase by around 0.08% in 2030. The loss in fuel duty revenues in 2035 and 2040 amounts to up to 0.03% and 0.07% of the EU-27 GDP.

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

Table 7: GDP impacts in the baseline (million euros in 2015 price) and percentage change from the baseline under the policy scenarios (E3ME results)

Scenario	2030	2035	2040
Baseline (M€2015)	14,704,321	15,689,067	16,925,347
MIX55_LSTD	0.00%	0.06%	0.28%
MIX55	0.01%	0.13%	0.45%
MIX55_HSTD	0.02%	0.26%	0.65%

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

In these scenarios, stricter CO_2 emission standards lead to lower spending on fuel and higher disposable income for consumers. Despite VAT increases to offset the loss in fuel duty revenues, consumers overall benefit from higher disposable income. Together with a reduction in imports of petroleum products, this would result in an overall small positive impact on GDP, including through indirect effects, related to the increase of demand of goods and services in the EU.

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

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

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

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

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

Table 8 shows the main impacts on the output within the most affected sectors for the different scenarios.

Table 8: Impacts on the output within the most affected sectors (million euros in 2015 price) and percentage change from the baseline (E3ME results)

	Baseline	MIX55_LSTD	MIX55	MIX55_HSTD
2030				
Petroleum refining	307,212	-0.21%	-0.83%	-1.52%
Automotive	940,332	-0.08%	-0.19%	-0.37%
Electronics	420,992	0.01%	0.04%	0.06%
Metals	1,051,402	0.00%	0.03%	0.04%
Electrical equipment	336,632	0.07%	0.28%	0.47%
Electricity, gas, water, etc	1,152,642	0.04%	0.14%	0.27%
2035				
Petroleum refining	236,989	-1.61%	-3.86%	-11.63%
Automotive	978,138	-0.20%	-0.72%	-1.93%
Electronics	450,782	0.07%	0.14%	0.32%
Metals	1,095,384	0.08%	0.06%	0.16%
Electrical equipment	360,498	0.18%	0.50%	0.99%
Electricity, gas, water, etc	1,216,738	0.27%	0.63%	1.64%
2040				
Petroleum refining	184,995	-7.07%	-15.99%	-22.80%
Automotive	1,019,037	-0.19%	-1.77%	-3.46%
Electronics	491,843	0.39%	0.49%	0.55%
Metals	1,153,916	0.35%	0.20%	0.09%
Electrical equipment	395,870	0.49%	0.92%	1.37%
Electricity, gas, water, etc	1,327,498	0.89%	1.84%	3.04%

Employment

As shown in **Table 9**, with stricter CO_2 target levels resulting in an increase in economic output, there is also an increase in the number of jobs across the EU-27 compared to the baseline, be it overall limited. The number of additional jobs also increases over time. The main drivers behind the GDP impacts also explain the employment impacts.

Table 9: Total employment impacts (E3ME) in terms of number of jobs in the baseline (000s) and changes to the baseline (000s jobs) under the three policy scenarios

	2030	2035	2040
Baseline	201,047	198,282	195,316
MIX55_LSTD	4	76	350
MIX55	24	129	477
MIX55_HSTD	39	297	588

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

In the different options assessed, the market uptake of battery and plug-in hybrid electric vehicles increases with respect to the baseline, while the conventional powertrains remain the majority of the fleet in 2030, but decrease thereafter, as shown in **Table 4**. This impacts the employment situation in the automotive sector.

In particular, as shown in **Table 10**, while the MIX55 scenario results in net 24,000 additional jobs economy-wide in 2030, it also results in 4,000 jobs losses in the automotive sector corresponding to 0.16% reduction compared to the baseline. Employment impacts are more pronounced in the long term. In 2040 there are net 477,000 additional jobs created economy-wide, while job losses in the automotive sectors increase by 36,000 jobs corresponding to 1.65% reduction compared to the baseline.

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

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

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

At the EU level, beside the Just Transition Fund, the European Social Fund Plus (ESF+) is the main EU instrument to address this concern, with the aim to support Member States to achieve a skilled workforce ready for the green and digital transition[82].

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

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

The Industrial Strategy for Europe[83] also highlights the importance of increasing investment in skills and life-long learning with collective action of industry, Member States, social partners and other stakeholders through a new **'Pact for Skills'**[84]. The Pact helps to mobilise the private sector and other stakeholders to upskill and reskill Europe's workforce.

[82] https://ec.europa.eu/esf/main.jsp?catId=62&langId=en
[83] COM(2021) 350 final and COM(2020) 102 final
[84] https://ec.europa.eu/social/main.jsp?catId=1517&langId=en

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

- The need to address the fragmentation of skills initiatives in the EU and encourage closer co-operation between companies and educational institutes.
- A key first step is to map those initiatives and identify ways for cooperation between initiatives building on the DRIVES project[85].
- The Pact for skills must be inclusive to take account of the whole value chain (including SMEs) and workforce with the different levels of skills required
- Local and regional training centres and clusters can play an important role in identifying skill needs (especially for SMEs) and help in the delivering of training.
- The Pact should build on the work of DRIVES and related blueprints such as the ALBATTS[86] project.

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

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

Table 10 also shows that jobs are also projected to decrease in the petroleum refining sector, by 1,000 in 2030 and 10,000 in 2040 as a consequence of the shift away from fossil fuels. However the electrification of road transport, increase employment in electricity sector.

Table 10: Employment impacts, broken down by sector (E3ME model)

	Baseline	MIX55_ LSTD	MIX55	MIX55_ HSTD	MIX55_ LSTD	MIX55	MIX55_ HSTD
	Number of jobs (000s)	Number of jobs (000s) change from baseline			% change from baseline		
2030							
Petroleum refining	125	0	-1	-2	-0.20%	-0.74%	-1.33%
Automotive	2,312	-1	-4	-7	-0.06%	-0.16%	-0.30%
Electronics	997	0	0	0	0.00%	0.01%	0.01%
Metals	4,171	0	1	1	0.00%	0.02%	0.02%
Electrical equipment	1,700	0	1	2	0.01%	0.07%	0.10%
Electricity, gas,	2,450	0	2	4	0.02%	0.08%	0.16%

[85] See www.project-drives.eu
[86] See www.project-albatts.eu

water							
Total	***201,047***	***4***	***24***	***39***	***0.00%***	***0.01%***	***0.02%***
2035							
Petroleum refining	96	-1	-3	-10	-1.54%	-3.42%	-10.46%
Automotive	2,245	-3	-13	-39	-0.14%	-0.59%	-1.75%
Electronics	993	0	1	2	0.05%	0.09%	0.15%
Metals	4,111	3	3	8	0.07%	0.07%	0.20%
Electrical equipment	1,834	2	3	9	0.11%	0.19%	0.48%
Electricity, gas, water, etc	2,355	5	9	21	0.19%	0.38%	0.90%
Total	***198,282***	***76***	***129***	***297***	***0.04%***	***0.07%***	***0.15%***
2040							
Petroleum refining	74	-5	-10	-14	-6.13%	-13.42%	-18.51%
Automotive	2,158	-4	-36	-70	-0.20%	-1.65%	-3.26%
Electronics	990	3	4	5	0.30%	0.37%	0.49%
Metals	4,038	13	11	10	0.31%	0.26%	0.26%
Electrical equipment	2,010	9	10	11	0.45%	0.51%	0.53%
Electricity, gas, water, etc	2,273	20	30	44	0.87%	1.34%	1.91%
Total	***195,316***	***350***	***477***	***588***	***0.18%***	***0.24%***	***0.30%***

6.2.1.1.8.3 GEM-E3 modelling results

GEM-E3 is a general equilibrium model. It therefore assumes that the economy is in perfect equilibrium, with no spare capacity that could boost economic output. This has consequences when introducing policy changes, with GEM-E3 typically seeing crowding out effects of investments. A policy intervention to increase investments in a particular sector, for instance road transport, therefore limits capital availability for other sectors and redistributes labour.

The same scenarios as for the E3ME analysis were assessed.

The model was run using two variants: a "self-financing" variant where businesses and households use financial resources out of their disposable income to purchase the new vehicles; a "loan-based" variant where businesses and households receive a loan to purchase vehicle at an 11% interest rate and 10-year repayment period.

Table 11 shows the GDP impact for the scenario MIX55, for the two financing schemes, in terms of percentage changes with respect to the baseline.

The loan-based variant presents a slightly positive effect. In this case, in the short term, the positive impacts are mostly driven by the possibility for firms and households to finance their purchases through loans, without crowding out other investments. This effect diminishes over time, in particular in the period post-2040, due to the pay-back of the loans. In the self-financing variant, the crowding out effect is dominant and there is a small negative impact. The additional upfront costs for vehicles reduce disposable income for other consumption purposes, thereby lowering spending of consumers on other goods and services.

Table 11: GDP in the baseline (million euros) and percentage change from the baseline under scenario MIX55 comparing the self-financing and loan-based variants (GEM-E3 results)

	2030	2035	2040
Baseline	14,793,953	15,687,771	16,805,408
MIX55 (self-financing)	-0.017%	-0.073%	-0.080%
MIX55 (loan-based)	0.015%	0.001%	0.114%

The impact on employment is presented in **Table 12**. In both variants the impact on employment is more positive than on GDP, indicating the change towards a more labour intensive economic structure[87]. In the loan-based scenario, the GDP growth is the main driver of increasing employment.

Table 12: Employment impacts under the self-financing and loan-based scenarios (000s jobs in the baseline and % difference from the baseline under the MIX55 policy scenario) (GEM-E3 results)

	2030	2035	2040
Baseline	202,522	200,716	199,072
MIX55 (self-financing)	0.012%	-0.065%	-0.014%
MIX55 (loan-based)	0.067%	0.057%	0.306%

The changes in employment directly affect the disposable income of households. The shift towards electric and hydrogen fuel cell vehicles, the related higher use of electricity and hydrogen as well as changes in the use of other fuels (such as biofuels or synthetic fuels) affect employment in the EU through two main channels: i) labour intensity of vehicle production (including batteries), ii) labour intensity of energy production. The impact from the first channel greatly depends on where the batteries will be manufactured as these are significant components in terms of labour intensity. The second channel however will certainly have a positive impact on employment as imported fossil fuels will be partly substituted by other energy sources, a large share of which is domestically produced.

The GDP and employment impacts for the other scenarios, depending on the stringency of vehicle CO_2 emission standards, are similar. **Table 13** and **Table 14** present the GDP and employment impacts for all the scenarios assessed in the loan-based variant. In general, the positive impact tends to be slightly higher for the scenarios with stricter CO_2 targets, where higher expenditures for more efficient vehicles financed by loans lead to an increase of GDP. Post-2040, the repayment of loans decelerates the GDP growth rate.

Table 13: GDP in the baseline (million euros) and percentage change from the baseline under the policy scenarios - loan-based variant (GEM-E3 results)

	2030	2035	2040
Baseline	14,793,953	15,687,771	16,805,408
MIX55_LSTD	0.006%	0.0001%	0.036%
MIX55	0.015%	0.001%	0.114%
MIX55_HSTD	0.019%	0.056%	0.090%

[87] The key mechanisms that drive the EU economy towards a more labour intensive structure are i) The expenditures that were leaking abroad for fossil fuel imports are now spent domestically stimulating demand for other goods and services, ii) The local content of biofuels and electricity production value chain is larger than that of imported oil.

Table 14: Employment in the baseline (000s jobs) and percentage change from the baseline under the policy scenarios - loan-based variant (GEM-E3 results)

	2030	2035	2040
Baseline	202,522	200,716	199,072
MIX55_LSTD	0.018%	0.019%	0.110%
MIX55	0.067%	0.057%	0.306%
MIX55_HSTD	0.093%	0.352%	0.308%

Vehicle manufacturing, electrical equipment manufacturing, fossil fuels production and power generation are the most impacted sectors. Annex 8 provides the sectoral results, which are driven by the switch between different vehicle technologies and fuels. Production and employment of the electric vehicles sector increases compared to baseline in all variants. Sectors producing the respective products and services for the operation and maintenance of these vehicles, such as electricity and batteries, increase their output and employment. For the sectors which supply fuels for road transport, the production is found to decrease, especially in the scenario with higher penetration of BEVs, displacing ICEVs and limiting the fuels use.

6.2.1.2 Social impacts

The main element considered as regards social impacts is whether and to what extent the CO_2 targets affect different population groups differentiated according to their income. Therefore, building on the economic analysis presented in Section 6.2.1.1.3 and in particular the total costs of ownership for first and second users, the analysis looks at the impacts of the different CO_2 target level options on the welfare of consumers, taking into account the particular characteristics of different income groups. It also looks at the affordability of ZEV in the different income groups.

Consumers in the EU were segmented into five income groups (quintiles Q1-Q5, with Q5 having the highest income, based on Eurostat statistics[88]). As a consequence of their different annual income, these consumer groups face different situations as regards (i) the need for finance for the upfront cost to purchase a car; and (ii) the consideration given to the future operating expenditures. In particular, different income groups have different levels of own-financing possibilities and face different maximum quotas and interest rates for loans when access to finance is needed. In addition, they use different discount rates to calculate the present value of future loan payments, fuel and other operating costs[89].

The impacts on different income groups are analysed in terms of (i) affordability of vehicles, and (ii) 'subjective TCO'. The affordability reflects the variety of vehicle choice available to the consumer groups in view of their financial capacity[90]. The 'subjective TCO' is conceptually defined as the TCO in Section6.2.1.1.1, but taking into account also income-group specific parameters. The detailed methodological description, including specific quantitative assumptions, is provided in Annex 8.

[88] https://ec.europa.eu/eurostat/cache/metadata/en/ilc_esms.htm

[89] Higher discount rates are used for lower income quintiles, since they assign lower value to future costs/savings.

[90] For the analysis, a vehicle is thought to be affordable when a household has enough savings and annual income to be able to repay the loan for upfront capital costs in five years, provided that no more than 36% of annual income can be designated to the loan repayment.

Affordability

Table 15 summarises the results on affordability for the baseline and the TL options in the years 2030, 2035 and 2040. It shows which car types (powertrains) and segments are not affordable in each of those cases for the affected income groups. The analysis did not indicate any affordability issues for third users, for income group Q3 as second user and for the income groups Q4 and Q5. Therefore, these categories are not included in the Table. The introduction of more stringent CO_2 targets does not change the situation compared to the baseline for Q1 as first and second users, since the same vehicles types are not affordable for them in the baseline and in the policy options.

For income group Q1 as second user and Q2, in general, higher TL options are associated with more restricted choices due to increased affordability issues for specific powertrain types. In most cases, these additional affordability restrictions are observed for large vehicles and for PHEV and/or FCEV powertrains.

In all scenarios, BEVs are affordable (except for larger segments), or become affordable (including for larger segments) with time. FCEVs continue being unaffordable, especially for larger segments. The TL_Low option does not change affordability compared to the baseline in 2030 and 2035; this effect is driven by the projected evolution of the costs of the technologies to reduce CO_2 and the extent to which these technologies are deployed into the new vehicles to meet the CO_2 targets. The CO_2 target levels in TL_Low do not require strong improvements of the efficiency of conventional engines. As a result, the affordability of the different powertrain types does not substantially change. Furthermore, in 2040, there is no difference in terms of affordability between TL_Med and TL_High options.

Table 15: Overview of unaffordable car types (powertrains) and segments per income group under the baseline and TL options in 2030, 2035 and 2040[91]

	Q1			Q2			Q3		
	2030	2035	2040	2030	2035	2040	2030	2035	2040
First user									
TL_0	S, LM, UM, L	S, LM, UM, L	S, LM, UM, L	LM (PHEV, BEV), UM, L	LM (PHEV, BEV), UM, L	LM (PHEV, BEV, FCEV), UM, L	L	L	L
TL_Low	S, LM, UM, L	S, LM, UM, L	S, LM, UM, L	LM (PHEV, BEV), UM, L	LM (CI+Hybrid, PHEV, BEV, FCEV), UM, L	LM (CI+Hybrid, PHEV, BEV, FCEV), UM, L	L	L	UM (FCEV), L
TL_Med	S, LM, UM, L	S, LM, UM, L	S, LM, UM, L	LM (CI+Hybrid, PHEV, BEV), UM, L	LM (CI+Hybrid, PHEV, BEV, FCEV), UM, L	LM, UM, L	L	UM (FCEV), L	UM (FCEV), L
TL_High	S, LM, UM, L	S, LM, UM, L	S, LM, UM, L	LM (CI+Hybrid, PHEV, BEV), UM, L	LM, UM, L	LM, UM, L	L	UM (FCEV), L	UM (FCEV), L
Second user									
TL_0	LM (PHEV), UM, L	LM (FCEV), UM, L	LM (FCEV), UM, L	L (BEV)					
TL_Low	LM (PHEV), UM, L	LM (FCEV), UM, L	LM (FCEV), UM, L	L (BEV)					
TL_Med	LM (PHEV), UM, L	LM (FCEV), UM, L	LM (FCEV), UM, L	L (BEV)		L (FCEV)			
TL_High	LM (PHEV), UM, L	LM (FCEV), UM, L	LM (FCEV), UM, L	L (BEV)	L (FCEV)	L (FCEV)			

Legend: S (Small), LM (Lower Medium), UM (Upper Medium), L (Large) *CI (Compression Ignition)*. *Note:* The table does not show segments (powertrains) with less than 1% share in sales.

<u>Subjective TCO</u>

It has been assessed how each of the three TL options affects subjective TCO for affordable options, as compared to the baseline[92]. For all TL options, absolute net savings are positively associated with income[93].

Figure 13 shows the percentage changes of the ratio between subjective TCO (only accounting for the affordable vehicles option per income group) and average annual income within the income group for the different TL options, as compared to the baseline.

In all scenarios, lower income groups are projected to see higher savings relative to their annual income. The expected savings are also increasing with the level of ambition of the CO_2 emission standards and with time, for all income groups. Higher income groups are expected to benefit less from higher ambition scenarios and will see lower increases in saving with time, compared to lower income groups.

This result is driven by two main factors: (i) lower income groups are assumed to be 3rd or 2nd users, while higher income groups are 1st or 2nd users, which has an implication on the technology cost that each group faces (with or without depreciation). As a result, lower income groups can benefit from fuel cost savings without having to pay a high price to have access to these vehicles; (ii) even the same differences in technology costs would imply

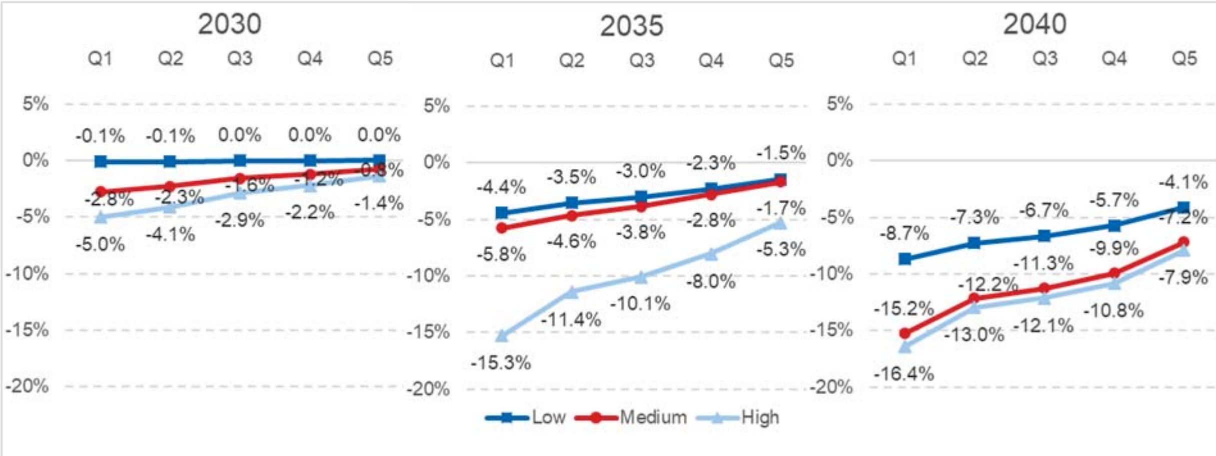
[91] When no particular powertrains are listed in parenthesis, this means that all powertrains are non-affordable. Segments which are not mentioned in the Table are affordable across all powertrains.

[92] All the analysis presented is executed in a MIX policy scenario context

[93] For example, in 2040, depending on the scenario, Q1 are expected to save 1,053-1,785 EUR over 5 year ownership period, Q2 – 1,443-1,858 EUR, Q3 – 1,811-3,014 EUR, Q4 – 2,049-3,609 EUR, Q5 – 2,370-4,287 EUR. Savings relative to income are higher for lower income groups, due to the differences in average annual income.

higher differences in savings across scenarios for lower income groups, when the savings are expressed in shares of annual income. It has to be however highlighted that the benefits for the lower income groups are delayed till they are able to access these more efficient vehicles in the second-hand market. Therefore, the faster these vehicles become available on the second-hand market, the faster the benefits for the lower income groups will materialise.

Figure 13: Average "subjective" TCO changes (% of annual income) for income groups across TL options for a car newly purchased in 2030, 2035 and 2040



Note: Negative values represent savings. Assumptions used to calculate the average TCO savings: all Q1 are 3rd users, 50% of Q2 are 3rd users and 50% are 2nd users, Q3 are all 2nd users, 50% of Q4 are 2nd users and 50% are 1st users, Q5 are all 1st users.

Infrastructure availability

In terms of non-monetary barriers, access to parking (and/or suitable on-street charging infrastructure in residential areas where off-street parking is not available) is expected to be a more important issue in the TL_High option, with higher levels of electrification. This will also have a higher impact on lower income households, as these are more likely to experience the restrictions compared to high income quintiles, explained by differences in housing across income groups.

In summary, the main results of the analysis show:

- For the higher income groups (Q3-Q4-Q5), there are no significant changes in the affordability issues with the 3 TL options.
- For the lowest income groups (Q1-Q2), there are some affordability restrictions for larger vehicles segments, mainly for PHEV and FCEV. However, these types of vehicles are generally not purchased by these income groups.
- BEV remain or become affordable with time for all the TL options except for the larger BEV for the lower income groups.
- From a TCO perspective for the affordable options, lower income groups are projected to see higher savings relative to their annual income. These relative savings increase with higher target levels.

The social impact analysis focuses on income groups defined at EU level since the CO_2 emission standards do not set specific targets and/or requirements at the Member States level. However the analysis provides useful insight on how consumers in different Member States may be affected.

The conclusions of the analysis are qualitatively valid for each Member State. In each Member State, lower income groups are expected to experience relatively more benefits than higher income groups, but are also more likely to face affordability issues.

Moreover, considering the distribution of impacts among Member States, consumers in Member States with average disposable income lower than the EU average are expected to experience higher TCO savings relative to their income than displayed in **Figure 13**. Conversely, consumers in Member States with average disposable income higher than the EU average are expected to experience lower TCO savings relative to their income than displayed in **Figure 13**.

6.2.1.3 Environmental impacts

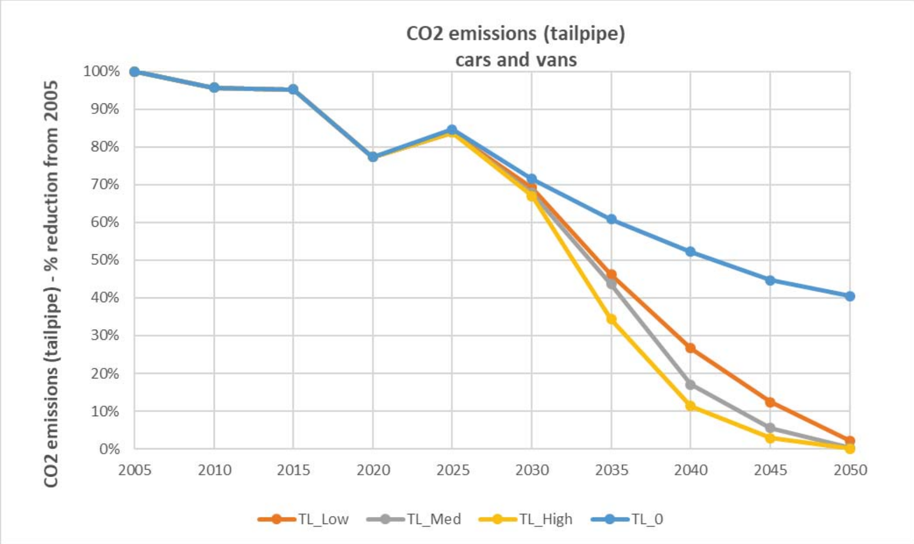
This section shows the environmental impacts, in terms of CO_2 and air pollutant emission reductions from cars and vans, up to 2050. While the stricter CO_2 emission targets in 2030 have an important impact already for emission reduction by 2030, this section also looks at the effects on emissions in the period post-2030. These effects will be stronger as a result of the increasing number of zero- and low-emission vehicles on the road through the fleet renewal.

6.2.1.3.1 CO_2 emissions (tailpipe)

Figure 14 shows the evolution of the tailpipe CO_2 emissions of cars and vans in EU-27 between 2005 (100%) and 2050 under the baseline and the TL options. These results take into account both the CO_2 emission standards and the other policies reducing emissions in the MIX policy scenario. The drop of the CO_2 emissions in 2020 is driven by the decrease in road transport activity due to COVID-19 crisis. As a consequence CO_2 emissions in 2025 show an increase as compared to 2020, but they are on a decreasing trajectory as compared to 2015. This emission profile is notable in all the scenarios, since the COVID-19 effect is embedded in the Reference Scenario 2020.

The projected emission reductions in 2030 as compared to 2005 are 28% (baseline), 31% (TL_Low), 32% (TL_Medium) and 33% (TL_High). The effect of the stricter targets becomes more visible from 2035 on. In 2035, these reductions increase to 39% (baseline), 54% (TL_Low), 56% (TL_Medium) and 66% (TL_High) In 2040, these reductions further increase to 48% (baseline), 73% (TL_Low), 83% (TL_Medium) and 89% (TL_High). In the case of TL_Low, further post-2040 action would be needed to ensure tailpipe emissions decrease to almost zero by 2050 in line with climate neutrality.

Figure 14: Tailpipe CO_2 emissions of cars and vans in EU-27 - % reduction compared to 2005



Considering the emissions reduction in 2040 compared to 2005, the CO_2 emission standards alone are responsible for 37% of the additional emission reduction in the TL_Low option compared to the baseline. They contribute 54% in the TL_Med option and 61% in the TL_High option. This is shown in **Table 16**, with additional calculations for the periods 2005-2030 and 2005-2035.

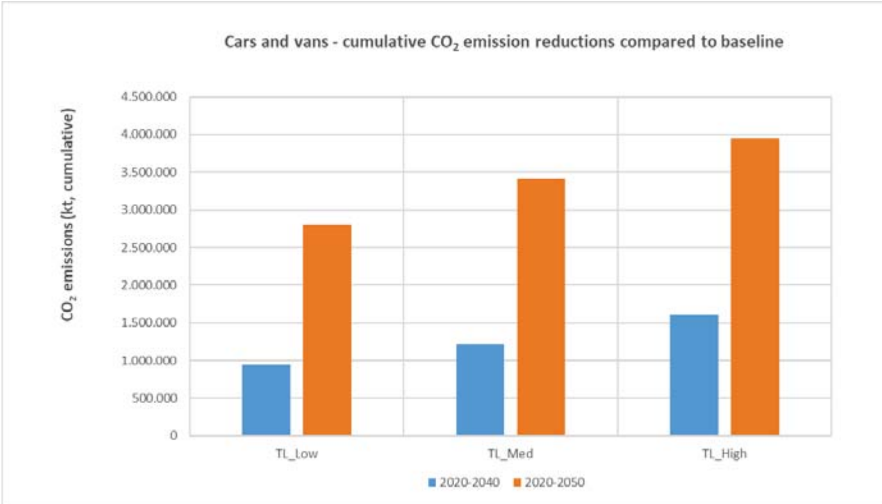
Table 16: Contribution of the CO_2 emission standards to the CO_2 emissions reduction under the policy options compared to the baseline in various periods

	2005-2030	2005-2035	2005-2040
TL_Low	9%	17%	37%
TL_Med	42%	30%	54%
TL_High	52%	54%	61%

Figure 15 below shows the reduction, compared to the baseline, of the cumulative CO_2 emissions from cars and vans over the periods 2020-2040 and 2020-2050 for the three TL options. These results take into account both the CO_2 emission standards and the other policies reducing emissions in the MIX policy scenario. Reductions increase with increasing stringency of the targets.

Cumulative emissions are reduced compared to the baseline by 11% (TL_Low), 15% (TL_Med), 19% (TL_High) in the period 2020-2040, and by 26% (TL_Low), 31% (TL_Med) and 36% (TL_High) in the period 2020-2050.

Figure 15: Tailpipe CO_2 emissions of cars and vans for EU-27 - cumulative 2020-2040 and 2020-2050 emission reductions from the baseline (kt)

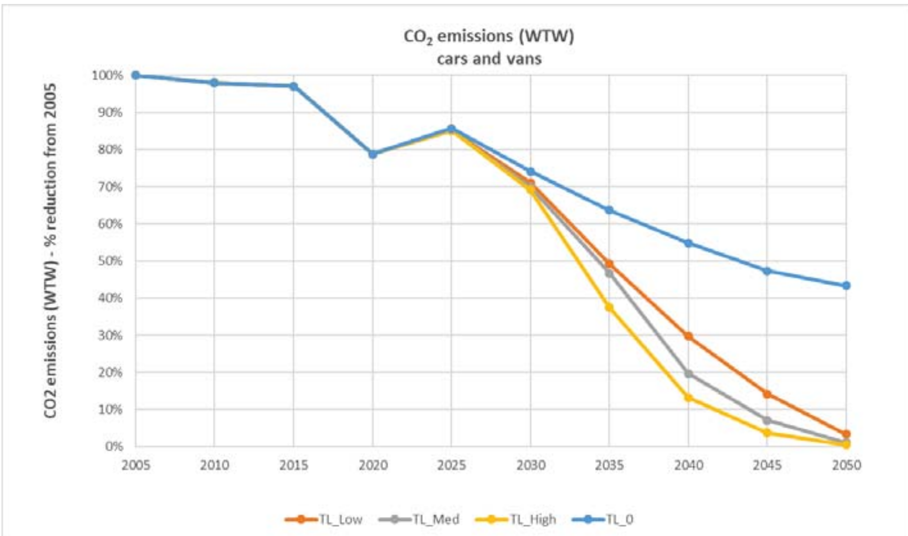


6.2.1.3.2 CO_2 emissions (WTW)

The trends for well-to-wheel (WTW) CO_2 emissions seen across the different TL options (see **Figure 16**) are very similar to those for the tailpipe CO_2 emissions. Due to the upstream emissions (Well-To-Tank), the emission reductions observed are slightly lower.

Under the baseline, WTW CO_2 emissions reduce by 26% between 2005 and 2030. In 2040 and 2050, emissions are 45%, resp. 57% lower than in 2005. From 2035 onwards, significant additional reductions on top of the baseline are achieved under the TL options. In 2040, these range from 25 (TL_Low) to 42 (TL_High) percentage points. In 2050, the range is from 40 (TL_Low) to 43 (TL_High) percentage points. All the figures take into account the effect of the other policies in the MIX scenario which act on the upstream emissions, in particular the strengthened EU ETS, which strongly decrease the emissions from the power generation, emissions trading for buildings and road transport as well as the Renewable Energy Directive.

Figure 16: Well-to-wheel (WTW) CO_2 emissions of cars and vans in EU-27 - % reduction compared to 2005



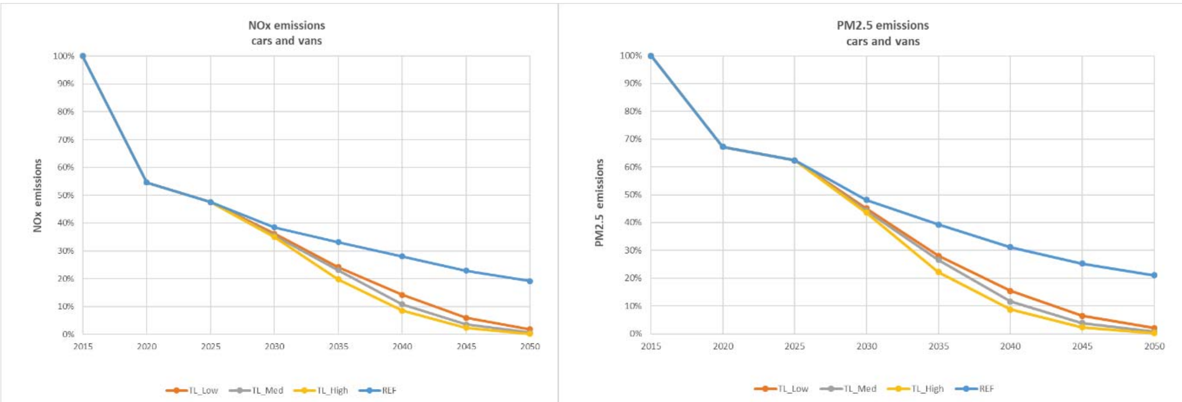
6.2.1.3.3 Air pollutant emissions

The changes in fuel consumption or mix triggered by stricter CO_2 targets will not only lead to lower CO_2 emissions, but also lower air pollutants emissions. These co-benefits have also been quantified and assessed for the baseline and the TL options.

The results are summarised in **Figure 17**. This covers the combined impacts of the CO_2 emission standards and stricter air pollutant emission standards, such as are expected to be proposed in the context of the Euro-7 emission legislation. The CO_2 emission standards contribute to reducing air pollutant emissions, since they drive the shift towards zero-emission vehicles, which have no pollutant tailpipe emissions.

The cumulative cost of the avoided pollutants compared to the baseline in the period 2030 to 2040 amounts to around 42, 49 and 59 billion euros, respectively for the three target levels considered. The estimation is based on the methodology of the 2019 Handbook on the external costs of transport[94], and it includes health effects, crop losses, material and building damage as well as biodiversity loss.

Figure 17: NO_x and PM2.5 emissions of cars and vans in EU-27 (% reduction compared to 2015)



6.2.2 *Timing of the targets (TT)*

Economic impacts

The current five-yearly target strengthening (option TT0) takes into account the time needed for manufacturers to develop and market new models, equipped with additional CO_2 reducing technologies, or platforms with novel powertrains. It thus acknowledges the typical investment cycles of the industry.

Option TT1, especially in the case of annually tightened targets, makes it more difficult for manufacturers to deal with year-to-year market fluctuations and to manage the introduction of new or upgraded models and technologies in the fleet. This is therefore likely to increase compliance costs for manufacturers. At the same time, economic savings for consumers or society are likely to increase.

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

In particular under a system of annually tightened targets, allowing the banking of credits obtained from overachieving the targets in a given year for use in following years would offer manufacturers greater flexibility and could increase the overall cost-effectiveness of the policy. It would reward early movers and help to alleviate efforts at a later stage, which may be generally more expensive. It would also allow for dealing with unexpected annual fluctuations in a manufacturer's fleet.

Compared to optin TT0, option TT1 would speed up the market introduction of ZLEV, which would have a positive impact on the technology cost reduction.

Environmental impacts

Option TT1 would ensure that CO_2 emission reductions either follow an annual path or would have to be achieved within 2-3 years from the previous binding target. In practice, also a five-yearly tightening of the targets (option TT0) may create some anticipation by manufacturers, in particular where a significant improvement of the average performance is required over those years. Nevertheless, the absence of more ambitious intermediate CO_2 targets would delay the introduction of CO_2 reducing technologies with high manufacturing costs.

Option TT1 would therefore provide greater certainty than option TT0 that a gradual CO_2 emission reduction will be effectively delivered. This will lead to lower CO_2 and air pollutant emissions in the intermediate period and beyond.

In a worst case scenario, where manufactures do not reduce the average specific emissions of their fleet in the period between 2030 and 2035, the CO_2 emissions (tailpipe) from cars and vans in 2035 would be 5% higher. This would also mean an increase by 5% of the cumulative CO_2 emissions from cars and vans over that period, equivalent to around 57 million tons CO_2. This scenario is however unlikely as it does not take into account any anticipation by manufacturers during that period. While the experience with the 2020 target shows that this anticipation was limited, with stricter targets and a clear signal for the longer term manufacturers are less likely to postpone improvements of their fleet emissions. The projected developments of the infrastructure for zero-emission vehicles, driven by the revision of the AFID, will also create better conditions for target anticipation.

In case banking of credits would be allowed to mitigate the effect of annually tightening targets, their accumulation and carry-over could undermine the effectiveness of the targets. To avoid such negative impacts, the level of credits banked could be capped and credits could be set to expire after a fixed time limit. In addition, there could be rules on the maximum carry over from one compliance period to another.

Social impacts

Under option TT1, consumers would benefit from energy cost savings earlier on than under option TT0.

Administrative burden

Under option TT1, administrative costs and complexity would increase in case of banking as the emissions monitoring system would need to keep track of the credits used. In case the composition of a pool changes during a banking period, it would be necessary to establish the correct reallocation of the credits banked as a pool to each manufacturer in the pool.

6.2.3 Use of the revenues from excess emissions premiums

Excess emission premiums are imposed on manufacturers if their average specific emissions exceed their targets in a given calendar year. Until 2019, the revenues from the excess emission premiums have been limited, and did not exceed 3 million euros in any given year.

However, with the increasing stringency of the EU fleet wide targets, it is not excluded that these revenues may increase significantly in the years to come. Even if more significant amounts would become available, they will, however, still be highly variable and difficult to predict over time.

6.2.3.1 Option REV 1: Assigning the revenue to a specific fund or programme

The possibility of assigning the revenue has been evaluated for the Just Transition Fund and the Innovation Fund.

The objective of the Just Transition Fund (JTF) to support the transition process towards the EU's 2030 target for energy and climate and a climate-neutral EU economy by 2050 is consistent with the overall objective of re-skilling and up-skilling of workers as expressed in the review Article of Regulation (EU) 2019/631.While the JTF does not foresee any means of channelling support directly to the automotive sector, it is not excluded that the sector could benefit indirectly, inter alia through re-skilling and up-skilling of workers, if such support is in line with the aims of the Member States' territorial just transition plans as approved by the Commission.

The Innovation Fund pursues objectives that are formally consistent with those of Regulation (EU) 2019/631. However, in its current set-up, as defined in the EU ETS Directive, it would not be possible to target the objective of re-skilling and up-skilling referred to in the review Article of Regulation (EU) 2019/631, nor to ring-fence any revenue from the premiums specifically to the automotive sector. Assigning the revenue to the Innovation Fund is therefore conditional on (i) the revision of the EU ETS Directive, and on how the automotive sector may be addressed, at least indirectly, by support from the Fund, and (ii) on the addition in the Directive of the relevant provisions on the receipt and distribution of the assigned revenue. It would also be necessary to revise the implementing legislation on the operation of the Innovation Fund as well as on the management of the revenue of the Fund by the EIB.

Environmental impacts

There are no direct environmental impacts. Where additional spending possibilities are created, there may, however, be some indirect beneficial impacts, by channelling the amounts available to climate related expenditure.

Economic impacts

Assigning the revenue to a specific fund or programme may in principle lead to increased spending possibilities. The overall impact of that revenue may, however, be 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.

Based on the current set up of the two Funds, it should also be noted that support could not be directly addressed to the automotive sector.

Social Impact

While the possibility is foreseen under the JTF to specifically support the up-skilling and reskilling, including training, of affected workers, it is likely that the social impact of assigning the revenue from the premiums to either of the two funds will have a limited social impact, considering that the amounts available may be quite small.

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.

This may be achieved by either allowing the revenues to accumulate over a longer period, or provide for a threshold over which the revenue would be assigned (if below the threshold, the premiums would be considered as revenue for the general budget).

In the case of the JTF, the additional resources resulting from the assigned revenue will be distributed among Member States in accordance with the distribution mechanisms foreseen in the JTF Regulation. Member States will, in order to include those additional resources, have to amend their spending programmes and those amendments will subsequently have to be approved by Commission Decisions. While excess emission premiums may be imposed annually, it would lead to excessive administrative burden if this would result in the need to annually revise and approve Member States' spending programmes.

In the case of the Innovation Fund, the revenue from the premiums could only be assigned once the amount is certain and can be included in the relevant financing decision preceding the call for projects. In order to ensure the certainty of the amounts, the premiums would have to be accumulated and this would require that the agreement with the EIB on the management of the revenue of the Innovation Fund would have to be renegotiated, including the fees charged by EIB to cover the additional costs.

6.2.3.2 Option REV 2: Consider the revenue from the excess emission premiums as an "own resource"

The EU budget is financed primarily by own resources. These are defined in Council Decision (EU, Euratom) 2020/2053 and do not currently include revenue from financial penalties such as that from excess emission premiums.

As mentioned in Recital (8) of that Decision, work should, however, continue, in the course of the multiannual financial framework for the period 2021-2027, towards the introduction of other own resources. A pre-condition for this option to be considered, is that the revenue may be defined as an "own resource" under that Decision. However, the inter-institutional agreement of 16 December 2020 states that the Commission should, in its proposal for defining additional own resources, give priority to revenue from the emissions trading system, the carbon border adjustment mechanism and a digital levy.

Environmental impact

There are no specific environmental impacts.

Economic impact

The objective of considering the revenue from the premiums as an "own resource" would be that this revenue can be considered additional to other own resources. As compared to the current approach, where the premiums are considered revenue for the general budget, this could in principle lead to increased spending possibilities.

It should, however, be noted that this option would not allow targeting the automotive sector any more than the current approach.

Social impact

There are no specific social impacts resulting from this option.

Administrative burden

It is expected that the administrative burden would increase as compared to BAU.

Own resources consist in principle of contributions from the Member States. Should the revenue from the premiums be considered as own resources, they would first have to be distributed among Member States and would as such reduce the Member States' contributions from other sources. This distribution would lead to additional administrative burden and is likely to be disproportionate considering the potentially limited and uncertain amounts that could be made available through this source of revenue.

6.2.4 Derogations for small volume manufacturers

Small volume derogations are available to manufacturers responsible for between 1 000 and 10 000 new cars or 22 000 new vans registered in a calendar year[95]. In 2019, such derogations were granted to 12 car manufacturers and two van manufacturers[96].

Under option SVM 1 the possibility for small volume manufacturers (SVMs) to be granted a derogation target would be removed from 2030 onwards. This would make all small volume manufacturers subject to a specific emission target based on the EU-wide fleet target.

Environmental impacts

With the applicable targets, the environmental benefits of removing the small volume derogation would be rather limited. However, as the EU fleet-wide targets get stricter and other manufacturers will have to reduce their emissions at a faster pace, the positive impact of this option will increase. Therefore, the environmental impacts of removing the derogation would most likely be slightly positive.

Economic impacts

Removing the small volume derogation would increase the cost of compliance for SVMs. However, SVMs are not a homogenous group in terms of their portfolio: they currently include specialist car manufacturers (e.g. of sports and luxury cars), parts of large international groups with limited sales in the EU, as well as recent market entrants and companies competing against the established mass-market manufacturers. In the case of vans, there are very few SVMs and differences between them are not as significant.

For those SVMs that are effectively large manufacturers with low levels of registrations in the EU, the implications of the transition would be no different from those experienced by the large volume manufacturers. As a result, a derogation does not seem justified anymore. .

For independent SVMs, the capacity to bear the additional cost will differ depending on their type of portfolio (market segment, price/margin of their vehicles), the number of vehicles they put on the EU market and their global scale. Many SVMs operate in the sports and luxury segments, which means that their vehicle prices tend to be higher than the market average, and the possibility to pass-on the costs of additional CO_2 emissions technologies to consumers is also higher. For the most succesful amongst them, this also translates into higher than average profit margins per vehicle[97]. The electrification efforts required to meet the future

[95] Manufacturers with fewer than 1,000 cars or vans registered per year would still be exempted from meeting a specific CO_2 emission target.

[96] Cars: 12 SVMs with a total of 25 844 vehicles registered (0.2% of EU fleet): Alpina (693 cars), Aston Martin, Bentley, DR Automobiles, DR Motor Company, Ferrari, General Motors, Lamborghini, Lotus (717 cars), Mahindra, Maserati, McLaren. Noble was granted a derogation target, but no new cars have been registered in 2019.
Vans: 2 SVMs with a total of 4 970 vehicles registered (0.3% of EU fleet): Piaggio, Ssangyong.

[97] https://www.autocar.co.uk/car-news/industry/inside-industry-why-scale-critical-mainstream-car-makers

targets might bring specific economic challenges for such independent manufacturers to develop and integrate electrified powertrains.

Without derogation targets, the possibility to pool with other manufacturers may allow some mitigation of the compliance costs. Also, as targets will become stricter over time, it is clear that emission reduction efforts will have to be made by all SVMs, also if they join a pool. Providing a date for the phasing-out of the small volume derogations should therefore provide planning certainty, help remove market distorting effects and ensure a more level playing field among these manufacturers.

Administrative burden

Removing the SVM derogation would simplify the implementation of the Regulation by avoiding the need for manufacturers to prepare and for the Commission to assess derogation applications. This would slightly lower the overall administrative costs of the Regulation. This effect may be partially balanced in case this option would lead to more pooling.

Social impacts

The social impacts of removing the SVM derogation are expected to be very small, taking into account the limited number and size of the manufacturers concerned.

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

6.3.1 Introduction and methodological considerations

6.3.1.1 Combined options for the ZLEV incentive type and scope

Based on the elements for possible options set out in Chapter 5 regarding the ZLEV incentive type (options ZLEVT) and the vehicles it would cover (options ZLEVAC), a large number of combinations of options could potentially be defined. For practical reasons it was decided to select three combinations to analyse the impacts, as shown in **Table 17**:

- ZLEV_Low is a bonus-only crediting system covering zero- and low-emission vehicles with emissions up to 25 g/km and linear accounting (vehicles emitting 25 g/km are counted as zero vehicles; ZEV are counted as one vehicle)
- ZLEV_Med is a two-way crediting system covering only ZEV;
- ZLEV_High defines a mandatory share of ZEV to be met by each manufacturer.

These combinations are considered representative for a range of ambition levels (low-medium-high) as regards the type and scope of the incentive mechanism. Their combined assessment therefore provides a good picture of the projected impacts across the full spectrum of possible ZLEV options.

The ZLEV share of the fleet from 2035 onwards is projected to be very high under all TL options considered (see Section 6.1), driven solely by the stringency of the CO_2 emission targets. In these cases, no additional specific incentive for ZLEV would be necessary. Therefore the options for the ZLEV incentive mechanism will only be considered in relation to the CO_2 emission target for 2030.

The baseline for this assessment will be the ZLEVT_no option (same CO_2 targets, but no additional ZLEV incentive).

Table 17: Combined options for the type of ZLEV incentive and its scope (vehicles covered) – cars and vans

Combined option	Incentive type (ZLEVT)	Vehicles covered (ZLEVAC)
ZLEV_Low	ZLEVT_B: bonus only	ZLEVAC_2: ZLEV < 25 g/km
ZLEV_Med	ZLEVT_BM: bonus/malus	ZLEVAC_1: ZEV
ZLEV_High	ZLEVT_M: mandate	ZLEVAC_1: ZEV

The crediting systems under options ZLEV_Low and ZLEV_Med would leave flexibility to manufacturers as to their fleet share of ZLEV, under the constraint that their CO_2 target is met. This means that the ZLEV benchmark may be over- or underachieved by individual manufacturers or pools, which in turn may affect their CO_2 target. To preserve the environmental integrity and limit the impacts on the CO_2 target, the changes to the target level are limited to +/- 5%[98].

As explained in the next sections, the impacts of these options will depend on the ZLEV share of different manufacturers and how it compares with the benchmarks set.

As it is not possible to project strategic decisions of individual manufacturers, several sets of scenarios are analysed to assess these options, representing different possible strategies and outcomes.

In order to ensure that the ZLEV incentive mechanism effectively provides an additional signal to increase the ZLEV market uptake, the ZLEV benchmark or mandate should be set higher than what would be otherwise projected. In the case of a bonus-only crediting system, too low benchmarks even bear a high risk of undermining the CO_2 targets without triggering an additional ZLEV uptake.

For the quantitative assessment, the CO_2 targets defined under option TL_Med were considered and the ZLEV benchmark/mandate levels in 2030 have been set at 45% for cars and 35% for vans, which is around 10% higher than the actual shares projected in the new vehicle fleet under this option when no ZLEV incentive would be in place.

6.3.1.2 General considerations regarding the incentive mechanism

When assessing the impacts of the ZLEV incentive, it needs to be considered how it delivers on its intended purpose, without creating unwanted side effects. The main aim of the mechanism should be to help overcome barriers hampering the uptake of ZLEV, by incentivizing manufacturers to preferentially put ZLEV on the market, reaching at least the ZLEV shares that would be required to meet the CO_2 targets. At the same time, it should be avoided that the incentive mechanism undermines the effectiveness of the standards or leads to much higher costs for manufacturers or consumers.

The analysis will therefore aim at understanding:

- whether the mechanism would indeed incentivise manufacturers to increase their share of ZLEV as compared to the ZLEV_no option;

- the environmental and economic effects of manufacturers meeting, under- or overachieving the ZLEV mandate or benchmark levels.

[98] A 5% cap is already applied in the current Regulation

6.3.2 *Economic impacts*

For the assessment of the economic impacts of the ZLEV incentive options, the TCO of the different options have been calculated.

For passengers cars, the TCO results show that no significant difference is experienced by either the first-user or the second user, between the ZLEV_no option and ZLEV_Low and ZLEV_med options in scenarios with ZLEV/ZEV shares that are equivalent to the benchmark levels (i.e. without triggering the bonus/malus), as well as in a ZLEV_High option.

The absolute differences in TCO over five years are in the order of 15 euro/vehicle for the first user and 20 to 50 euro/vehicle for the second user (in this last case, the TCO of the ZLEV_no option is always higher).

In all these scenarios the incentive mechanism determines change in the fleet composition that impacts the capital cost and the operating cost component of the TCO. In particular an increase penetration of zero-emission vehicles is combined with a decrease in the efficiency of conventional vehicles (including due to shifts of conventional vehicles towards larger segments). This leads to a decrease in the average capital costs, but also a decrease in the fuel savings.

Different results are shown in a scenario where in a bonus/malus system, the malus is triggered, i.e. manufacturers ZEV share remain below the benchmark levels set and their CO_2 emission target is therefore made stricter. Because of the impact on the CO_2 target level and the possible consequent additional difficulties for the manufacturers, this scenario has been specifically analysed. In this case, the conventional engines need to become more efficient, while the share of ZEV is still higher than in ZLEV_no (even if, they are lower than the benchmark). This determines overall a more beneficial TCO, with first and second user TCO benefits increasing by about 190 euro/car, related to a slightly more ambitious CO_2 target (up to 5%) as compared to ZLEV_no.

For vans, different dynamics are observed. In the ZLEV_Low and ZLEV_Med option, scenarios with ZLEV/ZEV shares equivalent to the benchmark levels (i.e. without triggering the bonus/malus), the TCO for the first user show net costs, with differences as compared to ZLEV_no of around 340 euro/vehicle. The TCO for the second user shows a deterioration of the savings of around 190 euro/van, compared to the around 370 euro/van TCO benefit of the ZLEV_no option. Both effects are related to the decrease of the fuel cost savings linked to less efficient conventional vehicles in the fleet.

In the case of the triggering of a malus in the ZLEV_Med for vans, the same conclusions can be drawn up as for cars.

<u>In summary</u>, the scenarios analysed for the different options show that:

- The TCOs for cars do not significantly change in case of mandates, or benchmark based incentive types when the benchmark levels are met.
- The TCOs for vans deteriorate in case of mandates, or benchmark based incentive types when the benchmark levels are met
- In case of benchmark-based system where the malus is triggered, the TCO show higher savings as compared to the option without incentive, both for cars and vans. The comparison is however biased by the fact that a different CO_2 target level applies.

Besides this analysis on the TCOs and from the perspective of the automotive manufacturers, a binding ZEV mandate or a bonus/malus system reduce significantly the flexibility for manufacturers to meet their CO_2 emission targets. Under these options manufacturers would be required to put on the market a predetermined share of zero-emission vehicles to avoid fines or having to meet stricter CO_2 emission targets with further improvement of conventional technologies. These options may therefore lead to the targets not being met in the most cost-efficient way. A bonus-only system would not lead to changes in the impacts for automotive manufacturers, as it would not impose additional requirements to the manufacturers, who are able to decide to meet the benchmark levels or not, depending on their specific circumstances.

Administrative burden

The different options considered as regards the ZLEV incentives would not create significant additional administrative costs.

In case of a binding mandate (ZLEV_High), an additional compliance assessment regime would need to be established and, in case of non-compliance, fines would have to be imposed and collected.

6.3.3 Social Impacts

All of the scenarios analysed for the different options for the ZLEV incentive show the same impacts in terms of the affordability of the different powertrains and vehicle segments among the five income groups. Furthermore, they lead to the same quantitative results as for option TL_M, see section 6.2.1.2.

6.3.4 Environmental impacts

The modelling of the different options for the ZLEV incentives revealed only limited variations in the overall tailpipe CO_2 emission levels of the vehicle fleet. Even though the fleet composition has an effect due to the differences between vehicle segments and powertrain types in the gap between test and real-word CO_2 emissions, the total tailpipe emissions are mainly determined by the EU-wide fleet CO_2 target.

Therefore, tailpipe CO_2 emissions will be slightly lower in case of ZLEV_Med leading to a full application of the “malus” and slightly higher in case of a full “bonus”. A result, the full “bonus” scenario may risk undermining the environmental effectiveness.

Emission reductions of NO_x and PM2.5 over the period 2030-2040 show limited variation among the different options considered.

<u>Interaction between the ZLEV incentive and the CO_2 target level: impact on conventional vehicles</u>

The introduction of a ZLEV incentive mechanisms aims to increase the market uptake of ZLEV. A higher ZLEV share in a manufacturer’s fleet also means that a given fleet-wide CO_2 target could be met while the other vehicles in the fleet become less efficient.

In both the ZLEV_Low and ZLEV_Med options, scenarios with Z(L)EV shares equivalent to the benchmark levels (i.e. without triggering the bonus/malus) showed that conventional vehicles in 2030 could potentially have 2% to 6% higher WLTP CO_2 emissions compared to a situation where no ZLEV incentive would apply. The same happens in the ZLEV_High option. More specifically, in the ZLEV_Med scenario analysed, emissions of diesel cars were found to increase up to 17% as the CO_2 target gets weakened. In this case, also a potential deterioration of the average emissions of those vehicles compared to 2020 could be observed, in the order of 1%-7%.

6.4 Mechanism for renewable and low-carbon fuels accounting

6.4.1 Economic impacts

6.4.1.1 Option FUEL1 (application of "carbon correction" factors)

Under this option, "carbon correction" factors would be applied to the type-approved CO_2 emissions of the vehicles, to reflect the carbon intensity and share of renewable and low-carbon fuels used by cars and vans.

This would lower the average specific emissions of a manufacturer's vehicle fleet. Therefore, in order to comply with its specific emission target, a manufacturer would need to implement less technologies to reduce the tailpipe CO_2 emissions of its vehicles put on the market and this would reduce the compliance costs for manufacturers.

The analysis carried out in the context of the MIX policy scenario and with the medium target levels (TL_M) shows that the technology costs for manufacturers would be reduced, as if the CO_2 emission standard to be met was around 6 percentage points less stringent than in TL_M in 2030.

The average net savings (EUR per vehicle) from a societal perspective and from the user's TCO perspective are less favourable under the option FUEL1 compared to the MIX scenario due to the lower uptake of ZEV. This is consistent with the analysis provided under section 6.2.1.1.3 as this option is equivalent to setting less ambitious CO_2 target levels.

6.4.1.2 Option FUEL2 (low-carbon fuels (LCF) crediting system)

Under this option, an individual manufacturer would have the possibility of obtaining credits for determining its average specific CO_2 emissions and meeting its specific targets if additional quantities of LCF were used in road transport. Such credits would have to be obtained from fuel suppliers marketing quantities of LCF which are higher than those required to comply with their obligations from the implementation of the Renewable Energy Directive (RED) in the Member States and their obligations under the Refuel Aviation and Maritime. This option could trigger additional investments in LCF.

In the economic analysis of this option, a comparison is made between (i) the costs for an additional newly registered battery electric vehicle (BEV) to meet the CO_2 target as compared to an ICEV 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 BEV. 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.

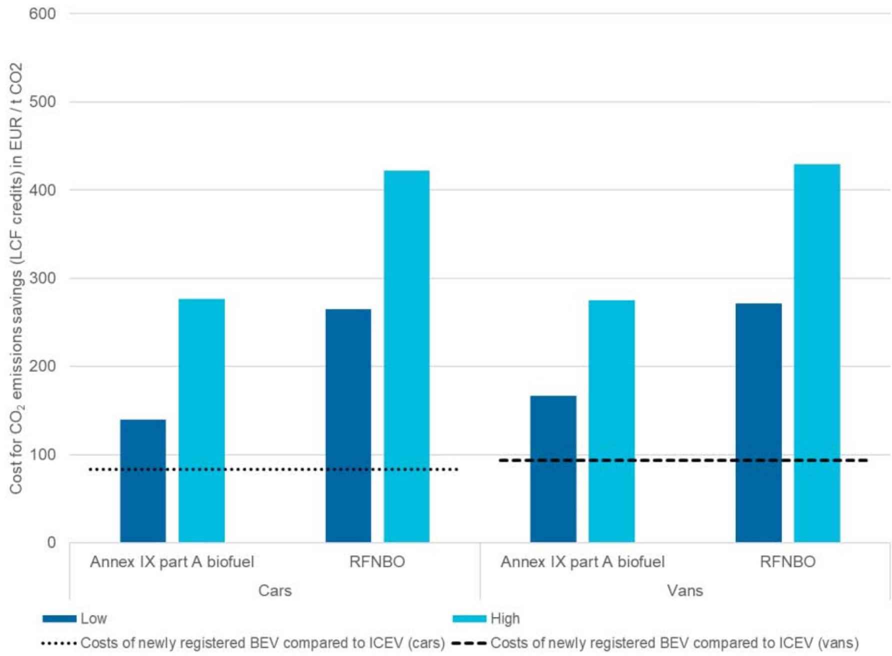
The cost analysis is limited to advanced biofuels (defined by Annex IX part A of RED) and Renewable Fuels of Non-Biological Origin (RFNBO) and newly registered cars and vans in 2030 and 2035. Different cost paths for the LCF are used for the calculations in order to illustrate different possible developments (see Annex 8).

From a manufacturer's perspective, the analysis carried out shows that the costs for a manufacturer of purchasing LCF credits are significantly higher than complying with its targets through an additional BEV.

Figure 18 shows the cost results, averaged over the EU-wide new vehicle fleet of petrol and diesel cars and vans registered in 2030. The same trends are observed for 2035 and 2040. In this case, crediting CO_2 reductions from advanced biofuels leads to higher compliance costs for manufacturers as compared to those required for achieving target compliance by an additional BEV. This is observed both in case of a low and high cost assumption for different types of advanced biofuels and RFNBOs.

Moreover, it has to be considered that the advanced biofuels with lower production costs, substitute for gasoline, will likely not be available in very large quantities in 2030 and 2035 in addition to the quantities needed under the requirements of RED and for CO_2 reduction in aviation and the maritime sector. The likelihood that a manufacturer can use such advanced biofuels with very low production costs to meet its CO_2 target is low for these reasons.

Figure 18: Costs (averaged over the EU-wide new vehicle fleet of petrol and diesel cars and vans) for CO_2 emission savings [EUR/tCO_2] for a manufacturer under a Low Carbon Fuels compliance strategy in 2030

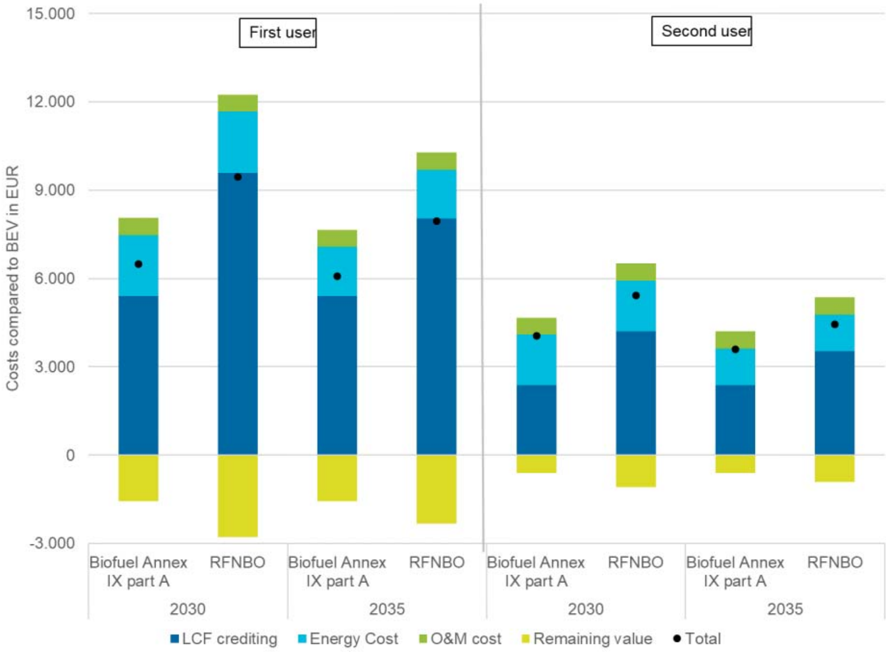


<u>For the costs for end-users and for the calculation of societal costs</u>, in addition to the costs of purchasing the vehicles, the operational costs of the vehicles during the use are a key element when comparing the costs of the two different target compliance options with each other.

Cost advantages arise for BEV due to their energy efficiency advantages. The analysis shows that the additional purchase costs for BEV are also lower than the costs required for LCF credits. For this reason, all calculations for the total costs for end users (both first and second users) and for societal costs show a clear cost advantage for the use of a BEV compared to CO_2 emission reduction via LCF credits, even considering increased electricity prices as a result of the EU ETS and policies acting on the power sector, as in the MIX policy scenario.

As an example, **Figure 19** displays for cars the significant additional costs for a first or a second user in case of a manufacturer would chose to comply with its 2030 or 2035 target by purchasing LCF credits rather than by an additional BEV. The same trends are observed from a societal perspective as well as for vans.

Figure 19: Average costs (EUR) as TCO-first user and TCO-second user of a Low Carbon Fuels compliance strategy compared to a BEV compliance strategy



6.4.2 Environmental impact

In the FUEL1 and FUEL2 options, the compliance of vehicles manufacturers with their CO_2 emission targets take into account the share of renewable and low-carbon fuels. As a result, the compliance of vehicles manufacturers with their targets requires less efforts to decrease their fleet CO_2 emissions per kilometre as compared to the FUEL0 option (no accounting for the renewable and low-carbon fuel contribution).

The results described below are all from specific PRIMES simulations. They refer to the MIX scenario policy context, where the CO_2 emission standards for vehicles are set at the level of the TL_M option with de-facto the FUEL0 option. The share of renewable and low-carbon fuels in road in the FUEL0 scenario is around 9% in 2030, driven by the increased ambition of the Renewable Energy Directive to mainstream renewable energy in transport.

In the FUEL1 option, the average WLTP CO_2 emissions[99] of the vehicle fleet increase by around 6% in 2030 compared to FUEL0, considering the actual lifecycle emission savings of renewable and low-carbon fuels relative to the fossil fuels comparator.

FUEL1 option leads to a higher uptake of ICEV in 2030 as compared to FUEL0, while the share of ZEV in the new registration of 2030 decreases by around 3 percentage points both for cars and for vans.

As a result of the combination of the effects described above, the reduction of CO_2 tailpipe emissions from cars and vans in FUEL1 during the period 2005-2030 slightly decreases compared to FUEL0, by around 1 percentage point.

While the FUEL1 option does not lead to an increase of the renewable and low carbon fuels share as compared to the MIX scenario, the FUEL2 option acts as an incentive for the fuel

[99] i.e. CO_2 emissions measured under the WLTP test cycle procedure which uses reference fuels

industry to produce and market additional quantities which would create credits for the automotive manufacturers compliance with the CO_2 emission standards.

In order for the FUEL2 option to create incentives for increased uptake of renewable and low carbon fuels, its scope needs to be limited to advanced biofuels from feedstocks listed in Part A of Annex IX of RED (thereinafter 'PartA biofuels') and to RFNBO, to ensure a consistent approach with the RED framework. The RED also limits the contribution of other types of biofuels, in particular food-based biofuels and biofuels from feedstocks listed in Part B of Annex IX, to minimise undesired impacts, including ILUC and system gaming/frauds.

The assessment of option FUEL2 is therefore limited to the impacts of credits for specific renewable and low-carbon fuels. In addition, in order to prevent disincentives for the automotive manufacturers to invest in vehicles zero-emission technologies, the overall contribution of the fuels credits to the manufacturers' compliance with the CO_2 emission standards is capped at 5%.

The overall biofuels consumption is approximately 19 Mtoe in 2030 in the FUEL0 scenario, out of which around 5 Mtoe of PartA biofuels. In the FUEL2 option, in case the 5% cap is met, an additional 5.3 Mtoe of PartA biofuels is consumed by cars and vans. This represents a doubling of the use of PartA biofuels in road in 2030 relative to FUEL0.

The same effect as in FUEL1 option is observed concerning the average WLTP CO_2 emissions of the vehicles fleet, which increase by around 5% in 2030 compared to FUEL0, considering the actual lifecycle emission savings of the additional renewable and low-carbon fuels in the scope of the option relative to the fossil comparator. The shares of ICEV registered in 2030 increases in FUEL2 compared to FUEL0, while the share of ZEV reduces by around 3 percentage points.

The additional quantities of PartA biofuels slightly overbalance the increase in the WLTP CO_2 emissions of new vehicles. As a result, the reduction of CO_2 tailpipe emissions in 2005-2030 from cars and vans, amounting to around 30% in FUEL0, increases by around 1 percentage point in FUEL1 under the most extreme case in which the additional PartA biofuels are enough to meet the cap.

However, the additional quantities of PartA biofuels in 2030 under the FUEL2 option lead to an increase in the overall gasoline and diesel blended fuel prices. This effect is driven by the need to use more expensive feedstocks, with an overall increase of around 20% of the costs of the additional PartA biofuels, due to competition with other transport modes, in particular aviation and maritime, for which specific targets are set under the MIX policy context.

In both FUEL1 and FUEL2 options, the incentives are not strong enough to incentivise the market uptake of RFNBO and/or other e-fuels for cars and vans by 2030. This is due to constraints related to technological developments, maturity, costs, as well as the need to ensure additionality compared to the targets set under RED II and the aviation and maritime fuels Initiatives, in the case of option FUEL2.

Should the market behave differently than what is projected under these scenarios and should RFNBO and/or e-fuels come to the road market by 2030, this could lead to negative impacts in terms of overall energy savings. 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[100], depending on

[100] See https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/2020_study_main_report_en.pdf

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. According to literature[101], the overall efficiency of electricity use for battery electric cars is 69%, while it deteriorates to around to 26% for hydrogen fuel cells vehicles, and to 13% for internal combustion engines powered with e-fuels.

Concerning pollutants emissions, literature sources show that, compared with fossil fuels, the use of biofuels and/or e-fuels does not provide benefits in terms of NO_x and PM emissions[102]. Therefore under both options FUEL1 and FUEL2 leading to reduced penetration of ZEV, a slight increase of pollutant emissions can be expected compared to FUEL0.

6.4.3 Social impact

Introducing the option FUEL1 would lead to social impacts equivalent to a lower level of ambition of the target levels. These impacts are described under section 6.2.1.2. 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 all the different income groups.

6.4.4 Administrative burden

Option FUEL1 would not lead to additional administrative burden.

The implementation of the LCF credits option (FUEL2) would significantly increase the administrative burden and complexity of the compliance system. This concerns in particular the following main issues:

(i) setting up of a new crediting, monitoring and reporting system for the credits generated by fuel suppliers in case of exceedance of their targets under the Renewable Energy Directive and Refuel aviation and maritime proposals and to allow manufacturers to purchase these credits.

(ii) additional checks at the stage of issuing the credits and checking of manufacturers compliance with their annual specific target in order to ensure full additionality of the system. Assessing compliance by vehicle manufacturers would therefore require involvement of the national authorities responsible for the implementation of the Renewable Energy Directive.

(ii) addressing the complexity of different timing in the reporting cycles as the compliance cycle for vehicle manufacturers is annual while the reporting under the Renewable Energy Directive is biannual.

6.5 Coherence and interaction with other policies in the “Fit for 55%” package

The Climate Target Plan highlights how achieving at least 55% greenhouse gas emissions reductions will require actions in all sectors. For road transport, the Climate Target Plan concluded that a basket of policy measures is necessary, and that *“in parallel to applying emissions trading to road transport at the level of the fuel supplier and road pricing in line*

[101] https://www.agora-verkehrswende.de/en/publications/the-future-cost-of-electricity-based-synthetic-fuels/
[102] https://www.concawe.eu/wp-content/uploads/2020-01-2147.pdf (Figures 9-13)

with the ongoing revision of the Eurovignette Directive, only stringent CO_2 emissions performance standards ensure the supply of modern and innovative clean vehicles".

This conclusion is underpinned by the analysis in the Climate Target Plan Impact Assessment. In all scenarios reaching the 2030 at least 55% target and climate neutrality by 2050, the stringency of the CO_2 standards for cars and vans increases as compared to the current legislation. The same conclusion is presented in the 'Sustainable and Smart Mobility Strategy', based on the analysis in its accompanying Staff Working Document.

6.5.1 Coherence and interaction with emissions trading for buildings and road transport

The 'Fit for 55' core scenarios confirm that, considering the effectiveness of the CO_2 emission standards at providing consumers with technology choice and lowering emissions in the transport sector, and the more limited responsiveness of this sector to carbon pricing alone, an increase in the ambition for the CO_2 emission standards is necessary for road transport to contribute to the -55% target.

In the MIX scenario, an increase in the stringency of the CO_2 emission standards and emissions trading for buildings and road transport complement each other to deliver emission reductions in road transport. The MIX scenario, where policies address market failures in a targeted manner and provide investor/consumer certainty while pushing for uptake of innovative technologies, is considered a balanced policy approach, limiting the risk of (i) a too high carbon price with related increase in energy prices for all consumers; (ii) higher costs for economic operators due to only regulatory measures.

The CO_2 emission standards address the supply of more fuel-efficient and zero-emission vehicles, setting requirements on vehicle manufacturers with regard to their new vehicle fleets. Emissions trading for buildings and road transport concerns the fuel use in the entire vehicle stock (existing and new vehicles). It could increase the demand for more fuel-efficient vehicles, facilitating the fulfilment of the CO_2 targets of the vehicle manufacturers.

While an emission trading system sets a cap to the overall emissions, the CO_2 emission standards are necessary to ensure that efficient and zero-emission vehicles, a key instrument to achieve the cap, are supplied to the market, thereby allowing the emission trading to function. This increases in importance under the option to create a separate emission trading for the new sectors, in which the relative role of the car sector to comply with the cap is bigger.

Furthermore, the CO_2 emission standards provide for an essential tool to keep road transport emissions below the cap for the new sectors. Emissions trading for buildings and road transport will require to set a cap for those sectors. The cap and the Linear Reduction Factor (LRF) for the separate emissions trading would be set in line with cost effective emission reductions resulting from a mix of carbon pricing and other policies in the sectors concerned. The CO_2 emission standards are one of these policies and are a strong driver for emission reductions over time. As a result, increasing the level of the CO_2 emission standards will contribute to increasing emission reductions and thus lower the carbon price required to achieve a given cap. Vice-versa, less stringent CO_2 emission standards will contribute to increase the carbon price to achieve a given cap. The draft Impact Assessment for the ETS also highlights the continued need for CO_2 emission standards.

6.5.2 Coherence and interactions with ESR, EED, RED, ETS and AFID

By ensuring a reduction of road transport emissions, the CO_2 emission standards notably support Member States in meeting their targets under the Effort Sharing Regulation.

Since the standards incentivise the increase in efficiency and the electrification of vehicles, they contribute to the Energy Efficiency Directive objective.

Complementarities exist with the Renewable Energy Directive. By providing a route to using renewable energy in transport, the CO_2 emission standards will contribute to the Renewable Energy Directive objective. Both instruments deliver reduction of emissions, the CO_2 emission standards by supplying new zero-emission vehicles to the market, the Renewable Energy Directive (RED) by incentivising the uptake of renewable and low carbon fuels for the combustion engine vehicles in the stock.

In addition, the revision of RED will work in synergy with the CO_2 emission standards for vehicles. The CO_2 emission standards will increase the electrification of road transport through the supply of zero-emission vehicles while the RED will additionally act on the energy supply side by introducing a credit mechanism incentivising the participation of electricity providers to the necessary roll-out of publically available recharging infrastructure.

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

Finally, while the CO_2 emission standards ensure the supply of zero-emission vehicles, the Alternative Fuels Infrastructure Directive (AFID), which incentivises the rollout of recharging and refuelling infrastructure, is a necessary complementary instrument to address the market barrier on the deployment of infrastructure. This in turn is also incentivised by the ESR, which incentivises Member States to take action in their road transport sectors.

7 COMPARISON OF OPTIONS

The options are compared against the following criteria:

- Effectiveness: the extent to which the different options would achieve the objectives set out 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 2050 climate neutrality objective and the consistency with the overall 'fit for 55%' package;
- Proportionality, in terms of administrative costs and complexity.

Table 18 summarizes the assessment of each option against the criteria of **effectiveness, efficiency, coherence and proportionality,** following the categories of issues considered in the previous Sections.

Table 18: Summary of key impacts expected

✗✗	✗	0	✓	✓✓
Strongly negative	Weakly negative	Neutral	Weakly positive	Strongly positive

Options considered	*Effectiveness*	*Efficiency*	*Coherence*	*Proportionality – added value*
1. CO_2 EMISSION TARGETS (cars and vans)				
1.1 Target Levels				
TL_0	*0*	*0*	*0*	*0*
TL_Low	✓	✓	✓	✓
TL_Medium	✓✓	✓✓	✓✓	✓
TL_High	✓✓	✓✓	✓✓	✓
1.2 Timing of targets				
TT 0	*0*	*0*	*0*	*0*
TT 1	✓	✗	*0*	✗✗
1.3 Use of revenues from excess emissions premiums				
REV 0	*0*	*0*	*0*	*0*
REV 1	*0*	✗	*0*	✗
REV 2	*0*	✗	*0*	✗
1.4 Derogations for small volume manufacturers				
SVM 0	*0*	*0*	*0*	*0*
SVM 1	✓	*0*	✓✓	*0*
2. INCENTIVE SCHEME FOR ZERO- AND LOW-EMISSION VEHICLES (cars and vans)				
ZLEVT_no	*0*	*0*	*0*	*0*
ZLEV_Low	✗✗	*0*	*0*	*0*
ZLEV_Med	*0*	✗	*0*	✗✗
ZLEV_High	✓	✗	*0*	✗✗
3. MECHANISM FOR RENEWABLE AND LOW-CARBON FUELS ACCOUNTING (cars and vans)				
FUEL0	*0*	*0*	*0*	*0*
FUEL1	✗✗	✗✗	✗✗	✗
FUEL2	✗	✗✗	✗✗	✗✗

7.1 CO_2 emission targets for cars and vans

7.1.1 CO_2 emission target levels

The options considered cover a range of target level trajectories up to 2040. As described in Section 6 of this IA, the stricter the target levels set for cars and vans, the higher their **effectiveness** in achieving the specific objectives of reducing CO_2 emissions and providing air quality benefits to consumers. TL_Low is the least effective option as it would lead to less CO_2 emission reduction, less air quality benefits to consumers and less supply of zero-emission vehicles.

Stricter targets should also lead to an increase in the market uptake of ZEV[103], and thereby increase the effectiveness of the policy to stimulate innovation in zero-emission technologies. This will in turn also provide a stronger signal stimulating investments in recharging and refuelling infrastructure. 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 consumers. With stricter targets, it is expected that manufacturers would bring on the market more ZEV models at lower prices in order to attract customers and avoid losing market share.

In terms of **efficiency**, the three TL options considered deliver benefits over the lifetime of a vehicle from a societal perspective. These savings increase with increasing target stringency. This is the case when considering the effect of the CO_2 standards separately, as well as when considering the combined effect of the CO_2 standards and the other policies as projected in the MIX scenario.

From a first and second end-user perspective, the CO_2 standards have a positive effect on the total cost of ownership, with higher targets delivering higher benefits. Savings in the fuel expenditure during the use of the vehicles outweigh the possible higher upfront costs of more efficient vehicles. Among the options considered, TL_Low provides less economic savings from a societal and end-users perspective.

However, up to 2035, costs for the manufacturers increase with stricter CO_2 targets, making the option with the highest target level score less positively on this point.

As regards the social impacts, lower income groups are projected to see higher savings relative to their annual income from a total cost of ownership perspective and this effect becomes more outspoken with higher target levels, while there is little impact on the affordability of different vehicle types. BEV remain or become affordable with time for all the TL options except for the larger BEV for the lower income groups.

As regards the macro-economic impacts, the results show a small positive impact for the policy scenarios compared to the baseline in terms of EU-27 GDP. It is projected that higher CO_2 targets trigger increased consumer expenditure as well as increased infrastructure investment. This combined impact, as well as a reduction in imports of petroleum products, would result in an overall positive impact on GDP and reduce the import dependency of the EU economy.

On the one hand, at the sectoral level, there would be an increase in the electric vehicles supply chain, with a production increase in sectors such as metals and electrical and

[103] For instance, the share of zero-emission cars in the new fleet in 2030 ranges from 25% in the baseline to between 30% and 45% in the three target levels options. In 2035, all new cars are ZEV under TL_High, around 55% under TL_Med and 40% under TL_Low.

machinery equipment. This reflects the impact of increased demand for batteries, 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 cars. Similarly, the power and hydrogen supply sectors would increase production reflecting increased demand for electricity and hydrogen to power electric vehicles, while the petroleum refining sector would see a lower production. With more stringent target levels, these effects would become slightly more pronounced.

With more ambitious CO_2 target levels resulting in an increase in economic output, there is also a marginal increase in the number of jobs across the EU-27 compared to the baseline. The number of additional jobs also increases slightly over time. The main drivers behind the GDP impacts also explain the employment impacts. Additional enabling measures for EU investments into battery production, such as the European Battery Alliance, would amplify the positive employment effects.

Shifts in sectoral economic activity will also affect the skills and qualifications required in the automotive sector. Re-skilling and up-skilling of workers will be necessary.

In terms of **coherence**, higher 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), in case of a continued ESR scope, as well as to achieving the 2050 climate neutrality objective. Conversely, ESR also incentivises Member States to develop the recharging and refuelling infrastructure for zero-emission vehicles, thus facilitating compliance of the automotive manufacturers with their targets. Higher CO_2 targets would also contribute more to the achievement of the energy efficiency objectives.

The CTP has shown that a set of policy instruments is needed to achieve the increased climate target. The 'Fit for 55' core scenarios (see joint methodological paper) build on the CTP and analyse the interplay among the different instruments, in particular the intensity of carbon pricing and regulatory measures, to reach the -55% climate target.

The CO_2 emission standards for vehicles are a key regulatory measure driving the results of the core scenarios in road transport. The ambition levels TL_Low, TL_Med and TL_High are embedded into the core scenarios, which therefore provide an assessment of the coherence and interplay of the CO_2 emission standards with the other instruments.

The 'Fit for 55' core scenarios show that, considering the effectiveness of the CO_2 emission standards at lowering emissions in the transport sector, and the limited responsiveness of this sector to carbon price, an increase in the ambition for the CO_2 emission standards is necessary to ensure a sufficient reduction of emissions in road transport to contribute to the -55% target.

The core scenarios also show that in general a combination of carbon pricing and regulatory measures limits the risk of (i) a too high carbon price with related increase in energy prices for all consumers; (ii) high costs for economic operators due to only regulatory measures.

In addition, there are clear complementarities between CO_2 emission standards and carbon pricing through an extension of emission trading to road transport fuels. The CO_2 emission standards address the supply on the market of more fuel efficient vehicles and set requirements on vehicle manufacturers with regards to their fleets of new vehicles. This will ensure 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. It could address possible rebound effects, whereby customers drive more as their vehicles become more efficient due to lower usage costs[104].

The MIX scenario**,** where policies address market failures in a targeted manner and provide investor/consumer certainty while pushing for uptake of innovative technologies, is therefore considered a balanced policy approach. In the MIX scenario, both carbon pricing and CO_2 emission standards are aligned to trigger investments in clean technologies and infrastructure.

In case the CO_2 emission standards were to be set at the level of TL_Low option in combination with emissions trading for buildings and road transport, the carbon prices would need to increase to ensure a contribution of road transport compatible with the overall 55% objective, leading to higher energy costs for consumers and transport operators, as shown in MIX-CP scenario. Conversely, the TL_High option, as shown in REG, could potentially result in a sufficient contribution of road transport to the -55% target, together with increase ambition in other regulatory policies (RED and EED in particular), even in absence of carbon pricing. The TL_High option can also contribute to limit the risks of excessively increasing carbon prices in the new emissions trading and their possible impacts on vulnerable consumers. The carbon prices in the new emissions trading depend on different policies, not only the CO_2 emission standards for cars and vans. Annex 4, in particular in Tables 25 and 26, provides detailed information on the levels of carbon prices and the levels of regulatory measures, including the CO_2 emission standards for cars and vans, in the different core policy scenarios.

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 stock. It therefore complements the CO_2 emission standards, which drive the supply of more efficient vehicles, by acting on the fuels supply side. In addition the RED contributes 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.

As the CO_2 emission standards will incentivise increasing shares of electric and hydrogen powered cars and vans in the market, the related refuelling and recharging infrastructure will have to be provided. With this respect, the ambition level of the CO_2 emission standards drives the needs of the revision of the Alternative Fuels Infrastructure Directive, also part of the 'Fit for 55%' package.

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

7.1.2 Timing of targets

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 is scored slightly negative 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.

[104] CE Delft, Analysis of the options to include transport and the built environment in the EU ETS (2014), p. 60. ICF et al. (2020): Possible extension of the EU Emissions Trading System (ETS) to cover emissions from the use of fossil fuels in particular in the road transport and the buildings sector, under DG CLIMA Framework Contract

Allowing the banking of credits obtained from overachieving the targets in a given year for use in following years could offer manufacturers greater flexibility, but would significantly increase the administrative costs and complexity, making this option score lower in terms of **proportionality**.

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

7.1.3 Use of revenues from excess emissions premiums

The options of assigning the revenue from excess emissions premiums collected under the Regulation to a specific fund or programme (REV_1) or as own resource (REV_2) 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. They are 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 two options.

The Just Transition Fund (JTF) option could be effective in contributing to the transition in this sector, but this requires that the support fits within the aims of the Member State plans approved by the Commission. Assigning the revenue to the Innovation Fund would be conditional on a series of amendments to the EU ETS and its implementing legislation. In both cases, the automotive sector could not benefit directly from the revenue.

In addition, these options would increase the administrative burden as mechanisms will need to be put into place in order to make it operational under these Funds, e.g. to distribute the additional resources. 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**.

The option of allocating the revenue from the premiums to the EU budget as an "own resource" would not allow targeting the automotive sector and would thus not be more effective than the current approach. In addition, also this option could disproportionately increase the administrative burden due to the legal architecture of the management of the own resources.

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

7.1.4 Derogations for small volume manufacturers

Removing from 2030 onwards the possibility for manufacturers to be granted a "small volume" derogation would improve the **effectiveness** and coherence of the legislation. It would help to better achieve the specific policy objectives by signalling also to those manufacturers the need to start introducing zero-emission vehicles in their fleet.

Coherence would be improved by removing a possible market distorting element in the current Regulation which allows some global players to benefit from a competitive advantage because of limited sales on the EU market. It may also be perceived as unduly protecting small volume manufacturers of conventional vehicles against competitors focusing on zero-emission vehicles, in particular in the longer term.

Removing the derogation regime would increase the regulatory burden and the costs on some small manufacturers, but this is mitigated by providing time until 2030 for these manufacturers to adapt and pursue new compliance strategies for the next decade. At the same time, this option would avoid maintaining a competitive disadvantage for manufacturers not belonging to the "small volume" category. In view of this, the option is not considered to create **proportionality** issues and scores neutral on the **efficiency** criteria.

7.2 Incentive scheme for zero- and low-emission vehicles

The assessment of the different options regarding the ZLEV incentive mechanism shows only limited variations in the overall tailpipe CO_2 emissions of cars and vans in the period 2030 to 2050.

The "bonus-only" option (ZLEV_Low) scores lowest in terms of environmental **effectiveness**, as it may risk undermining the environmental effectiveness, albeit that the effect is limited by the 5% cap. Compared to the no incentive option, tailpipe CO_2 emissions under the "bonus-malus" option (ZLEV_Med) will be slightly lower when this would lead to a full application of the "malus" and slightly higher in case of a full "bonus". As a possible side-effect, the average emissions of internal combustion engine vehicles could increase in the three options considered in case of an increased ZLEV market uptake. And

In terms of **efficiency**, little difference in impacts could be observed under the scenarios considered for these options: total costs of ownership for end-users do not significantly change compared to the ZLEVT_no option. However a binding ZEV mandate or a bonus/malus system reduce significantly the flexibility for manufacturers to meet their CO_2 emission targets. A bonus only system would not change the impacts as it would not impose additional requirements to the manufacturers, who are able to decide to meet or not the benchmark levels, depending on their specific circumstances.

A binding ZEV mandate (ZLEV_High) or a bonus/malus system (ZLEV_Med) reduce significantly the flexibility for manufacturers to meet their CO_2 emission targets. In particular the latter could lead to a disproportionate impact for manufacturers not meeting the ZLEV benchmark as this would cause their CO_2 target to be strengthened, leaving them with few or no compliance options. These two options therefore score low in terms of **proportionality**.

In terms of **coherence**, no major implications of either of the options could be identified.

7.3 Mechanism for renewable and low-carbon fuels accounting

The option FUEL1, i.e. the application of "carbon correction" factors to the type-approved CO_2 emissions of the vehicles to reflect the carbon intensity and share of renewable and low-carbon fuels used by cars and vans, scores lowest in terms of **effectiveness**. For a given CO_2 target level, it would yield lower CO_2 emission reductions for cars and vans than the 'no fuels accounting' option. Compared to the baseline, it also scores negatively with regards to air pollution and to innovation in zero-emission technologies.

This option scores also lower than the 'no fuels accounting' option in terms of economic savings, both from a societal perspective and from the user's TCO perspective. It would also reduce the planning certainty for automotive manufacturers and their suppliers, unless the carbon correction factor would be set in advance to a predefined value. It therefore scores negatively on the **efficiency** criteria.

In terms of **coherence**, it scores lower as it leads to double counting of the contribution of renewable and low-carbon fuels under the RED and under the CO_2 emission standards.

In terms of **proportionality**, option FUEL1 scores slightly negative compared to the baseline as it adds some degree of complexity through the application of "carbon correction" factors.

As regards option FUEL2, i.e. the introduction of a low-carbon fuels (LCF) crediting system, the following assessment can be made in terms of **effectiveness**. This option would be comparable to the ‘no fuels accounting’ option with regards to the CO_2 emission objective. A slight reduction of CO_2 tailpipe emissions reduction could be seen in an extreme case of a doubling of the amount of advanced biofuels used in the vehicles fleet. However, this 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.

The FUEL2 option also scores lower in terms of **efficiency** as the analysis shows that the costs for a manufacturer to comply with its CO_2 target by purchasing LCF credits are significantly higher than by adding a BEV to its fleet. It would also reduce the planning certainty for automotive manufacturers and their suppliers. The total costs of ownership for first and second users and the societal costs over a vehicle’s lifetime are also higher under the LCF crediting system.

In terms of **coherence**, implementation of the FUEL2 option also scores lower than the ‘no fuels accounting’ option as it risks incentivising the use of these fuels in road transport, lowering their availability for other transport modes where less or no alternative exist. This is not coherent with the need to reduce economy-wide emissions as explained in the conclusions of the Climate Target Plan. In view of the significant energy requirements for the production of RFNBO and e-fuels and of the low efficiency of their use in vehicles, this option also lacks coherence with the energy-efficiency-first principle underlined in the EU Strategy for Energy System Integration. Furthermore this option would risk creating an incentive for the further use of woody biomass-based products as biofuels, instead of using it for valuable resources for circular bio-based materials and products. It would therefore not be coherent with the approach taken in the LULUCF Regulation.

Finally, the FUEL2 option would also significantly increase the administrative burden and complexity of the compliance system. It therefore scores the lowest in terms of **proportionality**.

8 PREFERRED OPTION

When proposing its updated 2030 greenhouse gas emissions reduction of at least 55%[105], 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 cars and vans could effectively and efficiently contribute to the delivery of the updated target as part of a wider “Fit for 55” policy package.

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.

Policy interactions

Given the complex interdependence across policy tools and the interplay with the methodological issue outlined above, no simultaneous determination of a preferred policy package is thus possible. A sequential approach was therefore necessary.

First, the common economic assessment[106,107] underpinning the “Communication on Stepping up Europe’s 2030 climate ambition” looked at the feasibility of achieving a higher climate target and provided insights into the efforts that individual sectors would have to make. It could not, however, discuss precise sectoral ambitions or detailed policy tools. Rather, it looked at a range of possible pathways/scenarios to explore the delivery of the increased climate ambition. It noted particular benefits in deploying a broad mix of policy instruments, including strengthened carbon pricing, increased regulatory policy ambition and the identification of the investments to step up the climate ambition.

An update of the pathway/scenario focusing on a combination of carbon pricing and medium intensification of regulatory measures in all sectors of the economy, while also reflecting the COVID-19 pandemic and the National Energy and Climate Plans, confirmed these findings.

Taking this pathway and the Communication on Stepping up Europe’s 2030 climate ambition as central reference, individual impact assessments for all “Fit for 55” initiatives were then developed with a view to provide the required evidence base for the final step of detailing an effective, efficient and coherent “Fit for 55” package.

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105 Communication on Stepping up Europe’s 2030 climate ambition - COM(2020)562
106 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020SC0176
107 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0331

At the aggregate level, these impact assessments provide considerable reassurances about the policy indications adopted by the Commission in the Communication on Stepping up Europe's 2030 climate ambition. This concerns notably a stronger and more comprehensive role of carbon pricing, energy efficiency and renewable energy policies, land sector, instruments supporting sustainable mobility and transport. These would be complemented by a carbon border adjustment mechanism and phasing out free allowances. This would allow to continue to address the risk of carbon leakage in an efficient manner. It would also preserve the full scope of the Effort Sharing Regulation for achieving the increased climate target.

Various elements of the analyses also suggest that parts of the revenues of a strengthened and extended ETS should be used to counter any undesirable distributional impacts such a package would entail (between and within Member States). While the best way to do this is still to be determined, this would seem a superior alternative to foregoing the relevant measures altogether or simply disregarding the uneven nature of their distributional impacts. Under both these alternatives, the eventual success of any package proposed would be at risk.

Preferred policy options

Preliminarily assuming this fact and the analysis above as the framework for the aggregate "Fit for 55" package, 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 cars and vans.

1) CO_2 emission targets for cars and vans

In order to contribute to the overall 2030 increased ambition level and the 2050 climate neutrality objective, the preferred option is to significantly strenghten the CO_2 targets for cars and vans 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.

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.

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 possibility for small volume manufacturers to be granted a derogation target would be removed from 2030 onwards, thereby improving the effectiveness and coherence of the legislation.

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

It is preferable to remove as of 2030 the incentive scheme for zero- and low-emission vehicles (ZLEV). Such a scheme is not necessary in combination with the stricter CO_2 targets, as those will require manufacturers to deploy significantly more zero-emision vehicles. This would also simplify the legislation. It would avoid the risk of undermining its effectiveness in case of a bonus-only system or the risk of creating disproportionate impacts in case of a binding mandate or a bonus/malus system which would reduce significantly the flexibility for manufacturers to meet their CO_2 emission targets.

3) 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. Promoting the use of renewable and low-carbon fuels will be done through the revision of the fuels related legislation (RED II, emissions trading for buildings and road transport and Energy Taxation Directive).

Overall, the above elements would strengthen the CO_2 emission standards for cars and vans 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 Target Plan. 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 and the EED.

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.

Under the preferred options, two of the existing provisions, i.e. the ZLEV "bonus" incentive mechanism and the 'small volume' derogation, would be removed from 2030 onwards, which will contribute to the simplification of the legislation. At the same time, the regulatory system will continue to provide for flexibilities intended to lower the compliance cost for manufacturers.

No changes in the compliance monitoring regime or in the level of the excess emissions premium are foreseen. The preferred options will therefore neither increase administrative costs for manufacturers and competent national authorities nor enforcement costs for the Commission.

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. 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 is in place for monitoring the impacts of the legislation. Member States annually report data for all newly registered cars and vans to the Commission. In addition to the type-approved CO_2 emission and mass values, a number of other relevant data entries are monitored, including fuel type and CO_2 emission savings from eco-innovations. Manufacturers have the opportunity to notify errors in this provisional data.

The Commission, supported by the European Environment Agency (EEA), publishes every year the final monitoring data of the preceding calendar year including the manufacturer specific performance against the CO_2 targets. The legislation will continue to rely on this well-established monitoring and compliance framework.

9.1 Indicators

For the specific policy objectives the following core monitoring indicators have been identified:

- Contribute to the 2030 at least -55% GHG emissions target and to the climate neutrality objective by 2050 by reducing **CO_2 emissions** from cars and vans cost-effectively:
    - The EU fleet average CO_2 emissions measured at type approval will be monitored annually on the basis of the monitoring data against the target level set in the legislation;
    - The gap between the type-approved CO_2 emissions data and real-world CO_2 emissions data will be monitored through the collection and publication of real-world fuel consumption data as well as reporting of deviations from the type approved CO_2 emissions and corrections to the CO_2 emissions data as initially reported by Member States and corrected by manufacturers.
    - Cars and vans GHG emissions will be monitored through Member States' annual GHG emissions inventories;
    - The costs and effectiveness of technologies used in the vehicles to reduce emissions will be monitored on the basis of data to be collected from manufacturers, suppliers and experts.
- Provide benefits for **consumers** from wider deployment of zero-emission vehicles:
    - The number and share of newly registered zero- and low-emission vehicles will be monitored through the annual monitoring data submitted by Member States;
    - Developments in energy cost savings will be monitored through the EU-wide fleet average emissions as well as the collection of real world fuel and energy consumption data.
    - Air quality benefits will be monitored through Member States' annual pollutant emissions inventories and air quality monitoring data.
- Stimulate **innovation in zero-emission technologies**, thus strengthening the **technological leadership** of the EU automotive value chain and stimulating employment:

- 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.

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/low-emission vehicles

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PART 2/2

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Part 2

Accompanying the document

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

amending Regulation (EU) 2019/631 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition

{COM(2021) 556 final} - {SEC(2021) 556 final} - {SWD(2021) 188 final} -
{SWD(2021) 614 final}

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10 ANNEX 1: PROCEDURAL INFORMATION

10.1 Organisation and timing:

The Directorate-General for Climate Action is the lead service for the preparation of the initiative (PLAN/2020/8689) and the work on the impact assessment.

Commission Work Programme 2021, "A Union of vitality in a world of fragility" (COM(2020) 690 final), Annex I, "A European Green Deal", 1.j

An inter-service steering group (ISG), chaired by the Secretariat-General, was set up in 2020 with the participation of the following Commission Services and Directorates-General: LS, AGRI, BUDG, COMM, COMP, CNECT, DEVCO, DGT, DIGIT, EAC, ECFIN, ECHO, EMPL, ENER, ENV, ESTAT, FISMA, FPI, GROW, HOME, HR, IAS, JRC, JUST, MARE, MOVE, NEAR, OLAF, REGIO, RTD, SANTE, TAXUD, TRADE.

The ISG met three times between October 2020 and March 2021, to discuss the draft impact assessment.

10.2 Consultation of the Regulatory Scrutiny Board (RSB)

The Regulatory Scrutiny Board received the draft version of the present impact assessment report on 10 March 2021 and following the Board meeting on 17 April 2021 issued a 'positive opinion with reservations' on 19 April 2021.

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

Main RSB findings	**Response**
The report is not clear on the reasons for revising the existing regulation. It lacks clarity on the coherence and proportionality with other linked initiatives.	The reasons for revising the existing regulation have been further elaborated in Sections 2 and 3, to better frame the initiative in the context of the European Green Deal, and the need to contribute to the new climate objectives set out in the European Climate Law. In addition to Section 1.2 on the interaction of this initiative with other policies, the coherence and proportionality with other linked initiatives has been further analysed in a new Section 6.5 that focuses on the interlinkages with the related initiatives part of the 'Fit fot 55%' package.
The report does not sufficiently demonstrate the feasibility of the high-level reduction target. The trade-offs between the three target options are not sufficiently clear.	Section 6.2.1.1.4 has been updated to discuss in more details the feasibility of the different target level options, including in light of recent developments in the automotive industry.
The report does not provide sufficient information on the impacts of the preferred options on competiveness, innovation and smooth sector transition..	A new Section 6.2.1.1.5 has been added to present a more detailed assessment of the impacts on innovation and competitiveness. The issue of smooth sectoral transition, in particular

	in relation to the impacts on employment, is further elaborated in Section 6.2.1.1.8.
Stakeholders' views have not sufficiently informed the analysis	The views of stakeholders have been presented in more details in Annex II and throughout the report, as relevant, to explain how they have been used to inform the analysis. In particular, Sections 3 and 5 better explain how stakeholders' views concerning the objectives and the options have fed into the analysis.

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

RSB opinion: "what to improve"	**Response**
The initiative revises Regulation 2019/631 that only came into force in 2020. The report should explain upfront why another revision of the CO_2 standards is necessary after such a short period of implementation. It should clarify what new problems have arisen since the adoption. The report should make clear to what extent the very positive market developments in the uptake and availability of electric vehicles have been reflected in the baseline projections.	The reasons for revising the existing regulation have been further elaborated in Sections 2 and 3, to better frame the initiative in the context of the European Green Deal, and the need to contribute to the new climate objectives, set out in the European Climate Law. Section 2.3 on how the problems will evolve has been also been further elaborated.
The report should better explain the coherence with the linked 'Fit for 55' initiatives. In particular, the report should clarify the added value of the current initiative in view of a possible extension of the Emission Trading System to road transport. It should explain why the latter would not be sufficient to reach the climate target for passenger cars and light commercial vehicles, and assess the risk of over-regulating road transport emissions.	The coherence with other linked 'Fit for 55%' initiatives has been further analysed in new Section 6.5. This includes explanations and analysis on the synergies and complementarities with the possible extension of emission trading to road transport, as well as the interlinkages with the strenghtening of the EU ETS, the Effort Sharing Regulation, the Renewable Energy and Energy Efficiecny Directives, the Alternative Fuel Infrastructure Directive.
The report should better explain how feasible the high-level reduction target is given the substantial investment needs for the EU automotive sector and the need for timely availability of a full EU wide charging network. It should be transparent on related assumptions, uncertainties and risks. The report should better explain the differences between the	An analysis of the feasibility of the different options for the target levels has been further elaborated in Section 6.2.1.1.4. A full comparison of the options for the CO_2 emission standard levels in terms of effectiveness, efficiency, coherence, added value and proportionality has been further developed in Section 7. Table 18 has also been updated

three target levels options in terms of overall cost-efficiency and discuss the resulting trade-offs.	accordingly to better reflect the trade-offs. Annex 4 has been updated to include all the relevant assumptions on the analytical methods. Additional information is presented in the publication related to the EU Reference Scenario 2020.
The report should establish a clearer intervention logic throughout the report, especially for the objectives relating to consumer behaviour, and innovation and technological leadership. In particular, the report should strengthen the analysis of the impacts on innovation and competitiveness.	The intervention logic has been revised to better clarify the objectives, and their link with the problems and drivers, as also highlighted in an updated Figure 2. Section 6.2.1.1.5 has been added to strenghten the assessment of the impacts on innovation and competitiveness.
The baseline should show the likely evolution of the automotive sector under the current legislation, including emissions, availability of zero-emissions vehicles, employment, competitiveness, etc. It should be used consistently as point of comparison when assessing the policy options. Apart from a clear analysis of who will be directly affected and how, the report should also consider any indirect impacts that may be significant. The report should systematically take into account the views of consulted stakeholder groups in discussing impacts.	Section 2.3 further elaborates on the evolution of the problems without further action. It also points to the presentation of the impacts in the baseline scenario, as presented throughout Section 6. A full description of the Reference Scenario 2020, common baseline among all the initiaitves of the 'Fit for 55% package' is provided in a dedicated publication. Views of stakeholders on the impacts have been added in Annex 2.
The methodological section (in the annex), including methods, key assumptions, and baseline, should be harmonised as much as possible across all 'Fit for 55' initiatives. Key methodological elements and assumptions should be included concisely in the main report under the baseline section and the introduction to the options. The report should refer explicitly to uncertainties linked to the modelling. Where relevant, the methodological presentation should be adapted to this specific initiative.	Annex 4 has been updated to include all the relevant assumptions on the analytical methods. Additional information is also presented in the publication related to the EU Reference Scenario 2020.
Annex 3 should present a complete summary of costs and benefits with all key information, including quantified estimates. The Board notes the estimated costs and benefits of the preferred	Annex 3 has been updated with the summary of costs and benefits.

option(s) in this initiative, as summarised in the attached quantification tables.	

10.3 Evidence, sources and quality

For the quantitative assessment of the economic, social and environmental impacts, the Impact Assessment report builds on a range of scenarios developed for the PRIMES model. This analysis was complemented by applying other modelling tools, such as GEM-E3 and E3ME (for the macro-economic impacts) and the JRC DIONE model developed for assessing impacts at manufacturer (category) level (see Annex 4 for more details on the models used and other methodological considerations).

Monitoring data on greenhouse gas emissions and other characteristics of the new light-duty vehicle fleet was sourced from the annual monitoring data as reported by Member States and collected by the European Environment Agency (EEA) under Regulation (EU) 2019/631.

Further information was gathered through service contracts commissioned from external contractors.

11 ANNEX 2: STAKEHOLDER CONSULTATION

11.1 Introduction

Stakeholders' views have been an important element of input to this impact assessment. The main purpose of the consultation was to verify the completeness and accuracy of the information available to the Commission and to enhance its understanding of the views of stakeholders with regard to different aspects of the possible revision of the Regulation.
The following relevant stakeholder groups have been identified:

- Member States (national, regional authorities)
- Vehicle manufacturers
- Component and materials suppliers
- Energy suppliers
- Vehicle purchasers (private, businesses, fleet management companies)
- Drivers associations
- Environmental, transport and consumer NGOs
- Social partners

The Commission sought feedback from stakeholders through the following elements:

- a public on-line consultation (13 November 2020 until 5 February 2021)
- feedback on the inception impact assessment (29 October until 26 November 2020)
- meetings with relevant industry associations representing vehicle manufacturers, components and materials suppliers, energy suppliers.
- bilateral meetings with Member State authorities, vehicle manufacturers, suppliers, social partners and NGOs;
- position papers submitted by stakeholders or authorities in the Member States.

A detailed summary and the results of the public consultation are presented below.

11.2 Public consultation

An on-line public consultation was carried out between 13 November 2020 and 5 February 2021 on the EU Survey website[1]. The consultation was divided into eight sections, starting with a question on the importance of specific objectives for EU action, followed by others of a more technical nature related to policy design and intended for a well-informed audience. The key issues addressed reflect the key elements of the impact assessment as follows:

- The objectives of the future CO_2 standards for cars and vans;
- The CO_2 emission targets for cars and vans after 2025 and the timing of these targets;
- Incentivising zero- and low-emission vehicles;
- Contribution of renewable and low-carbon fuels;
- Allocation of excess emission premiums;
- Other elements of the regulatory approach (monitoring and reporting provisions, eco-innovations, pooling, exemptions, small volume derogation); and
- Impacts.

[1] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12655-Revision-of-the-CO2-emission-standards-for-cars-and-vans-

11.3 Results of the public consultation

11.3.1 Distribution of replies

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

The consultation received 1057 replies in total, of which 80% (841) were from EU citizens, and 1% (7) from non-EU citizens. Industry respondents contributed the next highest number of responses, as 82 (8% of the total) were received from company / business organisations and 62 (6%) from business associations, which included responses from manufacturers, fuel and electricity suppliers. There were 20 responses (2%) from NGOs, and fewer responses from consumer and environmental organisations (4, 0.4% and 3, 0.3%, respectively). The majority of the 13 responses from public authorities (1%), came from national bodies, covering seven Member States as well as Norway. An additional 1% of responses came from academics or research institutions (9), while four responses (0.3%) came from trade unions.

When considering the responses to individual questions by stakeholder category, these are grouped into the following aggregate categories:

- *industry*, meaning ‘business associations’ and ‘company / business organisations’ (covering 14% of responses), which include automotive manufacturers, fuel and electricity suppliers, as well as other entities representing the automotive industry;
- *citizens*, which includes both EU and non-EU citizens (80%);
- *public authorities* (1%);
- *other stakeholders* (5%), *which* covers the remaining categories provided in the consultation form (including NGOs, consumer organisations and environmental organisations). The ‘NGOs’ category included contrasting stakeholders, including environmental NGOs and organisations representing biofuel and other road transport interests.

The breakdown by category is presented in **Table 19**.

Table 19: Distribution of stakeholders by category

Category	Number of respondents	Percentage of total number of respondents
EU citizen	841	79,6%
Company/business organisation	82	7,8%
Business association	62	5.9%
NGO (Non-governmental organisation)	20	1.9%
Public authority	13	1.2%
Other	12	1.1%
Academic/research institution	9	0.9%
Non-EU citizen	7	0.7%
Consumer organisation	4	0.4%
Trade union	4	0.4%
Environmental organisation	3	0.3%
Total	**1057**	**100%**

It is to be noted that out of the 841 contributions submitted by EU citizens, 753 were provided by German citizens. A large portion of contributions provided by German citizens were reflecting views where (among others):

- the promotion of the market uptake of zero-emission vehicles is not seen as important;
- the strengthening of targets for listed years is not seen as important;
- CO_2 standards should not become so strict that all new cars are zero-emission;
- vehicles other than ZLEV should also be eligible for the incentive system; and
- a mechanism on the contribution of renewable and low-carbon fuels should be introduced.

The assessment of contributions (based on information provided in the consultation form by some respondents) identified a campaign[2] posted on the Facebook page of *e-Fuels Now,* with an embedded link to the consultation website of the initiative and an explanatory note[3] on how to fill out the consultation form and what exact responses to give. Approximately 30 contributions were identified as largely similar to the content of the explanatory note, while another approximately 50 were found to be quite similar. The content of many other contributions from German citizens resembled to varying extents the elements and messages highlighted in the campaign.

The analysis of responses also revealed suggestions of other smaller coordinated responses including: one mainly consisting of Dutch citizens (of around 10 responses); two sets from stakeholders representing gas industry (one with around 8 responses from different countries and one with 4 responses from Germany); two sets from various Swedish stakeholders (one of 7 and one of 4 responses); one from vehicle manufacturers (4 responses); and one from stakeholders representing biofuels industry (3 responses).

The fact that 90% of the EU citizen responses originated from Germany suggests that there has been some coordinated effort in this country to engage citizens in this consultation process. Many citizens were responding both positively and negatively to the same question, which may also suggest that there have been different campaigns focusing on different aspects of the Regulation.

However, as it is not possible to conclusively identify the extent of the campaign(s) or other possible coordination of responses in the analysis with an appropriate level of confidence, the analysis did not allow for a clear separation of these responses and for treating them differently from the rest. Nevertheless, for the purpose of evaluating the outcome of the consultation, it is important to acknowledge that they may have to a certain extent influenced the representation and proportion of certain views provided by EU citizens.

The majority of responses came from respondents based in Germany (824), followed by Belgium (41), the Netherlands (25), France (23), Sweden (22), and Italy (21). No responses were received from 7 Member States: Cyprus, Estonia, Greece, Latvia, Lithuania, Malta and Slovenia. In addition, responses were received from stakeholders from 16 other countries, including Japan (5), Norway (4), the UK (4) and the USA (4).

[2] https://www.openpetition.de/petition/online/regenerative-kraftstoffe-efuels-jetzt
[3] https://www.openpetition.de/pdf/blog/regenerative-kraftstoffe-efuels-jetzt_mitsprachemoeglichkeit-zum-erfolg-des-petitionsthemas_1611177081.pdf

A detailed factual summary with indications of the exact distribution of all responses provided to the consultation questions broken down per the abovementioned aggregate stakeholder categories is provided in the Summary Report[4] published on this consultation.

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

The results for each of the elements are as follows.

Objectives of CO_2 emission targets for cars and vans

Stakeholders were asked to rate (on a scale of 1 to 5, where '1' was of 'no importance' and '5' was the highest importance) **the importance of a number of objectives for the future cars and vans CO_2 legislation**.

There was most support for the objective of ***strengthening the competitiveness, industrial leadership, innovation and stimulating employment in the EU automotive value chain***, as it was considered to be important[5] by nearly three quarters of respondents (73%, 747 respondents, 31 'no responses'). The only other objective that was identified as being important by a majority of respondents (59%, 606 respondents, 35 'no responses') was that of ***reducing the total costs of ownership for consumers***. For both of these objectives, a majority of stakeholders of each stakeholder category [ranging from 80% (8 respondents, 3 'no responses') for *public authorities* to 69% (33 respondents, 4 'no responses') for *other stakeholders* for the first, and 65% (83 respondents, 17 'no responses') for *industry respondents* to 53% (26 respondents, 3 'no responses') for *other stakeholders* for the second] rated these as being important. As for the latter objective. The exception was the group of *public authority* respondents, as only a minority of them (40%; 4 respondents, 3 'no responses') of these considered that 'reducing the total costs of ownership' was important.

For three other objectives, there was no conclusive view, as a similar proportion of respondents considered these to be important, as considered these not to be important[6].

While just over two fifths (44%; 451 respondents, 26 'no responses') of respondents considered that ***reducing CO_2 emissions from cars and vans to implement the overall emissions reduction target of at least 55% by 2030 and the climate neutrality objective by 2050*** was important, another two fifths (40%; 414 respondents) did not. However, the majority of *industry respondents* (72%; 96 respondents, 10 'no responses'), *public authorities* (90%; 9 respondents, 3 'no responses') and *other stakeholders* (72%; 36 respondents, 2 'no responses') thought that this objective was important, even though nearly half (47%; 392 respondents, 11 'no responses') of *citizen*s did not.

One third of respondents (33%; 334 respondents, 37 'no responses') considered that ***contributing to reducing air pollution*** was important, compared to over two fifths (43%; 434 respondents) who thought that it was not. Two fifths (41%; 412 respondents, 40 'no responses') of respondents considered that ***reducing EU's energy consumption and import dependence*** was important, compared to just over one third (36%; 365 respondents) who did not]. For both of these objectives, this result was driven by responses provided by both the *industry* and *citizens*. However, a majority of *other stakeholders* for both of these objectives [60% (30 respondents, 2 'no response') for the former and 74% (37 respondents, 2 'no

[4] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12655-Revision-of-the-CO2-emission-standards-for-cars-and-vans-/public-consultation

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

[6] i.e. respondents gave this a rating of either a '1' or '2'.

response'), for the latter, respectively], and of *public authorities* for the latter (80%, 8 respondents, 3 'no responses'), believed that these were important.

On the other hand, a majority of respondents (52%; 533 respondents, 29 'no responses') considered that ***promoting the market uptake of zero-emission vehicles and boosting their supply so that they become more affordable*** was not important. This result was driven by responses from *citizens* [as a majority (59%; 493, 12 'no responses') who thought that this objective was not important], whereas the vast majority of *public authorities* (90%; 9 respondents, 3 'no responses') and two thirds (68%; 34 respondents, 1 'no response') of *other stakeholders* felt that this objective was important. The views of *industry respondents* on the importance of this objective were mixed, as 42% (56 respondents, 12 'no responses') considered it important, while 24% (32 respondents) considered it not important and 33% (44 respondents) were neutral. However, a majority of both *manufacturers* (87%; 13 respondents, 1 'no response') and *electricity providers* (67%; 4 respondents, no 'no responses') believed that this objective was important.

Future CO_2 emissions targets for cars and vans – target levels

Stakeholders were asked to rate **the importance of strengthening the car and van CO_2 targets in different years** (on a scale of 1 to 5, where '1' was of 'no importance' and '5' was the highest importance).

Overall, a majority of respondents did not believe that strengthening the targets, for either cars or vans, ***in any year***, was important. Around two thirds of respondents did not believe that strengthening the targets ***for 2025***, for either cars (67%; 679 respondents, 49 'no responses') or vans (63%; 630, 60 'no responses'), was important.

In each case the response was driven by the views of *citizens* [e.g. for the 2025 targets: 71% (590 respondents, 13 'no responses') for cars; 66% (547, 20 'no responses') for vans], although a majority of *industry respondents* [60% (70 respondents, 28 'no responses') for cars; 59% (67 respondents, 30 'no responses') for vans] also considered that strengthening the targets for 2025 was not important. The response of *industry respondents* was more mixed in relation to strengthening the ***2030*** targets [with just over one third believing that this was important for both cars (36%; 44 respondents, 22 'no responses') and vans (35%; 43 respondents, 22 'no responses'), while just under one third felt that it was not important (32%, 39 respondents for cars; 30%, 37 respondents for vans]. *Manufacturers* and *stakeholders representing the fossil fuel industry* were ambivalent about strengthening the 2030 targets for both cars and vans, as a majority or more in these cases were 'neutral' in this respect [i.e. 63% (10 respondents, no 'no responses') of *manufacturers* for cars and 73% (11 respondents, 1 'no response') for vans, and 50% (11 respondents, 7 'no responses') of *stakeholders representing the fossil fuel industry* for cars and 52% (12 respondents, 6 'no responses') for vans].

However, just short of a majority of *industry respondents* felt that it was important to set strict targets ***for 2035*** (44%; 53 respondents, 24 'no responses') ***and 2040*** (45%; 55 respondents, 23 'no responses'), while around one fifth of *industry respondents* disagreed for each year (16%, 19 respondents and 24%, 29 respondents, respectively). *Manufacturers* and *stakeholders representing the fossil fuel industry* were again more ambivalent in relation to settings targets for 2035 and 2040, as 75% (12 respondents, no 'no responses') of *manufacturers* for 2035 and 69% (11 respondents, no 'no responses') for 2040 were neutral to these actions, as were 61% (14 respondents, 6 'no responses') of *stakeholders representing the fossil fuel industry* for 2035 and 39% (9 respondents, 6 'no responses') for 2040. On the other hand, a majority of both *electricity suppliers* [100% (6 respondents, no 'no responses') for 2035 and 67% (4 respondents, no 'no responses') for 2040] and *stakeholders representing other fuel industry* [69% (11 respondents, 9 'no responses') for both 2035 and 2040] supported these actions.

On the other hand, a majority of *public authorities* (82%, 9 respondents, 2 'no response' for both cars and vans and for both 2025 and 2030) and *other stakeholders* [ranging from 52% (24 respondents, 6 'no responses') for cars in 2025 to 67% (31 respondents, 6 'no responses') for vans in 2030] felt that strengthening both the car and van targets in 2025 and 2030 was important. Support from *public authorities* and *other stakeholders* for stricter standards ***in 2035 and 2040*** was lower than that for 2025 and 2030. Although a majority of both supported stricter standards for 2035 [56% (5 respondents, 4 'no responses') for public authorities and 66% (31 respondents, 3 'no responses') for other stakeholders, respectively], there was less support for stricter standards for 2040 [50% (5 respondents, 3 'no responses') for public authorities and 44% (19 respondents, 9 'no responses'), respectively].

Stakeholders were also asked ***by when all new cars and vans should be zero emission, in order to contribute to the climate neutrality by 2050 objective***. For both cars and vans, the overwhelming majority of responses [70% (702 respondents, 56 'no responses') for cars and 66% (658 respondents, 63 'no responses') for vans, respectively] felt that the CO_2 standards should not become so strict that all new vehicles were zero emission, a result which again was driven by the views of *citizens* and was also in line with the views of *industry*. The views of *manufacturers* reflected the views of industry overall, as 75% (6 respondents, 8 'no responses') felt that the CO_2 standards should not become so strict that all new cars were zero emission and 67% (4 respondents, 10 'no responses') felt this way for vans. On the other hand, the most popular year in which new cars and vans should be zero emission for both *public authorities* and *other stakeholders* was 2035 [selected by 63% (5 respondents, 5 'no responses') of *public authorities* for cars and 50% (4 respondents, 5 'no responses') for vans, and by 44% (20 respondents, 7 'no responses') of *other stakeholders* for cars and 44% (18 respondents, 11 'no responses') for vans].

In addition, respondents were asked whether they had any **other views** on the level of the targets. Many *fuel suppliers* argued that a vehicle could not be considered to be zero emission solely by looking at its tailpipe emissions, and so called for a well-to-wheel or lifecycle approach that took account of the CO_2 reduction potential of low carbon fuels. Some *vehicle manufacturers, other industry respondents* and *other respondents* made a similar point about the potential role of low carbon fuels in reducing transport's CO_2 emissions and the importance of ensuring a technology-neutral approach to reducing CO_2 emissions from transport. Many manufacturers also argued that the 2025 targets should not be modified, as there was insufficient lead time to adjust the production of vehicles to comply with an amended target, while for later targets, they considered that it was important to link the level of ambition to enabling factors, such as the sufficient deployment of electric vehicle recharging infrastructure.

On the other hand, *electricity suppliers,* some *consumer organisations* and some *environmental NGOs* argued that, in order to have a chance of decarbonising light duty vehicles by 2050, all new vehicles should be zero emission by 2035. Some responses from *citizens* also mentioned the importance of considering lifecycle emissions for all fuels and energy sources, the potential of low carbon fuels and the need for a wide range of actions to reduce transport's CO_2 emissions.

Timing of the targets

Stakeholders were asked to express the extent of their agreement with three statements relating to the **timing of the targets**, on a rating of '1' (no agreement) to '5' (highest agreement).

Overall, marginally more respondents did not agree (44%; 436 respondents, 74 'no responses') than agreed (43%; 424 respondents) that the same targets should ***remain***

applicable for five years before being strengthened. This was the pattern across all of the main stakeholder categories, with the exception of *industry stakeholders*, the majority of which (59%; 66 respondents, 32 'no responses') supported setting targets every five years. Support for the targets remaining applicable for five years was even stronger amongst *manufacturers* (87%; 13 respondents, 1 'no response') and *stakeholders representing the fossil fuel industry* (78%, 18 respondents, 6 'no responses').

In addition, two thirds of respondents (67%; 660 respondents, 72 'no responses') did not agree that the targets ***should be strengthened every year***, with around two thirds of *citizens* (68%; 560 respondents, 30 'no responses') and *industry* (67%; 77 respondents, 29 'no responses') having this view. On the other hand, nearly two thirds (63%; five respondents, 5 'no responses') of *public authorities* were in favour of such an approach. The views of *other stakeholders* were mixed: 48% (21 respondents, 8 'no responses') did not support strengthening the targets every year, while 37% (17 respondents) did, and 13 % (6 respondents) were neutral.

Overall, around half of the respondents (50%; 477 respondents, 92 'no responses') agreed that there should be ***additional flexibility regarding compliance with the targets if these became stricter more frequently***, which reflected the overall views of *citizens*. However, over two thirds (69%; 78 respondents, 31 'no responses') of *industry respondents* and three quarters (75%; 6 respondents, 4 'no responses') of *public authorities* were in favour of such flexibility. The views of *other stakeholders* were mixed on this question, as 37% (15 respondents, 11 'no responses') were not in favour of additional flexibility, 32% (13 respondents) agreed and 32% (13 respondents) were neutral.

Incentivising zero- and low-emission vehicles

Respondents were asked for their views on ***the main barriers for the market uptake of zero-emission vehicles***. The 'limited range' of such vehicles and the 'availability of recharging/refuelling infrastructure' was raised by nearly two thirds of respondents [65% (685 respondents) and 64% (672 respondents), respectively, 31 'no responses'], while the 'price of zero emission vehicles' and the 'price-quality ratio of key components like batteries' were mentioned by over half of stakeholders [52% (546 respondents) and 51% (534 respondents), respectively]. On the other hand, the 'availability of vehicle models' was considered to be a barrier by a minority of respondents (18%; 193 respondents). *Citizens* were more likely to cite the 'limited range' of such vehicles and the 'price-quality ratio of key components like batteries' as barriers than were representatives of *other stakeholder* categories, all of which mentioned the 'price of zero emission vehicles' more frequently than citizens. On the other hand, *public authorities* were more likely to cite the 'price of zero-emission vehicles', the 'availability recharging/refuelling infrastructure' or 'other' barriers for the market uptake of zero-emission vehicles.

Overall, around half of the respondents (47%; 495 respondents) suggested that there were ***other barriers to the market uptake of zero-emission vehicles***. Other barriers that were suggested by respondents included: electric vehicle recharging time; the sustainability of electric vehicles in terms of their resource use and recyclability; insufficient regulatory support; the complexity of the recharging process (e.g. different memberships required); and consumers' understanding that electric vehicles were not zero emission vehicles, when taking account of electricity production.

Incentivising zero and low emission vehicles in the period up to 2030

Similar questions were asked on incentivising low and zero emission vehicles before and after 2030. For the period to 2030, respondents were asked for their views on **whether a**

mechanism for incentivising zero- and low emission vehicles (ZLEV) should be maintained, by responding with a rating of '1' (no agreement) up to '5' (highest agreement).

A majority of respondents (57%; 577 respondents, 48 'no responses') did not agree that a ZLEV mechanism should be maintained, although this result was driven by the views of *citizens* (61%; 512 respondents, 13 'no responses'), as a majority (55%; 6 respondents, 2 'no response') of *public authorities*, and nearly half (49%; 56 respondents, 29 'no responses') of *industry respondents*, supported maintaining the mechanism. Support for retaining the mechanism was even stronger amongst *manufacturers* (100%; 16 responses, no 'no responses') and *electricity suppliers* (67%, 4 respondents, no 'no responses'). The views of *other stakeholders* on this question were split, as 38% (18 respondents, 4 no responses) both disagreed and agreed with maintaining the mechanism pre-2030, while 25% (12 respondents) were neutral.

When asked for their views on which vehicles should be ***eligible for the ZLEV mechanism***, a majority from all stakeholder categories [ranging from 53% (50 respondents, 50 'no responses') of *industry respondents* to 70% (7 respondents, 3 'no responses') of *public authorities*) was against this applying to vehicles with emissions ***of 50 gCO_2/km or lower***, as in the current Regulation. However, an even higher majority [ranging from 58% (23 respondents, 12 'no responses') of *other stakeholders* to 87% (73 respondents, 60 'no responses') of *industry respondents*] in most stakeholder groups was against the ***50 gCO_2/km threshold being lowered***. *Citizens* (77%; 590 respondents, 79 'no responses') and *industry representatives* (78%; 72 respondents, 52 'no responses') were also against the ZLEV mechanism only applying to ***zero emission vehicles***, whereas a majority of *public authorities* (56%; 5 respondents, 4 'no responses') and *other stakeholders* (51%; 22 respondents, 9 'no responses') supported this option. A majority of *manufacturers* (88%, 14 respondents, no 'no responses') supported the mechanism continuing to apply to vehicles with emissions of 50 gCO_2/km or lower, as in the current Regulation, whereas all *electricity suppliers* (100%; 4 respondents, 2 'no responses') supported the mechanism only applying to zero-emission vehicles.

Amongst all stakeholder groups, there was significant support (69%; 432 respondents, 427 'no responses') for ***other options for the vehicles that should be eligible*** for the ZLEV mechanism. From the perspective of *fuel suppliers*, there was broad support for the definition of a ZLEV to be based on its well-to-wheel, rather than tailpipe, CO_2 emissions. While some *manufacturers* also shared this view, most wanted the incentive to remain unchanged until 2030, although with a more appropriate (higher) threshold for vans. Setting the ZLEV threshold on the basis of well-to-wheel or lifecycle emissions was also a common response from *other* types of stakeholders, while explicit support for a range of different fuels was the preference of many *citizens*.

Respondents were asked for their views on the **type of incentive** prior to 2030, again by responding with a rating of '1' (no agreement) up to '5' (highest agreement) to a set of statements.

A majority of respondents from all stakeholder categories [ranging from 54% (52 respondents, 48 'no responses') of *industry respondents* to 70% (7 respondents, 3 'no responses') of *public authorities*] were against the ***maintenance of the current one-way crediting system***. There was even less support for the option of ***replacing the current system with a mandate*** amongst *citizens* (72%; 548 respondents, 91 'no responses') and *industry* (81%; 71 respondents, 56 'no responses'), although the responses from *public authorities* and *other stakeholders* for this option were split between those who supported the option and those who were against it [i.e. 33% (3 respondents, 4 'no responses') of *public authorities* supported a mandate and 44% (4 respondents) were against, whereas 46% (18 respondents, 13 ‘no responses’) of *other stakeholders* supported a mandate, while 41% (16 respondents) were against]. However, *manufacturers* overwhelmingly supported the maintenance of the current one-way crediting system (93%; 14 respondents, 1 ‘no response’).

Amongst all stakeholder groups, there was significant support (68%; 297 respondents, 617 ‘no responses’) for ***other options for the incentive type***. *Manufacturers* suggested that the threshold for vans should be higher than that for cars, that the pooling provisions should be expanded and that the level of the benchmark should not lead to only one technology being able to be used to meet the targets. Responses from *other stakeholders* included: whether a car should be counted as a ZLEV should also take account of the CO_2 emissions associated with the fuel that it uses; that the mechanism should be replaced by a ZLEV sales target, which could have flexibilities; or that there should be no ZLEV mechanism.

Stakeholders were also asked to express their level of agreement that ***the benchmark/mandate levels should be increased when the target levels were increased*** (again on a scale of ‘1’ (no agreement) up to ’5’ (highest agreement).

A majority (67%; 518 respondents, 75 ‘no responses’) of *citizens* did not agree with this, nor did just under half (46%; 43 respondents, 51 ‘no responses’) of the *industry respondents*. However, *manufacturers* were more ambivalent, as 57% (8 respondents, 2 ‘no responses’) were neutral to this action, whereas only 29% (4 respondents) disagreed. On the other hand, a majority of *other stakeholders* (53%; 21 respondents, 12 ‘no responses’) agreed that the benchmark/mandate levels should be increased when the targets were increased. The views of *public authorities* were mixed on this question, as 44% (4 respondents, 4 ‘no responses’) agreed that the benchmark/mandate levels should be increased, while 33% (3 respondents) did not.

<u>Incentivising zero and low emission vehicles in the period post 2030</u>

For the post 2030 period, respondents were asked to express their level of agreement that ***a ZLEV mechanism would continue to be needed, even if the CO_2 targets became stricter***, by responding with a rating of ‘1’ (no agreement) up to ’5’ (highest agreement). A majority of *citizens* (64%; 513 respondents, 45 ‘no responses’) and *other stakeholders* (61%; 27 respondents, 8 ‘no responses’) disagreed that the incentive would still be needed, as did nearly half (48%; 57, 24 ‘no responses’) of the *industry respondents*. Again, support for retaining the mechanism was strong amongst *manufacturers* (88%; 14 respondents, no ‘no responses’) and *electricity suppliers* (67%, 4 respondents, no ‘no responses’). The views of *public authorities* were mixed, as 44% (4 respondents, 4 ‘no responses’) agreed with maintaining the mechanism post-2030, while 33% (3 respondents) did not.

Respondents were also asked to express the level of their agreement with the vehicles that should be ***eligible for the incentive post 2030***. As with the responses relating to the period before 2030, a majority of stakeholders in each category [ranging from 57% (4 respondents, 6 ‘no responses’) of *public authorities* to 73% (32 respondents, 8 ‘no responses’) of *other stakeholders*] was against this applying only to vehicles with emissions ***of 50 gCO_2/km or lower***, and an even higher majority [ranging from 72% (5 respondents, 6 ‘no responses’) of *public authorities* to 88% (70 respondents, 64 ‘no responses’) of *industry respondents*] was against the ***50 gCO_2/km being lowered***. A majority of *citizens* (77%; 576 respondents, 103 ‘no responses’) and *industry representatives* (67%; 59 respondents, 56 ‘no responses’) were also against the ZLEV mechanism only applying to ***zero emission vehicles***, whereas the responses from *public authorities* and *other stakeholders* were more evenly split between those who supported the ZLEV mechanism applying only to zero emission vehicles post 2030 and those who did not. Of the *public authority* respondents 44% (4 respondents, 3 ‘no responses') supported the incentive only applying to zero emission vehicles and 44% (4 respondents) were against, whereas 48% (20 respondents, 10 'no responses') of *other stakeholders* supported the incentive only applying to zero emission vehicles, while 41% (17 respondents) were against. A majority of *manufacturers* (63%; 5 respondents, 8 'no responses') supported the mechanism continuing to apply to vehicles with emissions of 50 gCO_2/km or lower, as in the current Regulation. However, a majority of *manufacturers* (62%, 8 respondents, 3 'no responses') also supported the mechanism only applying to zero-emission vehicles, as did all *electricity suppliers* (100%; 5 respondents, 1 'no response').

Respondents from each category also supported ***other options for the vehicles that should be eligible*** for the ZLEV incentive mechanism post 2030. From the perspective of many *fuel suppliers*, the importance of moving beyond a tailpipe-based approach to accounting for a vehicle's CO_2 emissions to a well-to-wheel or lifecycle approach was again underlined. Responses from *manufacturers* ranged from maintaining the current thresholds to only focusing on zero emission cars after 2030, although it was underlined that vans should have a higher threshold and that the extended pooling options should be retained; others called for a well-to-wheel approach and the introduction of a crediting system. Some *fuel suppliers* also called for the system to recognise the contribution of low carbon fuels, while others, including a *consumer organisation,* suggested that the need for the incentive post 2030 should be assessed nearer the time. Many *citizens* implied that the focus should be on specific fuels or suggested that there was no need for an incentive.

Respondents were also asked for their views on the ***type of incentive*** to be applied for the period after 2030, again by responding with a rating of '1' (no agreement) up to '5' (highest agreement). A majority of respondents from most stakeholder categories were against the ***maintenance of the current one-way crediting system*** [ranging from 63% (459 respondents, 121 'no responses') of *citizens* to 74% (28 respondents, 14 'no responses') of *other stakeholders*), with the exception of *public authorities* who were split (38%, 3 respondents, 5 'no responses') both for and against]. Again, *manufacturers* overwhelmingly supported the maintenance of the current one-way crediting system (93%; 14 respondents, 1 'no response'). An even higher majority was against ***replacing the current system with a mandate*** in most stakeholder groups [ranging from 70% (509 respondents, 123 'no responses') of *citizens* to 82% (79 respondents, 48 'no responses') of *industry respondents*]. The exception was *other stakeholders*, who were split evenly between those who supported a mandate post 2030 and those who were against it (45%, 18 respondents both for and against, 12 'no responses').

Other options for the type of incentive were suggested, including that the incentive should take account of the emissions reduction potential of low carbon fuels, that a quota or sales obligation for ZLEVs be imposed or a trading system be introduced. It was also suggested that it was too early to assess the type of incentive that was needed after 2030, while many *citizens* suggested that there was no need for the incentive or that it should focus on specific fuels.

Stakeholders were also asked to express the level of their agreement with the statement that ***the benchmark/mandate levels should be adapted to new targets*** after 2030. Two thirds (65%; 496 respondents, 88 'no responses') of *citizens* disagreed with this, as did nearly half (46%; 43 respondents, 50 'no responses') of *industry respondents*. Again, *manufacturers* were more ambivalent, as 53% (8 respondents, one 'no response') were neutral to this action, whereas only 33% (5 respondents) disagreed. On the other hand, a majority of *other stakeholders* (53%; 20 respondents, 14 'no responses') and half (50%; 4 respondents, 5 'no responses') of the *public authorities* agreed that the benchmark/mandate should be adapted to new targets after 2030.

When asked for any ***additional comments*** on the ZLEV incentive system, a common response was that it was too early to assess whether or not a system would be needed after 2030, while the importance of taking account of the potential of low and zero carbon fuels was also frequently mentioned. Some *manufacturers* also suggested that it was not necessary to link the level of the benchmark to the overall ambition level, and that any increased benchmark should be accompanied by an incentive, as in the current Regulation.

Contribution of renewable and low-carbon fuels

Respondents were asked to express the extent of their agreement to a series of statements ***on the role of renewable and low-carbon fuels within the policy framework*** by responding with a rating of '1' (no agreement) up to '5' (highest agreement). A majority of respondents in all stakeholder categories [ranging from 53% (26 respondents, 3 'no responses') of *other stakeholders* to 78% (103 respondents, 12 'no responses') of *industry respondents*] agreed that a mechanism ***should be introduced in the CO_2 emissions standards for cars and vans, so that manufacturers' compliance takes into account the contribution of renewable and low carbon fuels***. There was support for such a mechanism amongst the majority of *stakeholders representing the fossil fuel industry* (85%; 23 respondents, 2 'no responses'), *stakeholders representing other fuel industry* (92%; 22 respondents, 1 'no response') and *manufacturers* (64%; 7 respondents, 5 'no responses').

However, a majority of *industry respondents* (61%; 76 respondents, 20 'no responses') and *citizens* (53%; 411 respondents, 68 'no responses') disagreed that ***policies to decarbonise fuels and policies to reduce emissions from cars and vans should remain separate***. On the other hand, nearly two thirds (64%; 7 respondents, 2 'no response') of *public authorities* and a majority (60%; 28 respondents, 5 'no responses') of *other stakeholders* agreed with this approach. In addition, a majority of *manufacturers* (67%; 6 respondents, 7 'no responses') and *electricity suppliers* (83%; 5 respondents, no 'no responses') also agreed with this approach.

Stakeholders were asked for their views on a number of ***different potential effects*** of accounting for the contribution of renewable and low carbon fuels when assessing manufacturers' compliance with the CO_2 emissions standards for cars and vans. Three quarters of respondents agreed (75%; 742 respondents, 70 'no responses') that this would lead to ***more renewable and low carbon fuels being made available for road transport*** and over two thirds (68%; 661 respondents, 83 'no responses') that ***such a system will ensure a holistic approach to road transport decarbonisation***, with a majority from all stakeholder categories agreeing to both statements.

For all of the other potential effects, a majority of respondents did not agree with the statements. The least negative response for the other potential effects was that ***more renewable and low carbon fuel in road transport will come at the expense of the availability of those fuels for other sectors/modes***, with which nearly three fifths (57%; 558 respondents, 78 'no responses') of respondents disagreed.

Over three quarters of respondents disagreed that such a system ***will be incompatible with EU efforts to increase efficiency and reduce energy consumption*** and that such a ***system could weaken the signal for innovations that are needed to make vehicles on the road zero emission*** [77% (753 respondents, 84 'no responses') and 78% (753 respondents, 87 'no responses'), respectively]. For these two impacts, at least half of respondents in each category disagreed with the potential impact. Around two thirds (70%; 659 respondents, 110 'no responses') of respondents disagreed that under such a system ***air pollution co-benefits would not be achieved to the same degree***, as did a majority of responses in most stakeholder categories (except for *other stakeholders*).

While overall nearly three quarters (72%; 694 respondents, 97 'no responses') of respondents disagreed that ***such a system will no longer ensure clear and distinct responsibilities and accountability for vehicle manufacturers and fuel suppliers,*** *public authorities* and *other stakeholder* were split in their views, with similar numbers agreeing and disagreeing with the statement. Similarly, while three quarters (75%; 729 respondents, 90 'no responses') of respondents did not agree that ***the CO_2 emission standards for cars and vans should be tightened more rapidly in order to maintain the overall level of ambition***, *public authorities* and *other stakeholders* were again split in their views.

Stakeholders were also asked to express the extent of their agreement with different statements about the **design of the mechanism relating to renewable and low carbon fuels**. A majority of respondents overall (70%; 659 respondents, 120 'no responses'), and in each of the stakeholder categories, agreed that ***renewable and low-carbon fuels should be counted according to their actual greenhouse gas emission savings over the whole lifecycle***. Similarly, around two thirds (67%; 636 respondents, 104 'no responses') of respondents agreed that ***all renewable and low carbon fuels should be taken into account, as long as they meet the minimum sustainability criteria under the Renewable Energy Directive***.

While there was no majority, overall more respondents agreed (49%; 444 respondents, 158 'no responses') than disagreed (29%; 258 respondents) that ***to avoid double counting, renewable and low carbon fuels should be counted towards the targets set in fuels related legislation or to assess compliance under the CO_2 emissions standards for cars and vans***.

Whilst just short of a majority of respondents (50%; 456 respondents, 137 'no responses') disagreed that ***only renewable and low carbon fuels actually used in cars and vans in a particular year should be taken into account to assess compliance and CO_2 standards for these types of vehicles***, a majority of *industry respondents* (58%; 58 respondents, 43 'no responses') disagreed with this. On the other hand, nearly three quarters (72%; 5 respondents, 6 'no responses') of *public authorities* and a majority of *other stakeholders* (51%; 18 respondents, 17 'no responses') agreed that only the fuels used in a particular year should count in order to assess compliance.

Finally, more than two thirds of respondents disagreed (69%; 647 respondents, 116 'no responses') that ***only the renewable and low carbon fuels with the highest greenhouse gas emission savings should be taken into account***, as did a majority from all stakeholder groups other than *public authorities,* [whose responses were evenly split (22-22%; 2-2 respondents for both agree and disagree, 5 respondents with neutral views and 4 'no responses') between those who agreed and disagreed that only the fuels with the highest greenhouse savings should be taken into account).

Respondents were also asked for any ***other views or contributions that they would like to make in relation to a potential system to account for renewable and low carbon fuels*** when assessing compliance with the CO_2 standards. *Fuel suppliers* generally expressed their support for such a system, arguing that this would lead to a comprehensive approach that allows all technologies to contribute to the decarbonisation of transport, including the use of renewable and low carbon fuels, while arguing that not doing so would lead to an uneven playing field. On the other hand, *electricity suppliers* were against such a system, arguing that this would translate to double regulation, that it would be difficult to implement and not necessary for light duty vehicles (as electrification is the decarbonisation option for these vehicles), and that it would potentially slow down the electrification of light duty vehicles.

The views of *manufacturers* were more divided, with some calling for the introduction of an appropriate crediting mechanism, others implying that low carbon fuels should be incentivised in other legislation and some being explicitly against the inclusion of renewable and low carbon fuels in the CO_2 standards Regulation. Responses from *consumer organisations, citizens, NGOs* and *public authorities* made similar arguments for (including several in favour of a voluntary crediting mechanism) and against such a system.

Allocation of the revenues of the excess emissions premiums

Respondents were asked to express their views on how any revenues from the ***excess emissions premiums should be allocated***. A majority of responses in all stakeholder categories was in favour of these being allocated to a fund to ***support the just transition to a climate-neutral economy, in particular to support the workers of the automotive sector***. A larger proportion of *public authorities* (89%; 8 respondents, 4 'no responses') and *other stakeholders* (70%; 31 respondents, 8 'no responses') supported this option compared to *industry respondents* (62%; 71 respondents, 30 'no responses') and *citizens* (57%; 437 respondents, 85 'no responses'), a significant proportion of which supported the 'other' option [46% (52 respondents) of *industry respondents* and 39% (301 respondents) of *citizens*).

The most common ***'other' option*** for the use of the excess emissions premiums that was mentioned by *industry respondents* was that these should go to a fund that supported the decarbonisation of road transport in general. There were also more specific suggestions from *industry respondents* and *other stakeholders*, including that premiums should be used to: support the decarbonisation efforts of the automotive industry; support low carbon fuels and/or electrification; or to support the purchase of low emission vehicles. Some *citizens* called for the premiums to be used to support climate mitigation actions more generally, while others called for the premiums to be abolished.

Other elements of the regulatory approach (monitoring and reporting provisions, eco-innovations, pooling, exemptions, small volume derogations)

Respondents were asked for their views on which ***other provisions of the legislation needed to be changed***. There was no majority calling for a change to any provision, or indeed a majority against changing any provision (as a result of the number of 'neutral' responses in each case).

For two provisions, 'pooling' and 'eco-innovations', more respondents were in favour of a change than against: around two fifths of respondents (40%; 366 respondents, 134 'no responses') were in favour of amending the provisions relating to ***'pooling'*** [as opposed to one quarter (25%; 233 respondents) that opposed this], while just over one third of respondents (35%; 328 respondents, 132 'no responses') were in favour of amending the provisions on ***'eco-innovations'*** [compared to less than a third (32%; 298 respondents) who opposed this)]. Around half of *industry respondents* (50%; 56 respondents, 33 'no responses') and *other stakeholders* (49%; 22 respondents, 7 'no responses') supported changing the 'eco-innovation' provisions. On the other hand, for the other provisions, more respondents opposed a change than supported one. Only a third of respondents (33%; 303 respondents, 137 'no responses') supported changing the provisions relating to ***'small volume derogations'*** [as opposed to two fifths (41%; 379 respondents) who opposed this], while around a third (31%; 287 respondents, 125 'no responses') supported changing the exemption of ***manufacturers registering fewer than 1000 vehicles a year*** [compared to more than two fifths (44%; 409 respondents) that did not]. Similarly, just under one quarter (23%; 213 respondents, 136 'no responses') called for changes to the ***monitoring and reporting provisions*** [compared to just over one quarter (28%; 258 respondents) that opposed this].

On the other hand, a majority of *manufacturers* were in favour of changing the provisions relating to eco-innovations (94%; 15 respondents, no 'no responses'), monitoring and reporting (81%; 13 respondents, no 'no responses') and pooling (80%; 12 respondents, 1 'no response'). On the other hand, a majority of *manufacturers* were against changing the provisions relating to the small volume derogation and the exemption for manufacturers registering less than 1000 vehicles per year (80%; 12 respondents, 1 'no response', in both cases).

In response to an additional question asking for ***other aspects of the Regulation that needed to be addressed***, many respondents reiterated previous comments, particularly in relation to the importance of taking a well-to-wheel approach to the accounting of CO_2 emissions in the Regulation or calling for the introduction of a crediting system for renewable and low carbon fuels. From the perspective of *manufacturers*, there were calls to simplify and broaden the provisions on 'eco-innovations', to allow pooling between cars and vans and to improve the consistency of the monitoring data collated by Member States. An *SME manufacturer* suggested that there should be even fewer requirements on very small volume manufacturers (i.e. those that manufacture 100 vehicles or less per year) than there are on manufacturers that are subject to the *de minimis* requirements (those that register 1000 vehicles or less each year). *Other respondents*, particularly those from *academic/research institutions*, *consumer and environmental organisations*, called for: monitoring and enforcement of real-world CO_2 emissions; a phasing out of the mass-related CO_2 standards; and for transparent access to information, including that relating to real-world CO_2 emissions.

Potential impacts of the strengthening of the CO_2 emission standards

Respondents were asked to express their level of agreement ***on different potential impacts of strengthening the CO_2 standards*** for cars and vans by responding with a rating of '1' (no agreement) up to '5' (highest agreement) to different statements.

The majority of respondents were only in agreement with two statements: that there would be job losses in the automotive value chain and that new skills and qualifications would be needed for workers in the automotive value chain. The vast majority of respondents overall (79%; 787 respondents, 65 'no responses'), and of *citizens* (82%; 670 respondents, 27 'no responses') and *industry respondents* (78%; 90 respondents, 28 'no responses'), believed that there ***would be job losses***, along with two thirds (67%; 6 respondents, 4 'no responses') of *public authorities* and nearly half (46%; 21 respondents, 6 'no responses') of *other stakeholders*. Nearly two-thirds of respondents overall (65%; 650 respondents, 61 'no responses'), and the vast majority of *citizens* (62%; 508 respondents 31 'no responses') *industry* (77%; 93 respondents, 23 'no responses'), *public authorities* (100%; 9 respondents, 4 'no responses') and *other stakeholders* (85%; 40 respondents, 5 'no responses') believed that ***new skills and qualifications would be needed***.

The only other impact with which more respondents were in agreement than not was that the ***EU automotive industry will increase investment in zero-emission technologies***. Overall, just short of a majority of respondents (47%; 469 respondents, 60 'no responses') agreed with this statement, although the level of agreement was much higher amongst different categories of stakeholder, as around three quarters (74%; 92 respondents, 19 'no responses') of *industry respondents* and an even higher proportion of *public authority* (100%; 11 respondents, 2 'no response') and *other stakeholders* (79%; 38 respondents, 4 'no responses') agreed with this. The mixed views of *citizens* on this question influenced the overall results, as 40% (328 respondents, 35 'no responses') agreed, while 40% (32 respondents) disagreed and 20% (160) were neutral.

Whilst a majority of respondents disagreed with three other potential impacts, there was a notable difference in the views of different stakeholders, with *citizens* and *industry* more being negative, whereas *public authorities* and *other stakeholders* were more positive. While a majority of respondents (59%; 588 respondents, 65 'no responses') did not believe that ***the***

competitiveness of the EU automotive industry will be increased by strengthening the CO_2 standards [including a majority (64%; 521 respondents, 33 'no responses') of *citizens* and nearly half (48%; 57 respondents, 25 'no responses') of *industry respondents*], nearly three quarters (73%; 8 respondents, 2 'no response') of *public authorities* and nearly half (49%; 23 respondents, 5 'no responses') of *other stakeholders* agreed that the competitiveness of the EU automotive industry will be increased. Similarly, while overall a majority of respondents (62%; 611 respondents, 78 'no responses') disagreed that there would be ***co-benefits in terms of energy dependency*** from a strengthening of the CO_2 standards [two-thirds (67%; 546 respondents, 37 'no responses') of *citizens* and half (50%; 55 respondents, 33 'no responses') of *industry respondents*), half (50%; 5 respondents, 3 'no responses') of *public authorities* and two-thirds (64%, 30 respondents, 5 'no responses') of *other stakeholders* believed that there would be such benefits. Again, while a majority of respondents (58%; 578 respondents, 60 'no responses')and 63% of *citizens* (518 respondents, 28 'no responses') did not agree that strengthening the standards would deliver ***co-benefits in terms of better air quality***, the vast majority (82%; 9 respondents, 2 'no response') of *public authorities* and two thirds (67%; 32 respondents, 4 'no responses') of *other stakeholders* believed that this would be the case. *Industry* views were mixed: 43% (51 respondents, 26 'no responses') disagreed that there would be co-benefits in terms of better air quality, while 38% (45 respondents) agreed and 19% (22 respondents) were neutral.

The other two potential impacts received the most negative responses, as two-thirds (66%; 643 respondents, 87 'no responses') of respondents did not agree that there would be ***macroeconomic benefits*** from strengthening of the CO_2 standards and three quarters (72%; 714 respondents, 71 'no responses') did not believe that there will be ***potential benefits to lower income groups***. *Citizens* and *industry respondents* were most negative in each case, although in both cases more *public authorities* disagreed [40% (4 respondents, 3 'no responses') and 45% (5 respondents, 2 'no response'), respectively] than agreed [20% (2 respondents) and 27% (3 respondents)] with the respective statements. Responses from *other stakeholders* were more divided in relation to macroeconomic benefits, as just short of half (44%; 20 respondents, 7 'no responses') believed that there would be such benefits, although just short of half (46%; 22 respondents, 4 'no responses') of these did not agree that there would be benefits for lower income groups.

Respondents were also asked whether they thought that ***any other impacts*** were relevant in the context of strengthening the CO_2 standards. Many *fuel suppliers* suggested that including provisions for renewable and low carbon fuels will lead to a competitive and sustainable market and, in particular, that supporting the use of renewable gas would support the circular economy, whereas they felt that a focus on electromobility risked negative social and environmental impacts outside of the EU. Many *manufacturers* noted that the impacts of strengthening the Regulation depended on a range of factors that were beyond its scope, while others noted that the impacts of the Regulation depended on the details of the design of its provisions. Other impacts suggested by *industry respondents* included reduced EU competitiveness and increased resource dependency, if the fuels promoted by the Regulation were not diversified to include renewable and low carbon fuels, while others suggested that strengthening the Regulation as it stands will improve the EU's competitiveness in relation to electric vehicle technology.

Another potential impact, which was raised by *citizens* in particular, was that as a result of the promotion of electric cars, cars would become more expensive, which would have an impact on people's ability to buy a car. Many citizens re-iterated their support for an approach in the CO_2 standards Regulation that recognised the potential of renewable and low carbon fuels, while others were concerned about the scale of job losses and the resulting adverse social effects, or the loss of the EU's competitiveness and leadership in the development of internal combustion engines. A *consumer organisation* called for the impact on the second-hand car market to be assessed, while *NGOs* mentioned the impacts of the lower demand for petrol and diesel on government revenues and noted that the net impact on jobs of the transition (so not limited to the automotive value chain) would be positive.

Additional measures to ensure a socially acceptable and just transition to zero-emission mobility

Respondents were also asked to propose additional measures that would be needed to ***ensure a socially acceptable and just transition to zero-emission mobility***, taking into account the social effects of those regions that were particularly dependent on automotive jobs.

Responses from many *fuel suppliers* were concerned that too much increased ambition in the revised CO_2 standards would lead to negative economic and social consequences, including increasing the cost of mobility, whereas the inclusion of renewable and low carbon fuels would improve the affordability of sustainable mobility and its social acceptance. The importance of including renewable and low carbon fuels in the scope of the revised Regulation was also emphasised by *other stakeholders*. Additional measures suggested by *manufacturers* included more support for research in innovative technologies, including on different fuels and energy sources, a reform of EU state aid rules to enable more support for the transformation of the automotive sector and measures to encourage investment in innovation.

Other measures suggested by *industry respondents* included more incentives for fleet renewal (particularly for low income groups), measures to change user behaviour and support for research and development in alternative propulsion and fuels, as well as more financial support, e.g. from the European Investment Bank. A *consumer organisation* highlighted the importance of there being sufficient recharging infrastructure for electric vehicles that is easy to use, while an *environmental organisation* called for the consideration of a vehicle's carbon content in the revised Regulation. Responses from *citizens* again underlined their belief in the importance of more action on renewable and low carbon fuels, as well as support for relevant incentives, subsidies and taxation and the promotion of other modes.

Additional comments provided by respondents

Additional comments from a number of *fuel suppliers* re-emphasised their views that a crediting mechanism should be included in the Regulation to take account of the CO_2 reduction potential of renewable and low carbon fuels (this was also mentioned by other respondents), whereas electricity suppliers expressed their support for the Regulation as it stands. From the perspective of *manufacturers*, the importance of a strong and ambitious revision to the Alternative Fuels Infrastructure Directive (2014/94/EU) was underlined. Other *industry respondents* stressed the importance of regulating the sustainability of electro-mobility and of paying attention to the wider CO_2 footprint of vehicle production. A *consumer organisation* called for the swift revision of the car labelling Directive (1999/94/EC).

Some public authorities and other stakeholders also called for an indicative post-2035 target to be set that either requires most, or all, new cars and vans to be zero emission. There was also call from an NGO for a cap on emissions from internal combustion engine vehicles to be set at 2021 levels. One response from the authorities of a Member State called for a review of the use of 'mass' as the utility parameter, a ban from 2030 on the sale of new vehicles that emit more than 123 gCO_2/km on the WLTP (for 95% of the new car fleet in order to make allowance for specific uses) and for an end-of sale target for vehicles using fossil fuels in 2040. Another national Ministry called for an adjustment of the utility factor for PHEVs, in order to better reflect their real-world emissions, and for an indicative electric vehicle energy standard to be set. Various stakeholders also called for an increased level of ambition for the overall CO_2 reduction targets.

11.4 Summary of the feedback received on the Inception Impact Assessment

The feedback process on the Inception Impact Assessment was open from 29 October to 26 November 2020.

The initiative received 128 contributions in total[7], of which 46 by business associations, 32 by companies or business organisations, 20 by EU citizens, 19 by NGOs (including environmental organisations), 4 by academic/research institutions, 2 by public authorities, 1 each by consumer organisations and by non-EU citizens, and 3 by 'other' stakeholders.

Overall, the general trends in views represented and questions brought up in this feedback process were also reflected later on in contributions received during the public consultation as many stakeholders provided feedback to the two processes.

Mixed views were expressed on the strengthening of the CO_2 standards. Public authorities, environmental, transport and consumer organisations, as well as certain industry representatives (mainly electricity suppliers) were generally supportive of introducing stronger standards. Environmental organisations explicitly called for doing so already from 2025. Other industry respondents, such as many fuel suppliers, associations representing automotive manufacturers, and automotive suppliers raised concerns about a possible short-term strengthening of targets, e.g. as from 2025, and stressed the need for sufficient lead time for the industry to make the necessary investments. Most EU citizens responding were supportive of a strengthening of the targets, while only a few were not.

Many respondents emphasized the need to create an enabling environment for the transition towards stricter targets, most importantly to secure the sufficient and adequate recharging and refuelling infrastructure.

Environmental and transport organisations, as well as a research and a consumer organisation, also called for a phase-out date for internal combustion engine vehicles, by 2030 or 2035 at the latest. Companies and business organisations, as well as business associations were against introducing a phase-out date for such vehicles. Some respondents also called for revising the provisions on the mass adjustment mechanism to incentivize light-weighting.

Respondents provided different views as regards the incentive mechanism for zero and low emission vehicles. A number of respondents stressed that the system should be no longer kept or that its modalities should be revised in view of the current and anticipated high levels of EV penetration. Two research organisations, a consumer organisation and a number of environmental and transport organisations raised concerns about plug-in hybrid electric vehicles and their real-world emissions, and called for reconsidering the benchmarks so that only zero-emission vehicles are eligible and for the removal of the 0.7 multiplier. At the same time, many fuel and automotive suppliers were in favour of keeping the current incentive and ensuring the continued eligibility of low-emission vehicles.

Many fuel suppliers, some component manufacturers and a large share of citizens (mainly from Germany) emphasized the need for a technology-neutral approach and to recognize the potential of renewable and low-carbon fuels to decarbonise existing vehicle fleets. They

[7] A total of 129 contributions arrived to the feedback process on the Inception Impact Assessment, but one was submitted twice.

argued that a vehicle should not be considered zero-emission solely based on its tailpipe emissions. Therefore, they called for a well-to-wheel or lifecycle approach. Many of these stakeholders explicitly called for accounting for the use of renewable and low-carbon fuels in the compliance mechanism for vehicle manufacturers under the CO_2 standards Regulation.

11.5 Position papers on the revision

Many stakeholders contributing to the consultation activities complemented their contributions with additional position papers, which were duly considered in the analysis.

The following stakeholders submitted additional ad-hoc position papers on the revision, which were also duly considered in this impact assessment:

- Open letter to the Commission on the inclusion of sustainable renewable fuels in the EU mobility legislation signed jointly by 39 associations and companies representing the fuel, energy and other segments of the automotive sector
- Non-paper: Transition to zero-emission light-duty vehicles, signed by Austria, Belgium, Denmark, Greece, Ireland, Lithuania, Luxembourg, Malta, the Netherlands
- ACEA (European Automobile Manufacturers' Association) position paper: Review of the CO_2 regulation for cars and vans
- AECC (Association for Emissions Control by Catalyst): Comments on amendment of the Regulation setting CO_2 emissions standards for cars and vans Inception Impact Assessment
- NABU (Nature and Biodiversity Conservation Union) position paper on the Revision of the European CO_2 emission standards for passenger cars and vans
- T&E (Transport & Environment): Car CO_2 review: Europe's chance to win the e-mobility race
- CLEPA (European Association of Automotive Suppliers): Climate neutral transport and CO_2 emission standards
- Joint letter of AVERE (The European Association of Electromobility), BEUC (The European Consumer Organisation), The Climate Group, EPHA (European Public Health Alliance), ECOS (Environmental Coalition on Standards), and T&E (Transport & Environment): Call on the European Commission President to set and EU-wide end date for sales of internal combustion engine cars and vans by 2035.

11.6 Use of the stakeholder input for the impact assessment

Stakeholder input received during the different stakeholder consultation activities was an important tool during the impact assessment. The results from the analysis of the public consultation, the input provided through the feedback process on the Inception Impact Assessment, as well as stakeholder views provided in position papers have been used to develop and assess the policy options. Statements or positions brought forward by stakeholders have been highlighted as such.

12 ANNEX 3: WHO IS AFFECTED AND HOW?

12.1 Practical implications of the initiative

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

- Vehicle Manufacturers
- Suppliers of automotive components and materials
- Users of vehicles, both individuals and businesses
- Suppliers of fuels and energy suppliers
- Vehicle repair and maintenance businesses
- Other users of fuel and oil-related products (e.g. chemical industry, heating)
- Society at large

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

Type of stakeholder	Practical implications
Vehicle Manufacturers	<u>Investment / manufacturing costs</u> CO_2 standards require vehicle manufacturers to reduce CO_2 emissions as a result of which they will have to introduce CO_2 reducing measures and technologies – including new types of powertrains - in their vehicles. In the short term, this is likely to result in increased production costs and could affect the structure of their product portfolios. As a consequence, they will have increased investment costs for production capacity and new technologies. <u>Benefits</u> Demand for zero- and low-emission vehicles is increasing quickly throughout the world as climate and air quality policies develop and many jurisdictions introduce ambitious emission standards. European automotive manufacturers have an opportunity to gain first mover advantage and the potential to sell advanced vehicles in other markets. The revised regulatory framework will help them to retain or even increase their global market in particular in markets for ZLEV with very dynamic growth rates.
Suppliers of automotive components and materials	<u>Research and investment</u> Suppliers will be affected by changing demands. Research and investment costs for automotive component suppliers will differ depending on their position in the supply chain and their ability to adapt to the need for new powertrains and technologies. Suppliers of components that are only used in conventional vehicles will have to adapt their production and marketing in order to maintain their market position. They will have to invest in new or modified production lines

	targeting the new technology needs and in the reskilling of their workforce. Suppliers of components of zero- and low-emission technologies will have to invest in increased production capacity. <u>Benefits</u> Requirements leading to the uptake of new powertrains and batteries may create extra business activity for suppliers in these sectors.
Users of vehicles, both individuals and businesses	<u>Transport costs/prices</u> The use of technology to reduce the CO_2 emissions of vehicles has a cost which is expected to be passed on to the vehicle purchaser. The purchase cost of zero- and low-emission vehicles is expected to be higher than for less fuel-efficient vehicles. <u>Benefits</u> Reducing the vehicle's CO_2 emissions and in particular the uptake of zero- and low-emission vehicles will reduce the energy required to propel the vehicles, which will bring fuel cost savings for vehicle users. Operation and maintenance costs of battery electric vehicles will also be lower than for conventional vehicles. Over the vehicles' lifetime, operational cost savings, will thus compensate the higher procurement costs.
Suppliers of fuels and energy suppliers	<u>Adjustment costs</u> Suppliers of fossil fuels will be affected by reduced demand leading to less sales and utilisation of existing infrastructure. A shift in demand towards alternatively powered vehicles may require them to adapt the refuelling infrastructure. <u>Investment needs</u> The shift to electric vehicles will increase the need for investing in recharging infrastructure and smart grids. Energy suppliers/grid operators will have to invest into grid expansion and innovative technologies (e.g. smart metering) to cope with increased demand from recharging of vehicles and match them with renewable electricity to avoid new demand peaks and keep overall energy system costs and emissions down. <u>Benefits</u> There will be new business opportunities for suppliers of alternative fuels and electricity as a result of the increased demand for such energy sources.
Vehicle repair and maintenance businesses	More uptake of battery electric vehicles will lower demand for maintenance which will negatively affect vehicle repair and maintenance businesses. This could be partially compensated by a higher uptake of more complex plug-in hybrid electric vehicles.The repair and maintenance of electric vehicles will require reskilling of the staff.
Other users of fuel and oil-	<u>Benefits from reduced oil prices</u>

related products (e.g. chemical industry, heating)	Other users of fuel and oil-related products (e.g. chemical industry, heating) are expected to benefit from lower prices if demand from the transport sector decreases (all other factors remaining the same).
Society at large	Citizens, especially those living in urban areas with high of ambient air pollution will benefit from better air quality due to reduced air pollutant emissions, in particular when the uptake of zero-emission vehicles increases.

12.2 Summary of costs and benefits

Table 20: Overview of benefits of the preferred options

Description	*Amount*	*Comments*
	Direct benefits	
Environmental benefits	CO_2 emissions from cars and vans are projected to decrease by around 32-33% in 2030, 56-66% in 2035 and 83-89% in 2040 as compared to 2005. On a well-to-wheel basis, CO_2 emissions significantly decrease by around 30-31% in 2030, 53-63% in 2035 and 80-87% in 2040 as compared to 2005. As a result of the market uptake of zero-emission vehicles co-benefits are observed for air quality, with pollutants emissions decreasing by around 64-65%, 77-80%, 89-91% for NOx and 55-56%, 73-77%, 88-91% for $PM_{2.5}$ in 2030, 2035 and 2040 compared to 2015. The cumulative cost of the avoided pollutants compared to the baseline in the period 2030 to 2040 amounts to around 49 - 59 billion euros.	Main beneficiaries are society overall and, in particular as regards air quality benefits, citizens, especially those living in urban areas.
Economic savings for society and end-users	Net economic savings from a societal and end-user perspective 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 cars and vans registered in 2030, 2035 or 2040. The total costs include the capital costs, the fuel or electricity costs, and the operation and maintenance (O&M) costs of the vehicles. For the societal perspective, they also include the external cost of CO_2 emissions. The end-user perspective is presented for the first user (first 5 years after first registeration) and the second user (years 6-10). Net economic savings from a societal perspective over the vehicle lifetime for new cars and new vans amount to the following ranges: - 860-1600, 1500-3400, 4600-5100 euro/car in 2030, 2035, 2040 - 1000-1200, 4000-5100, 5600-6400 euro/van in 2030, 2035, 2040 TCO (total cost of ownership) for first users of new cars and new vans show savings in	Main beneficiaries are the end users and society overall.

	the ranges : - 330-600, 970-2200, 2800-3100 euro/car in 2030, 2035, 2040 - 340-600, 3400-4000, 5200-5500 euro/van in 2030, 2035, 2040 TCO (total cost of ownership) for second users of new cars and new vans show savings in the ranges: - 450-800, 1300-2700, 2800-3000 euro/car in 2030, 2035, 2040 - 460-880, 2800-4400, 3700-3900 euro/van in 2030, 2035, 2040.	
Energy (fuel) savings	Final energy demand in cars and vans decreases by around 21-22%, 36-45% and 55-63% in 2030, 2035, 2040 as compared to 2015. The CO_2 emission standards alone will contribute to the 2040 reductions of the final energy demand for cars and vans by 20 percentage points. Over the period 2030-2050 the cumulative savings of diesel and gasoline compared to the baseline amount to 913-1100 Mtoe. This is equivalent to around 200-300 billion euros at current oil prices.	Main beneficiaries are the end users and society overall.
Indirect benefits		
Economic benefits due to removing the the possibility for small volume manufacturers to be granted a derogation target from 2030	By removing the derogation possibility, market distortion affecting competition between manufacturers operating in the same segments would be reduced.	Main beneficiaries are manufacturers having to meet the stricter targets, which are competing with manufacturers benefiting from the derogation
Employment benefits	Overall a small increase in employment is projected. Positive impacts are mainly seen in the sectors supplying to the automotive sector as well as in the power sector. Other sectors experience some positive second order effects, e.g. as a result of overall increased consumer expenditure. The further expansion of the value chain driven by	Main beneficiaries are the automotive suppliers and power sectors, as well as the electronics, software

	other trends than the transition to zero-emission mobility is also likely to create new job opportunities in sectors traditionally not part of the automotive value chain, such as electronics, software and services. Small negative impacts are seen in the automotive sector and in petroleum refining. Adequate policies and programs are needed for the reskilling of workers as well as educational programmes to provide future employees with a set of skills adapted to the new demands.	and service sectors.
Other macro-economic benefits	A small positive impact is projected on GDP, with an increase of 0.01-0.02%, 0.13-0.26%, 0.45-0.65% in 2030, 2035 and 2040 respectively as compared to the baseline.	Main beneficiaries are society overall
Benefits regarding innovation and competitiveness	Innovation in zero-emission technologies (and in fuel efficiency technologies) will be stimulated through the requirement to supply zero-emission vehicles to the market as the share of new zero emission cars is projected to increase to around 36-46% , 50-100%, 100% in 2030, 2035, 2040, as compared to around 6% of 2020. The associated investments are expected to lead to benefits for the competitiveness of the automotive industry in a context where zero-emission technologies will be more and more demanded on the global market.	Main beneficiaries are the automotive sector.
SME benefits	SMEs are impacted in particular as frequent users of light commercial vehicles. Positive impacts are expected as a result of lower operating costs for the vehicles and TCO savings for first, second and third users.	Main beneficiaries are SMEs operating vans.

Table 21: Overview of costs of the preferred options

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Citizens/Consumers</td><td colspan="2">Businesses</td><td colspan="2">Administrations</td></tr>
<tr><td>One-off</td><td>Recurrent</td><td>One-off</td><td>Recurrent</td><td>One-off</td><td>Recurrent</td></tr>
<tr><td rowspan="2">CO_2 emission target levels</td><td>Direct costs</td><td>N/A</td><td>See qualitative assessment in Section 3.1 of this Annex.</td><td>N/A</td><td>Automotive manufacturers:

Projected costs for manufacturers are:
- 300-550, 940-1700, 1400-1700 euro/car in 2030, 2035, 2040
- 450-940, 1500-2800, 2300-2700 euro/van in 2030, 2035, 2040
The additional cumulative investments for automotive manufacturers over the period 2021-2040 in the range 12-19 billion euros annually over the period 2021 to 2040. This represents an increase of around 3-4% compared to the annual investments necessary to meet the current CO_2 emission standards.</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Indirect costs</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

13 ANNEX 4: ANALYTICAL METHODS

The analytical work underpinning this Impact Assessment uses a series of models: PRIMES-TREMOVE, E3ME, GEM-E3, JRC DIONE. They have a successful record of use in the Commission's transport, energy and climate policy impact assessments.

A brief description of each model is provided below.

13.1 Analytical methods

13.1.1 Common analytical framework for the Impact Assessments of the revision of ESR, ETS, CO2 standards, LULUCF, RED and EED

13.1.1.1 Introduction

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

As a consequence, it is crucial to ensure consistency of the analysis across all initiatives. For this purpose, the impact assessments underpinning the "Fit for 55" policy package are using a collection of integrated modelling tools covering the entire GHG emissions of the EU economy.

These tools are used to produce a common Baseline and a set of core scenarios reflecting internally coherent policy packages aligned with the revised 2030 climate target, key policy findings of the CTP (see annex 1) and building on the Reference Scenario 2020, a projection of the evolution of EU and national energy systems and GHG emissions under the current policy framework[8]. These core scenarios serve as a common analytical basis for use across different "Fit for 55" policy initiatives, and are complemented by specific variants as well as additional tools and analyses relevant for the different initiatives.

This Annex describes the tools used to produce the common baseline (the Reference Scenario 2020) and the core policy scenarios, the key assumptions underpinning the analysis, and the policy packages reflected in the core policy scenarios.

13.1.2 Modelling tools for assessments of policies

13.1.2.1 Main modelling suite

The main model suite used to produce the scenarios presented in this impact assessment has a successful record of use in the Commission's energy, transport and climate policy assessments. In particular, it has been used for the Commission's proposals for the Climate Target Plan[9] to analyse the increased 2030 mitigation target, the Sustainable and

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[8] The "current policy framework" includes EU initiatives adopted as of end of 2019 and the national objectives and policies and measures as set out in the final National Energy and Climate Plans – see the EU Reference Scenario 2020 publication.

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020SC0176

Smart Mobility Strategy[10], the Long Term Strategy[11] as well as for the 2020 and 2030 EU's climate and energy policy framework.

The PRIMES and PRIMES-TREMOVE models are the core elements of the modelling framework for energy, transport and CO_2 emission projections. The GAINS model is used for non-CO_2 greenhouse gas emission projections, the GLOBIOM-G4M models for projections of LULUCF emissions and removals and the CAPRI model is used for agricultural activity projections.

The model suite thus covers:

- **The entire energy system** (energy demand, supply, prices and investments to the future) and **all GHG emissions and removals** from the EU economy.
- **Time horizon:** 1990 to 2070 (5-year time steps).
- **Geography:** individually all EU Member States, EU candidate countries and, where relevant the United Kingdom, Norway, Switzerland and Bosnia and Herzegovina.
- **Impacts:** energy system (PRIMES and its satellite model on biomass), transport (PRIMES-TREMOVE), agriculture, waste and other non-CO_2 emissions (GAINS), forestry and land use (GLOBIOM-G4M), atmospheric dispersion, health and ecosystems (acidification, eutrophication) (GAINS).

The modelling suite has been continuously updated over the past decade. Updates include the addition of a new buildings module in PRIMES, improved representation of the electricity sector, more granular representation of hydrogen (including cross-border trade[12]) and other innovative fuels, improved representation of the maritime transport sector, as well updated interlinkages of the models to improve land use and non-CO_2 modelling. Most recently a major update was done of the policy assumptions, technology costs and macro-economic assumptions in the context of the Reference scenario 2020 update.

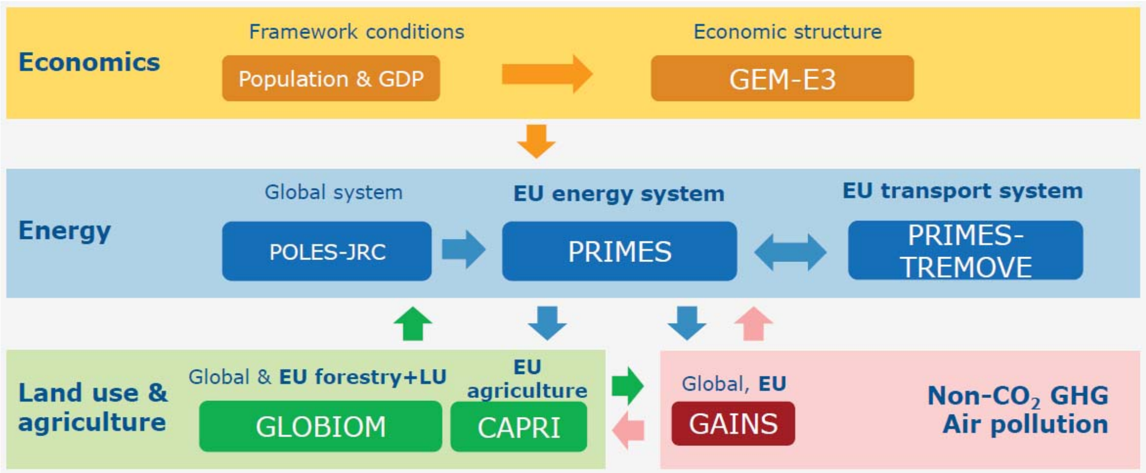
The models are linked with each other in such a way to ensure consistency in the building of scenarios (**Figure 20**). These inter-linkages are necessary to provide the core of the analysis, which are interdependent energy, transport and GHG emissions trends.

Figure 20: Interlinkages between models

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0331

[11] https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf

[12] While cross-border trade is possible, the assumption is that there are no imports from outside EU as the opposite would require global modelling of hydrogen trade.



13.1.2.2 Energy: the PRIMES model

The PRIMES model (Price-Induced Market Equilibrium System)[13] is a large scale applied energy system model that provides detailed projections of energy demand, supply, prices and investment to the future, covering the entire energy system including emissions. The distinctive feature of PRIMES is the combination of behavioural modelling (following a micro-economic foundation) with engineering aspects, covering all energy sectors and markets.

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

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

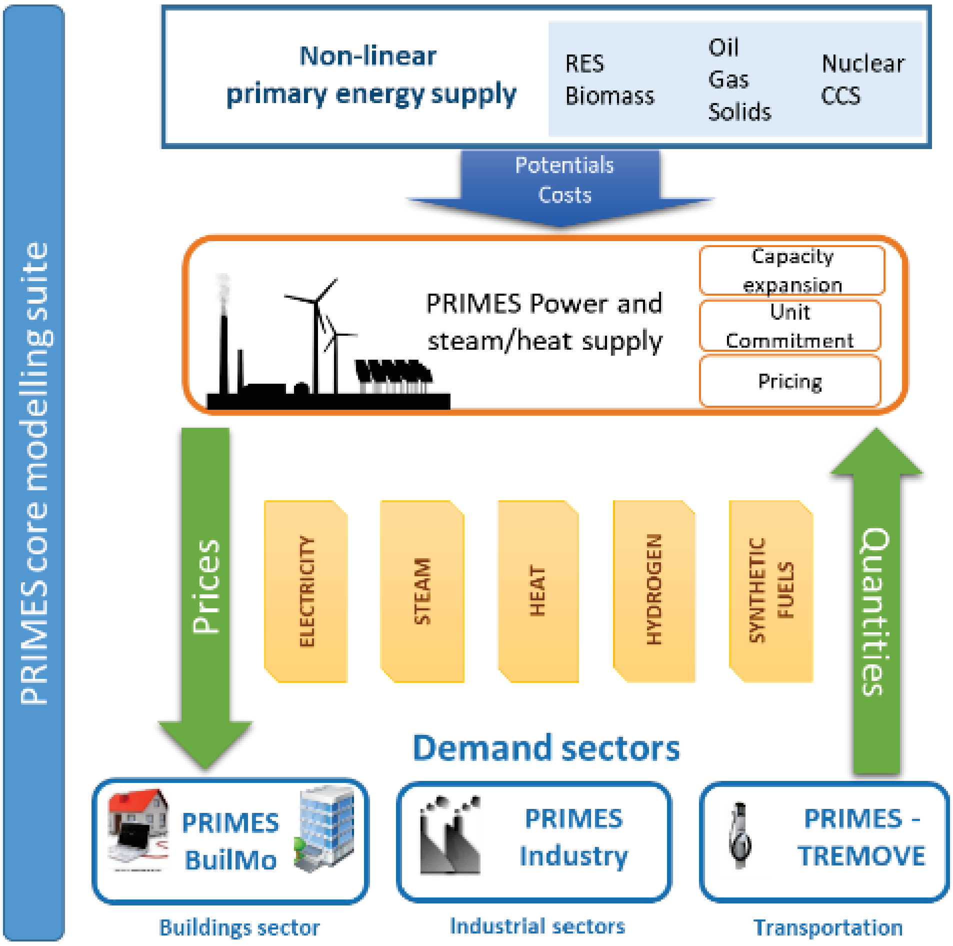
PRIMES offer the possibility of handling market distortions, barriers to rational decisions, behaviours and market coordination issues and it has full accounting of costs (CAPEX and OPEX) and investment on infrastructure needs.

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

PRIMES allows simulating long-term transformations/transitions and includes non-linear formulation of potentials by type (resources, sites, acceptability etc.) and technology learning. **Figure 21** shows a schematic representation of the PRIMES model.

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

Figure 21: Schematic representation of the PRIMES model



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

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

PRIMES is a private model maintained by E3Modelling[14], originally developed in the context of a series of research programmes co-financed by the European Commission.

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

The model has been successfully peer-reviewed, last in 2011[15]; team members regularly participate in international conferences and publish in scientific peer-reviewed journals.

Sources for data inputs

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

- Eurostat and EEA: Energy Balance sheets, Energy prices (complemented by other sources, such IEA), macroeconomic and sectoral activity data (PRIMES sectors correspond to NACE 3-digit classification), population data and projections, physical activity data (complemented by other sources), CHP surveys, CO_2 emission factors (sectoral and reference approaches) and EU ETS registry for allocating emissions between ETS and non ETS
- Technology databases: ODYSSEE-MURE[16], ICARUS, Eco-design, VGB (power technology costs), TECHPOL – supply sector technologies, NEMS model database[17], IPPC BAT Technologies[18]
- Power Plant Inventory: ESAP SA and PLATTS
- RES capacities, potential and availability: JRC ENSPRESO[19], JRC EMHIRES[20], RES ninja[21], ECN, DLR and Observer, IRENA
- Network infrastructure: ENTSOE, GIE, other operators
- Other databases: EU GHG inventories, district heating surveys (e.g. from COGEN), buildings and houses statistics and surveys (various sources, including ENTRANZE project[22], INSPIRE archive, BPIE[23]), JRC-IDEES[24], update to the EU Building stock Observatory[25]

13.1.2.3 Transport: the PRIMES-TREMOVE model

The PRIMES-TREMOVE transport model projects the evolution of demand for passengers and freight transport, by transport mode, and transport vehicle/technology, following a formulation based on microeconomic foundation of decisions of multiple actors. Operation, investment and emission costs, various policy measures, utility factors and congestion are among the drivers that influence the projections of the model. The projections of activity, equipment (fleet), usage of equipment, energy consumption and emissions (and other externalities) constitute the set of model outputs.

The PRIMES-TREMOVE transport model can therefore provide the quantitative analysis for the transport sector in the EU, candidate and neighbouring countries covering activity, equipment, energy and emissions. The model accounts for each country

[15] SEC(2011)1569 : https://ec.europa.eu/energy/sites/ener/files/documents/sec_2011_1569_2.pdf
[16] https://www.odyssee-mure.eu/
[17] Source: https://www.eia.gov/outlooks/aeo/info_nems_archive.php
[18] Source: https://eippcb.jrc.ec.europa.eu/reference/
[19] Source: https://data.jrc.ec.europa.eu/collection/id-00138
[20] Source: https://data.jrc.ec.europa.eu/dataset/jrc-emhires-wind-generation-time-series
[21] Source: https://www.renewables.ninja/
[22] Source: https://www.entranze.eu/
[23]Source: http://bpie.eu/
[24] Source: https://ec.europa.eu/jrc/en/potencia/jrc-idees
[25] Source: https://ec.europa.eu/energy/en/eubuildings

separately which means that the detailed long-term outlooks are available both for each country and in aggregate forms (e.g. EU level).

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

The PRIMES-TREMOVE has been developed and is maintained by E3Modelling, based on, but extending features of, the open source TREMOVE model developed by the TREMOVE[26] modelling community. Part of the model (e.g. the utility nested tree) was built following the TREMOVE model.[27] Other parts, like the component on fuel consumption and emissions, follow the COPERT model.

Data inputs

The main data sources for inputs to the PRIMES-TREMOVE model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[28]. Excise taxes are derived from DG TAXUD excise duty tables. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports.

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

13.1.2.4 Maritime transport: PRIMES-maritime model

The maritime transport model is a specific sub-module of the PRIMES and PRIMES-TREMOVE models aiming to enhance the representation of the maritime sector within the energy-economy-environment modelling nexus. The model, which can run in stand-

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

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

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

alone and/or linked mode with PRIMES and PRIMES-TREMOVE, produces long-term energy and emission projections, until 2070, separately for each EU Member-State.

The coverage of the model includes the European intra-EU maritime sector as well as the extra-EU maritime shipping. The model covers both freight and passenger international maritime. PRIMES-maritime focuses only on the EU Member State, therefore trade activity between non-EU countries is outside the scope of the model. The model considers the transactions (bilateral trade by product type) of the EU-Member States with non-EU countries and aggregates these countries in regions. Several types and sizes of vessels are considered.

PRIMES-maritime features a modular approach based on the demand and the supply modules. The demand module projects maritime activity for each EU Member State by type of cargo and by corresponding partner. Econometric functions correlate demand for maritime transport services with economic indicators considered as demand drivers, including GDP, trade of energy commodities (oil, coal, LNG), trade of non-energy commodities, international fuel prices, etc. The supply module simulates a representative operator controlling the EU fleet, who offers the requested maritime transport services. The operator of the fleet decides the allocation of the vessels activity to the various markets (representing the different EU MS) where different regulatory regimes may apply (e.g. environmental zones). The fleet of vessels disaggregated into several categories is specific to cargo types. PRIMES maritime utilises a stock-flow relationship to simulate the evolution of the fleet of vessels throughout the projection period and the purchasing of new vessels.

PRIMES-maritime solves a virtual market equilibrium problem, where demand and supply interact dynamically in each consecutive time period, influenced by a variety of exogenous policy variables, notably fuel standards, pricing signals (e.g. ETS), environmental and efficiency/operational regulations and others. The PRIMES maritime model projects energy consumption by fuel type and purpose as well as CO_2, methane and N_2O and other pollutant emissions. The model includes projections of costs, such as capital, fuel, operation costs, projections of investment expenditures in new vessels and negative externalities from air pollution.

The model serves to quantify policy scenarios supporting the transition towards carbon neutrality. It considers the handling of a variety of fuels such as fossil fuels, biofuels (bioheavy[29], biodiesel, bio-LNG), synthetic fuels (synthetic diesel, fuel oil and gas, e-ammonia and e-methanol) produced from renewable electricity, hydrogen produced from renewable electricity (for direct use and for use in fuel cell vessels) and electricity for electric vessels. Well-to-Wake emissions are calculated thanks to the linkage with the PRIMES energy systems model which derives ways of producing such fuels. The model also allows to explore synergies with Onshore Power Supply systems. Environmental regulation, fuel blending mandates, GHG emission reduction targets, pricing signals and policies increasing the availability of fuel supply and supporting the alternative fuel infrastructure are identified as drivers, along fuel costs, for the penetration of new fuels.

[29] Bioheavy refers to bio heavy fuel oil.

As the model is dynamic and handles vessel vintages, capital turnover is explicit in the model influencing the pace of fuel and vessel substitution.

Data inputs

The main data sources for inputs to the PRIMES-maritime model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[30]. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports. PRIMES-maritime being part of the overall PRIMES model is it calibrated to the EUROSTAT energy balances and transport activity; hence the associated CO_2 emissions are assumed to derive from the combustion of these fuel quantities. The model has been adapted to reflect allocation of CO_2 emissions into intra-EU, extra-EU and berth, in line with data from the MRV database.[31] For air pollutants, the model draws on the EEA database.

In the context of this exercise, the PRIMES-maritime model is calibrated to 2005, 2010 and 2015 historical data.

13.1.2.5 Non-CO_2 GHG emissions and air pollution: GAINS

The GAINS (Greenhouse gas and Air Pollution Information and Simulation) model is an integrated assessment model of air pollutant and greenhouse gas emissions and their interactions. GAINS brings together data on economic development, the structure, control potential and costs of emission sources and the formation and dispersion of pollutants in the atmosphere.

In addition to the projection and mitigation of non-CO_2 greenhouse gas emissions at detailed sub-sectorial level, GAINS assesses air pollution impacts on human health from fine particulate matter and ground-level ozone, vegetation damage caused by ground-level ozone, the acidification of terrestrial and aquatic ecosystems and excess nitrogen deposition of soils.

Model uses include the projection of non-CO_2 GHG emissions and air pollutant emissions for the EU Reference scenario and policy scenarios, calibrated to UNFCCC emission data as historical data source. This allows for an assessment, per Member State, of the (technical) options and emission potential for non-CO_2 emissions. Health and environmental co-benefits of climate and energy policies such as energy efficiency can also be assessed.

The GAINS model is accessible for expert users through a model interface[32] and has been developed and is maintained by the International Institute of Applied Systems Analysis[33]. The underlying algorithms are described in publicly available literature. GAINS and its predecessor RAINS have been peer reviewed multiple times, in 2004, 2009 and 2011.

Sources for data inputs

[30] Source: https://ec.europa.eu/transport/facts-fundings/statistics_en
[31] https://mrv.emsa.europa.eu/#public/eumrv
[32] Source: http://gains.iiasa.ac.at/models/
[33] Source: http://www.iiasa.ac.at/

The GAINS model assesses emissions to air for given externally produced activity data scenarios. For Europe, GAINS uses macroeconomic and energy sector scenarios from the PRIMES model, for agricultural sector activity data GAINS adopts historical data from EUROSTAT and aligns these with future projections from the CAPRI model. Projections for waste generation, organic content of wastewater and consumption of F-gases are projected in GAINS in consistency with macroeconomic and population scenarios from PRIMES. For global scenarios, GAINS uses macroeconomic and energy sector projections from IEA World Energy Outlook scenarios and agricultural sector projections from FAO. All other input data to GAINS, i.e., sector- and technology- specific emission factors and cost parameters, are taken from literature and referenced in the documentation.

13.1.2.6 Forestry and land-use: GLOBIOM-G4M

The Global Biosphere Management Model (GLOBIOM) is a global recursive dynamic partial equilibrium model integrating the agricultural, bioenergy and forestry sectors with the aim to provide policy analysis on global issues concerning land use competition between the major land-based production sectors. Agricultural and forestry production as well as bioenergy production are modelled in a detailed way accounting for about 20 globally most important crops, a range of livestock production activities, forestry commodities as well as different energy transformation pathways.

GLOBIOM covers 50 world regions / countries, including the EU27 Member States.

Model uses include the projection of emissions from land use, land use change and forestry (LULUCF) for EU Reference scenario and policy scenarios. For the forestry sector, emissions and removals are projected by the Global Forestry Model (G4M), a geographically explicit agent-based model that assesses afforestation, deforestation and forest management decisions. GLOBIOM-G4M is also used in the LULUCF impact assessment to assess the options (afforestation, deforestation, forest management, and cropland and grassland management) and costs of enhancing the LULUCF sink for each Member State.

The GLOBIOM-G4M has been developed and is maintained by the International Institute of Applied Systems Analysis[34].

Sources for data inputs

The main market data sources for GLOBIOM-EU are EUROSTAT and FAOSTAT, which provide data at the national level and which are spatially allocated using data from the SPAM model[35]. Crop management systems are parameterised based on simulations from the biophysical process-based crop model EPIC. The livestock production system parameterization relies on the dataset by Herrero et al[36]. Further datasets are incorporated, coming from the scientific literature and other research projects.

[34] Source : http://www.iiasa.ac.at/

[35] See You, L., Wood, S. (2006). An Entropy Approach to Spatial Disaggregation of Agricultural Production, Agricultural Systems 90, 329–47 and http://mapspam.info/.

[36] Herrero, M., Havlík, P., et al. (2013). Biomass Use, Production, Feed Efficiencies, and Greenhouse Gas Emissions from Global Livestock Systems, Proceedings of the National Academy of Sciences 110, 20888–93.

GLOBIOM is calibrated to FAOSTAT data for the year 2000 (average 1998 - 2002) and runs recursively dynamic in 10-year time-steps. In the context of this exercise, baseline trends of agricultural commodities are aligned with FAOSTAT data for 2010/2020 and broadly with AGLINK-COSIMO trends for main agricultural commodities in the EU until 2030.

The main data sources for G4M are CORINE, Forest Europe (MCPFE, 2015)[37], countries' submissions to UNFCCC and KP, FAO Forest Resource Assessments, and national forest inventory reports. Afforestation and deforestation trends in G4M are calibrated to historical data for the period 2000-2013.

13.1.2.7 Agriculture: CAPRI

CAPRI is a global multi-country agricultural sector model, supporting decision making related to the Common Agricultural Policy and environmental policy and therefore with far greater detail for Europe than for other world regions. It is maintained and developed in a network of public and private agencies including the European Commission (JRC), Universities (Bonn University, Swedish University of Agricultural Sciences, Universidad Politécnica de Madrid), research agencies (Thünen Institute), and private agencies (EuroCARE), in charge for use in this modelling cluster). The model takes inputs from GEM-E3, PRIMES and PRIMES Biomass model, provides outputs to GAINS, and exchanges information with GLOBIOM on livestock, crops, and forestry as well as LULUCF effects.

The CAPRI model provides the agricultural outlook for the Reference Scenario, in particular on livestock and fertilisers use, further it provides the impacts on the agricultural sector from changed biofuel demand. It takes into account recent data and builds on the 2020 EU Agricultural Outlook[38]. Depending on the need it may also be used to run climate mitigation scenarios, diet shift scenarios or CAP scenarios.

Cross checks are undertaken ex-ante and ex-post to ensure consistency with GLOBIOM on overlapping variables, in particular for the crop sector.

Sources for data inputs

The main data source for CAPRI is EUROSTAT. This concerns data on production, market balances, land use, animal herds, prices, and sectoral income. EUROSTAT data are complemented with sources for specific topics (like CAP payments or biofuel production). For Western Balkan regions a database matching with the EUROSTAT inputs for CAPRI has been compiled based on national data. For non-European regions the key data source is FAOSTAT, which also serves as a fall back option in case of missing EUROSTAT data. The database compilation is a modelling exercise on its own because usually several sources are available for the same or related items and their reconciliation involves the optimisation to reproduce the hard data as good as possible while maintaining all technical constraints like adding up conditions.

[37] MCPFE (2015). Forest Europe, 2015: State of Europe's Forests 2015. Madrid, Ministerial Conference on the Protection of Forests in Europe: 314.

[38] EU Agricultural Outlook for markets, income and environment 2020-2030, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/agricultural-outlook-2020-report_en.pdf

In the context of this exercise, the CAPRI model uses historical data series at least up to 2017, and the first simulation years (2010 and 2015) are calibrated on historical data.

13.1.3 Assumptions on technology, economics and energy prices

In order to reflect the fundamental socio-economic, technological and policy developments, the Commission prepares periodically an EU Reference Scenario on energy, transport and GHG emissions. The scenarios assessment used for the "Fit for 55" policy package builds on the latest "EU Reference Scenario 2020" (REF2020)[39].

The main assumptions related to economic development, international energy prices and technologies are described below.

13.1.3.1 Economic assumptions

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

Population projections from Eurostat[40] are used to estimate the evolution of the European population, which is expected to change little in total number in the coming decades. The GDP growth projections are from the Ageing Report 2021[41] by the Directorate General for Economic and Financial Affairs, which are based on the same population growth assumptions.

Table 22: Projected population and GDP growth per MS

	Population			GDP growth	
	2020	2025	2030	2020-'25	2026-'30
EU27	447.7	449.3	449.1	0.9%	1.1%
Austria	8.90	9.03	9.15	0.9%	1.2%
Belgium	11.51	11.66	11.76	0.8%	0.8%
Bulgaria	6.95	6.69	6.45	0.7%	1.3%
Croatia	4.06	3.94	3.83	0.2%	0.6%
Cyprus	0.89	0.93	0.96	0.7%	1.7%
Czechia	10.69	10.79	10.76	1.6%	2.0%
Denmark	5.81	5.88	5.96	2.0%	1.7%
Estonia	1.33	1.32	1.31	2.2%	2.6%

[39] See related publication.
[40] EUROPOP2019 population projections https://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data
[41] The 2021 Ageing Report : Underlying assumptions and projection methodologies https://ec.europa.eu/info/publications/2021-ageing-report-underlying-assumptions-and-projection-methodologies_en

Finland	5.53	5.54	5.52	0.6%	1.2%
France	67.20	68.04	68.75	0.7%	1.0%
Germany	83.14	83.48	83.45	0.8%	0.7%
Greece	10.70	10.51	10.30	0.7%	0.6%
Hungary	9.77	9.70	9.62	1.8%	2.6%
Ireland	4.97	5.27	5.50	2.0%	1.7%
Italy	60.29	60.09	59.94	0.3%	0.3%
Latvia	1.91	1.82	1.71	1.4%	1.9%
Lithuania	2.79	2.71	2.58	1.7%	1.5%
Luxembourg	0.63	0.66	0.69	1.7%	2.0%
Malta	0.51	0.56	0.59	2.7%	4.1%
Netherlands	17.40	17.75	17.97	0.7%	0.7%
Poland	37.94	37.57	37.02	2.1%	2.4%
Portugal	10.29	10.22	10.09	0.8%	0.8%
Romania	19.28	18.51	17.81	2.7%	3.0%
Slovakia	5.46	5.47	5.44	1.1%	1.7%
Slovenia	2.10	2.11	2.11	2.1%	2.4%
Spain	47.32	48.31	48.75	0.9%	1.6%
Sweden	10.32	10.75	11.10	1.4%	2.2%

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

13.1.3.2 International energy prices assumptions

Alongside socio-economic projections, EU energy modelling requires projections of international fuel prices. The 2020 values are estimated from information available by mid-2020. The projections of the POLES-JRC model – elaborated by the Joint Research Centre and derived from the Global Energy and Climate Outlook (GECO[42]) – are used to obtain long-term estimates of the international fuel prices.

[42] https://ec.europa.eu/jrc/en/geco

The COVID crisis has had a major impact on international fuel prices[43]. The lost demand cause an oversupply leading to decreasing prices. The effect on prices compared to pre-COVID estimates is expected to be still felt up to 2030. Actual development will depend on the recovery of global oil demand as well as supply side policies[44].

Table 23 shows the international fuel prices assumptions of the REF2020 and of the different scenarios and variants used in the "Fit for 55" policy package impact assessments.

Table 23: International fuel prices assumptions

in $'15 per boe	2000	'05	'10	'15	'20	'25	'30	'35	'40	'45	'50
Oil	38.4	65.4	86.7	52.3	39.8	59.9	80.1	90.4	97.4	105.6	117.9
Gas (NCV)	26.5	35.8	45.8	43.7	20.1	30.5	40.9	44.9	52.6	57.0	57.8
Coal	11.2	16.9	23.2	13.1	9.5	13.6	17.6	19.1	20.3	21.3	22.3
in €'15 per boe	2000	2005	'10	'15	'20	'25	'30	'35	'40	'45	'50
Oil	34.6	58.9	78.2	47.2	35.8	54.0	72.2	81.5	87.8	95.2	106.3
Gas (NCV)	23.4	31.7	40.6	38.7	17.8	27.0	36.2	39.7	46.6	50.5	51.2
Coal	9.9	15.0	20.6	11.6	8.4	12.0	15.6	16.9	18.0	18.9	19.7

Source: Derived from JRC, POLES-JRC model, Global Energy and Climate Outlook (GECO)

13.1.3.3 Technology assumptions

Modelling scenarios on the evolution of the energy system is highly dependent on the assumptions on the development of technologies - both in terms of performance and costs. For the purpose of the impact assessments related to the "Climate Target Plan" and the "Fit for 55" policy package, these assumptions have been updated based on a rigorous literature review carried out by external consultants in collaboration with the JRC[45].

Continuing the approach adopted in the long-term strategy in 2018, the Commission consulted on the technology assumption with stakeholders in 2019. In particular, the technology database of the main model suite (PRIMES, PRIMES-TREMOVE, GAINS, GLOBIOM, and CAPRI) benefited from a dedicated consultation workshop held on 11th November 2019. EU Member States representatives also had the opportunity to comment on the costs elements during a workshop held on 25th November 2019. The updated technology assumptions are published together with the EU Reference Scenario 2020.

[43] IEA, Global Energy Review 2020, June 2020
[44] IEA, Oil Market Report, June 2020 and US EIA, July 2020.
[45] JRC118275

13.1.4 The existing 2030 framework: the EU Reference Scenario 2020

13.1.4.1 The EU Reference Scenario 2020 as the common baseline

The EU Reference Scenario 2020 (REF2020) provides projections for energy demand and supply, as well as greenhouse gas emissions in all sectors of the European economy under the current EU and national policy framework. It embeds in particular the EU legislation in place to reach the 2030 climate target of at least 40% compared to 1990, as well as national contributions to reaching the EU 2030 energy targets on Energy efficiency and Renewables under the Governance of the Energy Union. It thus gives a detailed picture of where the EU economy and energy system in particular would stand in terms of GHG emission if the policy framework were not updated to enable reaching the revised 2030 climate target to at least -55% compared to 1990 proposed under the Climate Target Plan[46].

The Reference Scenario serves as the common baseline shared by all the initiatives of the "Fit for 55" policy package to assess options in their impact assessments:

- updating the Effort Sharing Regulation,
- updating the Emission Trading System,
- revision of the Renewables Energy Directive,
- revision of the Energy Efficiency Directive,
- revision of the Regulation setting CO_2 emission performance standards for cars and light commercial vehicles,
- review of the LULUCF EU rules.

13.1.4.2 Difference with the CTP "BSL" scenario

The REF2020 embeds some differences compared to the baseline used for the CTP impact assessment. While the technology assumptions (consulted in a workshop held on 11th November 2019) were not changed, the time between CTP publication and the publication of the "Fit for 55" package allowed updating some other important assumptions:

- GDP projections, population projections and fossil fuel prices were updated, in particular to take into account the impact of the COVID crisis through an alignment with the 2021 Ageing Report[47] and an update of international fossil fuel prices notably on the short run.
- While the CTP baseline aimed at reaching the current EU 2030 energy targets (on energy efficiency and renewable energy), the Reference Scenario 2020, used as the baseline for the "Fit for 55" package, further improved the representation of the National Energy Climate Plans (NECP). In particular it aims at reaching the national contributions to the EU energy targets, and not at respecting these EU targets themselves.

13.1.4.3 Reference scenario process

[46] COM/2020/562 final

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

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

It benefitted from a stakeholders consultation (on technologies) and is aligned with other outlooks from Commission services, notably DG ECFIN's Ageing Report 2021 (see section 0), as well as, to the extent possible, the 2020 edition of the EU Agricultural Outlook 2020-2030 published by DG AGRI in December 2020[48].

13.1.4.4 Policies in the Reference scenario

The REF2020 also takes into account the still-unfolding effects of the COVID-19 pandemic, to the extent possible at the time of the analysis. According to the GDP assumptions of the Ageing Report 2021, the pandemic is followed by an economic recovery resulting in moderately lower economic output in 2030 than pre-COVID estimates.

The scenario is based on existing policies adopted at national and EU level at the beginning of 2020. In particular, at EU level, the REF2020 takes into account the legislation adopted in the Clean Energy for All European Package[49]. At national level, the scenario takes into account the policies and specific targets, in particular in relation with renewable energy and energy efficiency, described in the final National Energy and Climate Plans (NECPs) submitted by Member States at the end of 2019/beginning of 2020.

The REF2020 models the policies already adopted, but not the target of net-zero emissions by 2050. As a result, there are no additional policies introduced driving decarbonisation after 2030. However, climate and energy policies are not rolled back after 2030 and several of the measures in place today continue to deliver emissions reduction in the long term. This is the case, for example, for products standards and building codes and the ETS Directive (progressive reduction of ETS allowances is set to continue after 2030).

Details on policies and measures represented in the REF2020 can be found in the dedicated "EU Reference Scenario 2020" publication.

13.1.4.5 Reference Scenario 2020 key outputs

For 2030, the REF2020 scenario mirrors the main targets and projections submitted by Member States in their final NECPs. In particular, aggregated at the EU level, the REF2020 projects a 33.2% share of renewable energy in Gross Final Energy Consumption. Final energy consumption is 823 Mtoe, which is 29.6% below the 2007 PRIMES Baseline.

In the REF2020, GHG emissions from the EU in 2030 (including all domestic emissions & intra EU aviation and maritime) are 43.8% below the 1990 level. A carbon price of 30 EUR/tCO_2eq. in 2030 drives emissions reduction in the ETS sector. **Table 24** shows a

[48] https://ec.europa.eu/info/news/eu-agricultural-outlook-2020-30-agri-food-sector-shown-resilience-still-covid-19-recovery-have-long-term-impacts-2020-dec-16_en
[49] COM(2016) 860 final.

summary of the projections for 2030. A detailed description of the REF2020 can be found in a separate report published by the Commission[50].

Table 24: REF2020 summary energy and climate indicators

EU 2030	REF2020
GHG reductions (incl. Domestic emissions & intra EU aviation and maritime) vs 1990	-43.8%
RES share	33.2%
PEC energy savings	-32.7%
FEC energy savings	-29.6%
Environmental impacts	
GHG emissions reduction in current ETS sectors vs 2005	-48.2%
GHG emissions reduction in current non-ETS sectors vs 2005	-30.7%
Energy system impacts	
GIC (Mtoe)	1224.2
- Solid fossil fuels	9.3%
- Oil	31.9%
- Natural gas	22%
- Nuclear	11%
- Renewables	25.8%
Final Energy Demand (Mtoe)	822.6
RES share in heating & cooling	32.8%
RES share in electricity	58.5%
RES share in transport	21.2%
Economic and social impacts	
System costs (excl. auction payment) (average 2021-30) as % of GDP	10.9%
Investment expenditures (incl. transport) average annual (2021-30) vs (2011-20) (bn€)	285
EU ETS carbon price (€/ton, 2030)	30
Energy- expenditures (excl. transport) of households as % of total consumption	7.0%

Source: PRIMES model

The system costs (excluding ETS carbon-related payments) reaches close to 11% of the EU's GDP on average over 2021-2030. This cost[51] is calculated ex-post with a private

[50] EU Reference Scenario 2020 publication

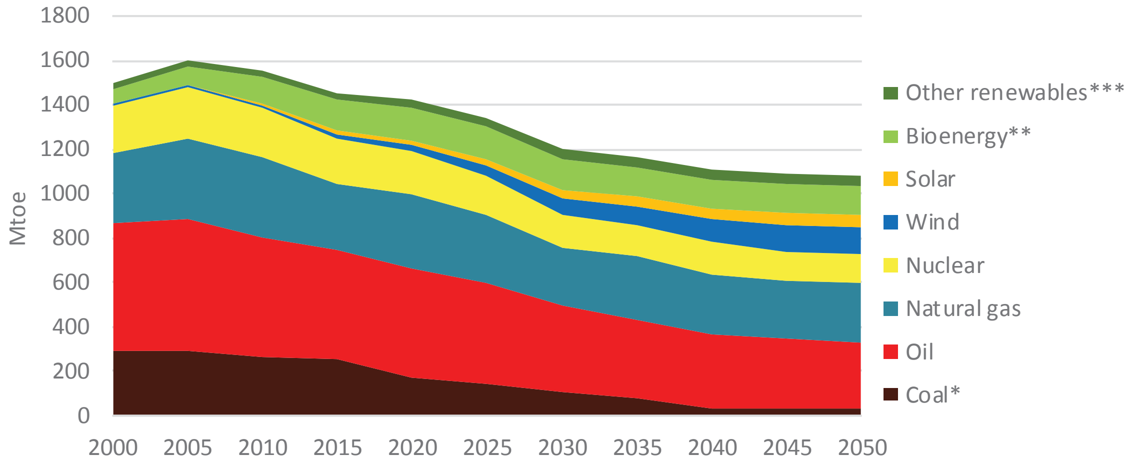
[51] Energy system costs for the entire energy system include capital costs (for energy installations such as power plants and energy infrastructure, energy using equipment, appliances and energy related costs of transport), energy purchase costs (fuels + electricity + steam) and direct efficiency investment costs, the latter being also expenditures of capital nature. For transport, only the additional capital costs for energy purposes (additional capital costs for improving energy efficiency or for using alternative fuels, including alternative fuels infrastructure) are covered, but not other costs including the significant transport related infrastructure costs e.g. related to railways and roads. Direct efficiency investment costs include additional costs for house insulation, double/triple glazing, control systems, energy management and for efficiency enhancing changes in production processes not accounted for under energy capital and fuel/electricity purchase costs. Energy system costs are calculated ex-post after the model is solved.

sector perspective applying a flat 10% discount rate[52] over the simulation period up to 2050 to compute investment-related annualized expenditures.

By 2050, final energy consumption is projected at around 790 Mtoe and approximately 74% of the European electricity is generated by renewable energy sources. GHG emissions in the EU are projected to be about 60% lower than in 1990: the REF2020 thus falls short of the European goal of climate neutrality by 2050.

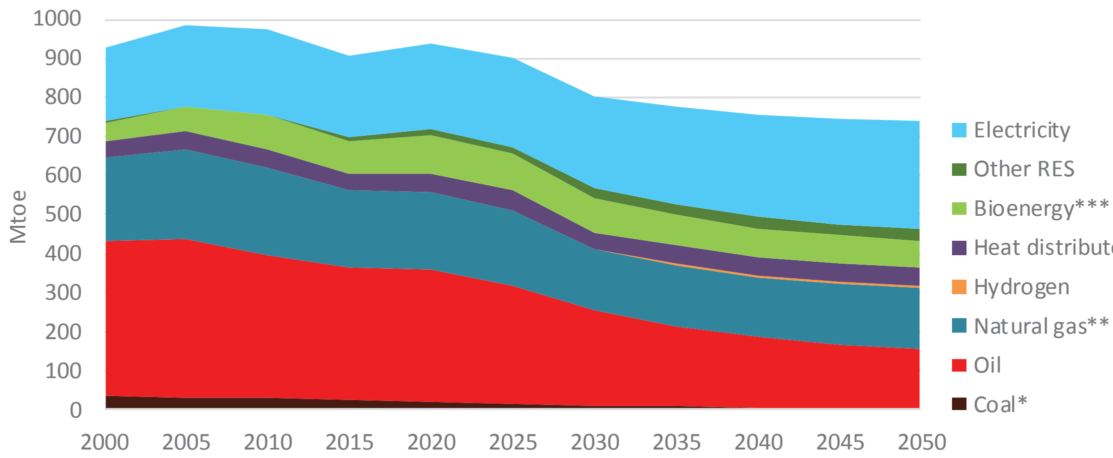
Focusing on the energy system, REF2020 shows that in 2030 fuel mix would still be dominated by fossil fuels. While the renewables grow and fossil fuels decline by 2050, the substitution is not sufficient for carbon neutrality. It also has to be noted that there is no deployment of e-fuels that are crucial for achievement of carbon neutrality as analysed in the Long Term Strategy[53] and in the CTP.

Figure 22: Fuel mix evolution of the Reference Scenario 2020



Source: Eurostat, PRIMES model

Figure 23: Share of energy carriers in final energy consumption in the Reference Scenario 2020



[52] See the EU Reference Scenario 2020 publication for a further discussion on the roles and levels of discount rates in the modelling, which also represent risk and opportunity costs associated with investments.

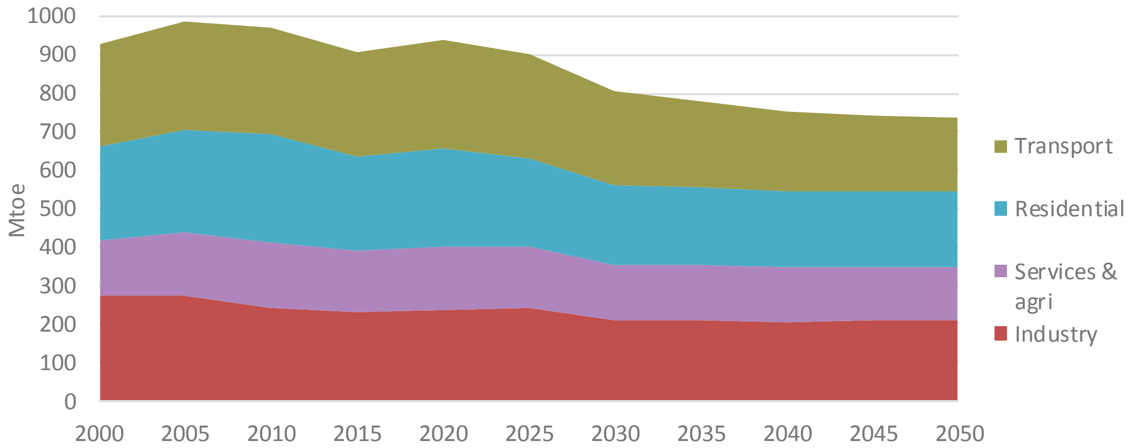
[53] COM(2018) 773

*Note: * includes peat and oil shale; ** includes manufactured gases, *** includes waste*

Source: Eurostat, PRIMES model

Coal use in power generation decrease by 62% by 2030 and almost completely disappear by 2050. Also demand for oil sees a significant decrease of 54% over the entire period – the most important in absolute terms. Electricity generation grows by 24% by 2050.

Figure 24: Final energy demand by sector in the Reference Scenario 2020



Source: Eurostat, PRIMES model

Despite continued economic growth, final energy demand decreases by 18% between 2015 and 2050 (already by 2030 it decreases by more than 8%).

13.1.5 Scenarios for the "Fit for 55" policy analysis

13.1.5.1 From the Climate Target Plan scenarios to "Fit for 55" core scenarios

In the Climate Target Plan (CTP) impact assessment, the increase of efforts needed for the GHG 55% target was illustrated by policy scenarios (developed with the same modelling suite as the scenarios done for the "Fit for 55" package) showing increased ambition (or stringency) of climate, energy and transport policies and, consequently, leading to a significant investment challenge.

The first key lesson from the CTP exercise was that while the tools are numerous and have a number of interactions (or even sometimes trade-offs) a **complete toolbox of climate, energy and transport policies is needed** for the increased climate target as all sectors would need to contribute effectively towards the GHG 55% target.

The second key lesson was that even though policy tools chosen in the CTP scenarios were different - illustrating in particular the fundamental interplay between the strength of the carbon pricing and intensity of regulatory measures - **the results achieved were convergent**. All CTP policy scenarios that achieved a 55% GHG target[54] showed very similar levels of ambition for energy efficiency, renewables (overall and on sectoral level) and GHG reductions across the sectors indicating also the cost-effective pathways.

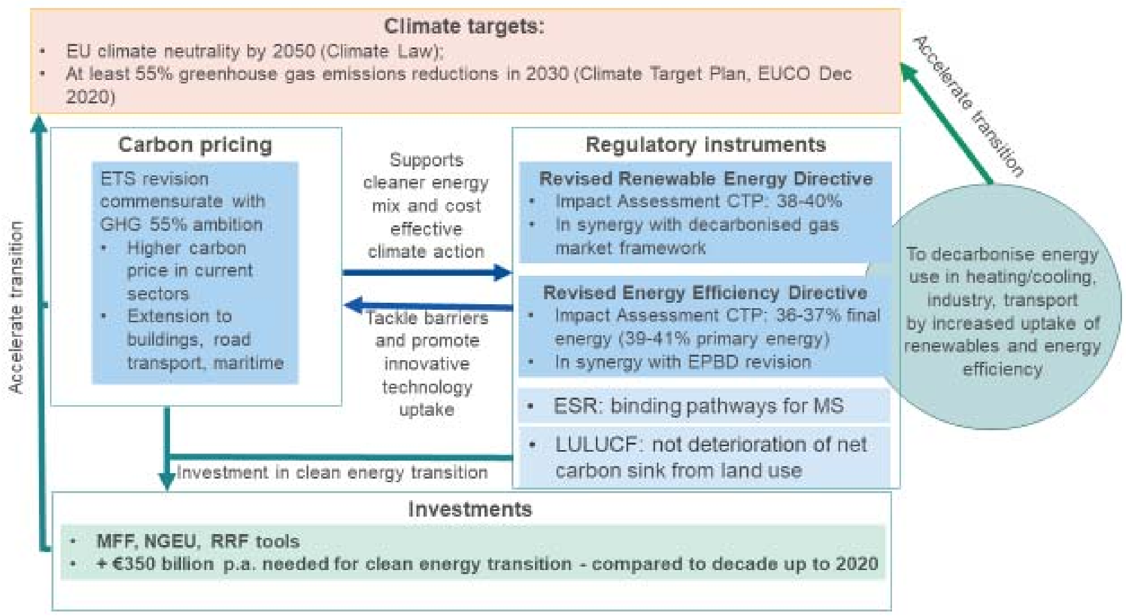
The third lesson was that carbon pricing working hand in hand with regulatory measures helps avoid "extreme" scenarios of either:

[54] A 50% GHG target was also analysed

- a very high carbon price (in absence of regulatory measures) that will translate into increased energy prices for all consumers,
- very ambitious policies that might be difficult to be implemented (e.g. very high energy savings or renewables obligations) because they would be costly for economic operators or represent very significant investment challenge.

Figure 25 below illustrates the interactions between different policy tools relevant to reach the EU's climate objectives.

Figure 25: Interactions between different policy tools



With the 55% GHG target confirmed by EU leaders in the December 2020 EUCO Conclusions[55] and the 2021 Commission Work Programme[56] (CWP 2021) that puts forward the complete toolbox to achieve the increased climate target (so-called "Fit for 55" proposals), the fundamental set-up of the CTP analysis was confirmed. This set-up is still about the interplay between carbon pricing and regulatory measures as illustrated above, and the extension of the ETS is the central policy question.

As described above, the policy scenarios of the CTP assessment are cost-effective pathways that capture all policies needed to achieve the increased climate target of 55% GHG reductions. This fundamental design remains robust and the CTP scenarios were thus used as the basis to define the "Fit for 55" policy scenarios.

In the context of the agreed increased climate target of a net reduction of 55% GHG compared to 1990, the 50% GHG scenario (CTP MIX-50) explored in the CTP has been discarded since no longer relevant. The contribution of extra EU aviation and maritime emissions in the CTP ALLBNK scenario was assessed in the respective sector specific impact assessments and was not retained as a core scenario. This leaves the following CTP scenarios in need of further revisions and updates in the context of preparing input in a coherent manner for the set of IAs supporting the "Fit for 55" package, ensuring the

[55] https://www.consilium.europa.eu/media/47328/1011-12-20-euco-conclusions-fr.pdf
[56] COM(2020) 690 final

achievement of the overall net 55% GHG reduction ambition with similar levels of renewable energy and energy efficiency deployment as in CTP:

- CTP REG (relying only on intensification of energy and transport policies in absence of carbon pricing beyond the current ETS sectors);
- CTP MIX (relying on both carbon price signal extension to road transport and buildings and intensification of energy and transport policies);
- CTP CPRICE (relying chiefly on carbon price signal extension, and more limited additional sectoral policies).

13.1.5.2 Scenarios for the "Fit for 55"package

Based on the Climate Target Plan analysis, some **updates were needed** though for the purpose of the "Fit for 55" assessment, in terms of:

- **Baseline**:
  - o to reflect the most recent statistical data available, notably in terms of COVID impacts,
  - o to capture the objectives and policies put forward by Member States in the NECPs, which were not all available at the time of the CTP analysis,

The baseline used in the Fit for 55 package is thus the "Reference Scenario 2020", as described in section 2.1.4.

- **Scenario design** in order to align better with policy options as put forward in the CWP 2021 and respective Inception Impact Assessments[57].

As a consequence, the three following core policy scenarios were defined to serve as common policy package analysis across the various initiatives of the "Fit for 55" policy assessments:

- **REG**: an update of the CTP REG case (relying only on very strong intensification of energy and transport policies in absence of carbon pricing beyond the current ETS sectors).
- **MIX**: reflecting an update of the CTP MIX case (relying on both carbon price signal extension to road transport and buildings and strong intensification of energy and transport policies). With its uniform carbon price (as of 2025), it reflects either an extended and fully integrated EU ETS or an existing EU ETS and new ETS established for road transport and buildings with emission caps set in line with cost-effective contributions of the respective sectors.
- **MIX-CP**: representing a more carbon price driven policy mix, combining thus the general philosophy of the CTP CPRICE scenario with key drivers of the MIX

[57] Importantly, all "Fit for 55" core scenarios reflect the Commission Work Programme (CWP) 2021 in terms of elements foreseen. This is why assumptions are made about legislative proposals to be made later on - by Quarter 4 2021. On the energy side, the subsequent proposals are: the revision of the EPBD, the proposal for Decarbonised Gas Markets and the proposal for reducing methane emissions in the energy sector. For transport they refer to the revision of the TEN-T Regulation and the revision of the ITS Directive. In addition, other policies that are planned for 2022 are also represented in a stylised way in these scenarios, similar to the CTP scenarios. In this way, core scenarios represent all key policies needed to deliver the increased climate target.

scenario albeit at a lower intensity. It illustrates a revision of the EED and RED but limited to a lower intensification of current policies in addition to the carbon price signal applied to new sectors.

Unlike MIX, this scenario allows to separate carbon price signals of "current" and "new" ETS. The relative split of ambition in GHG reductions between "current" ETS and "new ETS" remains, however, close in MIX-CP to the MIX scenario leading to differentiated carbon prices between "current" ETS and "new" ETS[58].

These three "Fit for 55" core policy scenarios have been produced starting from the Reference Scenario 2020 and thus use the same updated assumptions on post-COVID economics and international fuel prices.

Table 5 provides an overview of the policy assumptions retained in the three core policy scenarios. It refers in particular to different scopes of emissions trading system ("ETS"):

- "current+": refers to the current ETS extended to cover also national and international intra-EU maritime emissions[59]: this scope applies to all scenarios,
- "new": refers to the new ETS for buildings and road transport emissions: this scope applies in MIX and MIX-CP up to 2030,
- "large": refers to the use of emissions trading systems covering the "current" scope ETS, intra-EU maritime, buildings and road transport (equivalent to "current+" + "new"): this scope applies in MIX and MIX-CP after 2030.

The scenarios included focus on emissions within the EU, including intra-EU navigation and intra-EU aviation emissions. The inclusion or not of extra-EU navigation and extra-EU maritime emissions is assessed in the relevant sector specific Impact Assessments.

[58] This is a feature not implemented in the CTP CPRICE scenario.

[59] For modelling purposes "national maritime" is considered as equal to "domestic navigation", i.e. also including inland navigation.

Table 25: Scenario assumptions description (scenarios produced with the PRIMES-GAINS-GLOBIOM modelling suite)

<table>
<tr><th>Scenario</th><th>REG</th><th>MIX</th><th>MIX-CP</th></tr>
<tr><td rowspan="3">Brief description: ETS</td><td rowspan="3">Extension of “current” ETS to also cover intra-EU maritime navigation[60]

Strengthening of “current+” ETS in line with -55% ambition</td><td colspan="2">By 2030: 2 ETS systems:
- one “current+” ETS (current extended to intra-EU maritime)
- one “new” ETS applied to buildings and road transport

After 2030: both systems are integrated into one “large” ETS</td></tr>
<tr><td rowspan="2">*Relevant up to 2030*: the 2 ETSs are designed so that they have the same carbon price, in line with -55% ambition</td><td>*Relevant up to 2030:* “current+” ETS reduces emissions comparably to MIX</td></tr>
<tr><td>Lower regulatory intervention resulting in higher carbon price than in MIX, notably in the “new” ETS</td></tr>
<tr><td>Brief description: sectoral policies</td><td>High intensity increase of EE, RES, transport policies versus Reference</td><td>Medium intensity increase of EE, RES and transport policies versus Reference</td><td>Lower intensity increase of EE and RES policies versus Reference.

Transport policies as in MIX (except related to CO_2 standards)</td></tr>
<tr><td>Target scope</td><td colspan="3">EU27</td></tr>
</table>

[60] “Intra-EU navigation” in this table includes both international intra-EU and national maritime. Due to modelling limitations, energy consumption by “national maritime” is assumed to be the same as “domestic navigation”, although the latter also includes inland navigation.

Scenario	REG	MIX	MIX-CP
Aviation	Intra-EU aviation included, extra-EU excluded		
Maritime navigation	Intra-EU maritime included, extra-EU excluded		
Achieved GHG reduction of the target scope			
Including LULUCF	Around 55% reductions		
Excluding LULUCF	Around 53% reductions		
Assumed Policies			
Carbon pricing (stylised, for small industry, international aviation and maritime navigation may represent also other instruments than EU ETS such as taxation or CORSIA for aviation)			
Stationary ETS	Yes		
Aviation-Intra EU ETS	Yes		
Aviation - Extra EU ETS	Yes: mixture 50/50 carbon pricing (reflecting inclusion in the “current+” / “large” ETS, or taxation, or CORSIA) and carbon value (reflecting operational and technical measures); total equal to the carbon price of the “current+” (up to 2030) / “large” ETS		
Maritime-Intra EU ETS	Yes, carbon pricing equal to the price of the “current+” (up to 2030) / “large” EU ETS		

Scenario	REG	MIX	MIX-CP
Maritime-Extra EU ETS	As in MIX (but applied to the “current+” ETS)	Up to 2030: no carbon pricing. After 2030: 50% of extra-EU MRV[61] sees the “large” ETS price, while the remaining 50% sees a carbon value equal to the “large” ETS carbon price.	
Buildings and road transport ETS	No	Yes (in the “new” ETS up to 2030, and in the “large” ETS after 2030)	
CO_2 standards for LDVs and HDVs	CO_2 standards for LDVs and HDVs + Charging and refuelling infrastructure development (review of the Directive on alternative fuels infrastructure and TEN-T Regulation & funding), including strengthened role of buildings		
	High ambition increase	Medium ambition increase	Lower ambition increase
EE policies overall ambition	High ambition increase	Medium ambition increase	Lower ambition increase
EE policies in buildings	High intensity increase (more than doubling of renovation rates assumed)	Medium intensity increase (at least doubling of renovation rates assumed)	Lower intensity increase, no assumptions on renovation rates increases
EE policies in transport	High ambition increase	Medium intensity increase	As in MIX
RES policies overall ambition	High ambition increase	Medium intensity increase	Lower ambition increase except for transport (see below)

61 50% of all incoming and all outgoing extra-EU voyages

Scenario	REG	MIX	MIX-CP
RES policies in buildings + industry	Incentives for uptake of RES in heating and cooling	Incentives for uptake of RES in heating and cooling	No increase of intensity of policy (compared to Reference)
RES policies in transport and policies impacting transport fuels	Increase of intensity of policies to decarbonise the fuel mix (reflecting ReFuelEU aviation and FuelEU maritime initiatives). Origin of electricity for "e-fuels" under the aviation and shipping mandates: up to 2035 (inclusive) "e-fuels" (e-liquids, e-gas, hydrogen) are produced from renewable electricity, applying additionality principle. from 2040 onwards "e-fuels" are produced from "low carbon" electricity (i.e. nuclear and renewable origin). No application of additionality principle. CO_2 from biogenic sources or air capture.		
Taxation policies	Central option on energy content taxation of the ETD revision		
Additional non-CO_2 policies (represented by a carbon value)	Medium ambition increase		

13.1.5.3 Quantitative elements and key modelling drivers

Policies and measures are captured in the modelling analysis in different manners. Some are explicitely represented such as for instance improved product energy performance standards, fuel mandates or carbon pricing in an emission trading system. Others are represented by modelling drivers ("shadow values") used to achieve policy objectives.

The overall need for investment in new or retrofitted equipment depends on expected future demand and expected scrapping of installed equipment. The economic modelling of the competition among available investment options is based on:

- the investment cost, to which a "private" discount rate is applied to represent risk adverseness of the economic agents in the various sectors[62],
- fuel prices (including their carbon price component),
- maintenance costs as well as performance of installations over the potential lifetime of the installation,
- the relevant shadow values representing energy efficiency or renewable energy policies.

In particular, carbon pricing instruments impact economic decisions related to operation of existing equipment and to investment, in the different sectors where they apply. Table 6 shows the evolution of the ETS prices by 2030 in the Reference and core scenarios.

Table 26: ETS prices by 2030 in the difference scenarios (€2015/tCO2)

Scenarios	Carbon price "current" ETS sectors		Carbon price "new" ETS sectors	
	2025	2030	2025	2030
REF2020	27	30	0	0
REG	31	42	0	0
MIX	35	48	35	48
MIX-CP	35	52	53	80

The investment decisions are also taken considering foresight of the future development of fuel prices, including future carbon values[63] post 2030. Investment decisions take into account expectations about climate and energy policy developments, and this carbon value achieves in 2050 levels between €360/tCO_2 (in REG, where energy policy drivers play comparatively a larger role) and €430/tCO_2 (MIX-CP)[64].

[62] For more information on the roles and levels of discount rates applied per sector, see the EU Reference Scenario 2020 publication.

[63] Post 2030, carbon values should not be seen as a projected carbon price in emissions trading, but as a shadow value representing a range of policies to achieve climate neutrality that are as yet to be defined.

[64] The foresight and the discounting both influence the investment decisions. While in the modelling the discounting is actually applied to the investment to compute annualised fixed costs for the investment

In complement to carbon pricing drivers, the modelling uses "shadow values" as drivers to reach energy policy objectives of policies and measures that represent yet to be defined policies in the respective fields: the so-called "energy efficiency value" and "renewable energy value", which impact investment decision-making in the model. These values are thus introduced to achieve a certain ambition on energy efficiency, for instance related to national energy efficiency targets and renewable energy targets in the NECPs as represented in the Reference Scenario 2020, or increased renovation rates in buildings and increased sector specific renewable energy ambition related to heating and cooling in the policy scenarios.

Table 7 shows average 2025-2035 values for the different scenarios. The values in REF2020 reflect the existing policy framework, to meet notably the national energy targets (both energy efficiency and renewable energy) as per the NECPs. They are typically higher in policy scenarios that are based on regulatory approaches than in scenarios that are more based on carbon pricing. The "energy efficiency value" and "renewable energy value" also interact with each other through incentivising investment in options which are both reducing energy demand and increasing the contribution of renewables, like heat pumps. This is for instance the case in the REG scenario, where the comparatively higher "energy efficiency value" complements the "renewable energy value" in contributing to the renewable energy performance of the scenario, notably through the highest heat pump penetration of all scenarios.

Table 27: Energy efficiency value and renewable energy value (averaged 2025-2035)

Scenarios	Average renewables shadow value	Average energy efficiency shadow value
	(€'15/ MWh)	(€'15/ toe)
REF2020	62	330
REG	121	1449
MIX	61	1052
MIX-CP	26	350

Specific measures for the transport system

Policies that aim at improving the efficiency of the transport system (corresponding to row "EE in Transport" in the Table 5), and thus reduce energy consumption and CO_2 emissions, are phased-in in scenarios that are differentiated in terms of level of ambition (low, medium, high ambition increase). All scenarios assume an intensification of such policies relative to the baseline. Among these policies, the CO_2 emission standards for vehicles are of particular importance. The existing standards[65], applicable from 2025 and

decision, its effect can be illustrated if applied to the future prices instead: for example, the average discounted carbon price in 2030 for the period 2030-2050 for renovation of houses and for heating equipment, applying a 12% discount rate, is €65 in the MIX scenario and €81 in the MIX CP scenario.

[65] The existing legislation sets for newly registered passengers cars, an EU fleet-wide average emission target of 95 gCO_2/km from 2021, phased in from 2020. For newly registered vans, the EU fleet-wide average emission target is 147 gCO_2 /km from 2020 onward. Stricter EU fleet-wide CO_2 emission targets, start to apply from 2025 and from 2030. In particular emissions will have to reduce by 15% from 2025 for both cars and vans, and by 37.5% and 31% for cars and vans respectively from 2030, as compared to 2021. From 2025 on, also trucks manufacturers will have to meet CO_2 emission targets.

from 2030, set binding targets for automotive manufacturers to reduce emissions and thus fuel consumption and are included in the Reference Scenario.

Medium ambition increase

In this case, the following policy measures are considered that drive improvements in transport system efficiency and support a shift towards more sustainable transport modes, and lead to energy savings and emissions reductions:

- Initiatives to increase and better manage the capacity of railways, inland waterways and short sea shipping, supported by the TEN-T infrastructure and CEF funding;
- Gradual internalisation of external costs ("smart" pricing);
- Incentives to improve the performance of air navigation service providers in terms of efficiency and to improve the utilisation of air traffic management capacity;
- Incentives to improve the functioning of the transport system: support to multimodal mobility and intermodal freight transport by rail, inland waterways and short sea shipping;
- Deployment of the necessary infrastructure, smart traffic management systems, transport digitalisation and fostering connected and automated mobility;
- Further actions on clean airports and ports to drive reductions in energy use and emissions;
- Measures to reduce emissions and air pollution in urban areas;
- Pricing measures such as in relation to energy taxation and infrastructure charging;
- Revision of roadworthiness checks;
- Other measures incentivising behavioural change;
- Medium intensification of the CO_2 emission standards for cars, vans, trucks and buses (as of 2030), supported by large scale roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 50% for cars and around 40% for vans.

Low ambition increase

In this case, the same policy measures as in the *Medium ambition increase* are included. However, limited increase in ambition for CO_2 emission standards for vehicles (passenger cars, vans, trucks and buses) as of 2030 is assumed, supported by the roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 40% for cars and around 35% for vans.

High ambition increase

Beyond measures foreseen in the medium ambition increase case, the high ambition increase case includes:

- Further measures related to intelligent transport systems, digitalisation, connectivity and automation of transport - supported by the TEN-T infrastructure;
- Additional measures to improve the efficiency of road freight transport;

In particular, the EU fleet-wide average CO_2 emissions of newly registered trucks will have to reduce by 15% by 2025 and 30% by 2030, compared to the average emissions in the reference period (1 July 2019–30 June 2020). For cars, vans and trucks, specific incentive systems are also set to incentivise the uptake of zero and low-emission vehicles.

- Incentives for low and zero emissions vehicles in vehicle taxation;
- Increasing the accepted load/length for road in case of zero-emission High Capacity Vehicles;
- Additional measures in urban areas to address climate change and air pollution;
- Higher intensification of the CO_2 emission standards for cars, vans, trucks and buses (as of 2030) as compared to the medium ambition increase case, leading to lower CO_2 emissions and fuel consumption and further incentivising the deployment of zero- and low-emission vehicles, supported by the large scale roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 60% for cars and around 50% for vans.

Drivers of reduction in non-CO2 GHG emissions

Non-CO_2 GHG emission reductions are driven by both the changes taking place in the energy system due to the energy and carbon pricing instruments, and further by the application of a carbon value that triggers further cost efficient mitigation potential (based on the GAINS modelling tool) in specific sectors such as waste, agriculture or industry.

Table 28: Carbon value applied to non-CO2 emissions in the GAINS model (€2015/tCO2)

Scenarios	Non-CO_2 carbon values	
	2025	2030
REF2020	0	0
REG	4	4
MIX	4	4
MIX-CP	5	10

13.1.5.4 Key results and comparison with Climate Target Plan scenarios

Table 29: Key results of the “Fit for 55” core scenarios analysis for the EU**2030 unless otherwise stated**		REF	REG	MIX	MIX-CP
Key results					
GHG emissions* reductions (incl. intra EU aviation and maritime, incl. LULUCF)	% reduction from 1990	45%	55%	55%	55%
GHG emissions* reductions (incl. intra EU aviation and maritime, excl. LULUCF)	% reduction from 1990	43.4%	53.0%	52.9%	52.9%
Overall RES share	%	33%	40%	38%	38%
RES-E share	%	59%	65%	65%	65%
RES-H&C share	%	33%	41%	38%	36%
RES-T share	%	21%	29%	28%	27%
PEC energy savings	% reduction from 2007 Baseline	33%	39%	39%	38%
FEC energy savings	% reduction from 2007	30%	37%	36%	35%

	Baseline				
Environmental impacts					
CO_2 emissions reductions (intra-EU scope, excl. LULUCF), of which	(% change from 2015)	-30%	-43%	-42%	-42%
Supply side (incl. power generation, energy branch, refineries and district heating)	(% change from 2015)	-49%	-62%	-63%	-64%
Power generation	(% change from 2015)	-51%	-64%	-65%	-67%
Industry (incl. process emissions)	(% change from 2015)	-10%	-23%	-23%	-23%
Residential	(% change from 2015)	-32%	-56%	-54%	-50%
Services	(% change from 2015)	-36%	-53%	-52%	-48%
Agriculture (energy)	(% change from 2015)	-23%	-36%	-36%	-35%
Transport (incl. domestic and intra EU aviation and navigation)	(% change from 2015)	-17%	-22%	-21%	-21%
Non-CO_2 GHG emissions reductions (excl. LULUCF)	(% change from 2015)	-22%	-32%	-32%	-33%
Reduced air pollution vs. REF	(% change)			-10%	
Reduced health damages and air pollution control cost vs. REF - Low estimate	(€ billion/year)			24.8	
Reduced health damages and air pollution control cost vs. REF - High estimate	(€ billion/year)			42.7	
Energy system impacts					
Primary Energy Intensity	toe/M€'13	83	75	76	76
Gross Available Energy (GAE)	Mtoe	1,289	1,194	1,198	1,205
- Solids share	%	9%	6%	5%	5%
- Oil share	%	34%	33%	33%	33%
- Natural gas share	%	21%	20%	20%	21%
- Nuclear share	%	10%	11%	11%	11%
- Renewables share	%	26%	31%	30%	30%
- Bioenergy share	%	13%	13%	12%	12%
- Other Renewables share	%	13%	18%	18%	18%
Gross Electricity Generation	TWh	2,996	3,152	3,154	3,151
- Gas share	%	14%	12%	13%	14%
- Nuclear share	%	17%	16%	16%	16%
- Renewables share	%	59%	65%	65%	65%
Economic impacts					
Investment expenditures (excl. transport) (2021-30)	bn €'15/year	297	417	402	379
Investment expenditures (excl. transport) (2021-30)	% GDP	2.1%	3.0%	2.9%	2.7%
Additional investments to REF	*bn €'15/year*		*120*	*105*	*83*
Investment expenditures (incl. transport) (2021-30)	bn €'15/year	944	1068	1051	1028
Investment expenditures (incl. transport) (2021-30)	% GDP	6.8%	7.7%	7.6%	7.4%
Additional investments to REF	*bn €'15/year*		*124*	*107*	*84*
Additional investments to 2011-20	*bn €'15/year*	*285*	*408*	*392*	*368*
Energy system costs excl. carbon	bn €'15/year	1518	1555	1550	1541

pricing and disutility (2021-30)					
Energy system costs excl. carbon pricing and disutility (2021-30)	% GDP	10.9%	11.2%	11.15%	11.1%
Energy system costs incl. carbon pricing and disutility (2021-30)	bn €'15/year	1535	1598	1630	1647
Energy system costs incl. carbon pricing and disutility (2021-30)	% GDP	11.0%	11.5%	11.7%	11.8%
ETS price in current sectors (and maritime)	€/tCO_2	30	42	48	52
ETS price in new sectors (buildings and road transport)	€/tCO_2	0	0	48	80
Average Price of Electricity	€/MWh	158	156	156	157
Import dependency	%	54%	52%	53%	53%
Fossil fuels imports bill savings compared to REF (2021-30)	bn €'15		136	115	99
Energy-related expenditures in buildings (excl. disutility)	% of private consumption	6.9%	7.5%	7.5%	7.4%
Energy-related expenditures in transport (excl. disutility)	% of private consumption	18.1%	18.1%	18.3%	18.5%

*Note: *All scenarios achieve 55% net reductions in 2030 compared to 1990 for domestic EU emissions, assuming net LULUCF contributions of 255 Mt CO_2-eq. in 1990 and 225 Mt CO_2-eq. in 2030 and including national, intra-EU maritime and intra-EU aviation emissions[66].*

Source: PRIMES model, GAINS model

Table 30: Comparison with the CTP analysis

Results for 2030	CTP 55% GHG reductions scenarios range (REG, MIX, CPRICE, ALLBNK)	"Fit for 55" core scenarios range (REG, MIX, MIX-CP)
Overall net GHG reduction (w.r.t. 1990)*	55%	55%
Overall RES share	38-40%	38-40%
RES-E	64-67%	65%
RES-H&C	39-42%	36-41%
RES-T	22-26%	27-29%
FEC EE	36-37%	35-37%
PEC EE	39-41%	38-39%
CO_2 reduction on the supply side (w.r.t. 2015)	67-73%	62-64%

[66] Emissions estimates for 1990 are based on EU UNFCCC inventory data 2020, converted to IPCC AR5 Global Warming Potentials for notably methane and nitrous oxide. However, international intra-EU aviation and international intra-EU navigation are not separated in the UNFCCC data from the overall international bunker fuels emissions. Therefore, 1990 estimates for the intra-EU emissions of these sectors are based on (a combination of) data analysis for PRIMES modelling and 2018-2019 MRV data for the maritime sector.

CO_2 reduction in residential sector (w.r.t. 2015)	61-65%	50-56%
CO_2 reduction in services sector (w.r.t. 2015)	54-61%	48-53%
CO_2 reduction in industry (w.r.t. 2015)	21-25%	23%
CO_2 reduction in intra-EU transport (w.r.t. 2015)	16-18%	21-22%
CO_2 reduction in road transport (w.r.t. 2015)	19-21%	24-26%
Non-CO_2 GHG reductions (w.r.t. 2015, excl. LULUCF)	31-35%	32-33%
Investments magnitude, excluding transport (in bn€/per year)	401-438 bn/year	379-417 bn/per year
Energy system costs (excl. auction payments and disutility) as share of GDP (%, 2021-2030)	10.9-11.1%	11.1-11.2%

*Note: *All scenarios achieve 55% net reductions in 2030 compared to 1990 for domestic EU emissions, assuming net LULUCF contributions of 255 Mt CO_2-eq. in 1990 and 225 Mt CO_2-eq. in 2030 and including national, intra-EU maritime and intra-EU aviation emissions[60] (except the CTP ALLBNK that achieves 55% net reductions including also emissions from extra-EU maritime and aviation).*

Source: PRIMES model, GAINS model

13.1.6 Results per Member State

This document is completed by detailed modelling results at EU and MS level for the different core policy scenarios:

- Energy, transport and overall GHG (PRIMES model)
- Details on non-CO_2 GHG emissions (GAINS model)
- LULUCF emissions (GLOBIOM model)
- Air pollution (GAINS model)

13.2 Specific analytical elements for this impact assessment

13.2.1 DIONE model (JRC)

The DIONE model suite is developed, maintained and run by the JRC. It has been used for the assessment of capital and operating costs presented in Chapter 6 of the Impact Assessment. The suite consists of different modules, such as:

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

Many of them were developed specifically for the analysis of the total cost of ownership of vehicles in the framework of EC impact assessments[67]. The DIONE model was previously used in support of the analytic work supporting the current regulations setting CO_2 standards for light-duty vehicles (Regulation (EU) 2019/631) and heavy-duty vehicles (Regulation (EU) 2019/1242).

For this Impact Assessment, the DIONE Cost Curve Model was run to update previous light-duty vehicle cost curves in several regards. In particular, recent battery development trends were reflected, in line with the assumptions made in the EU Reference scenario 2020, by updating the cost curves for advanced electrified vehicles (SI PHEV, SI REEV, CI PHEV, CI REEV, BEV). Moreover, variants of the cost curves were developed to include technology costs to meet more stringent air pollutant standards. These variants were developed for all vehicles disposing of a combustion engine, and respective cost differences to reference vehicles were included in the cost curves for BEV and FCEV. Cost curves for all powertrains, conventional as well as electrified, were extended up to the year 2050.

On the basis of the cost curves, the DIONE Cross-Optimization Module determines the optimal (i.e. cost minimizing) CO_2 and energy consumption reduction for each powertrain and segment, given the relevant targets, fleet compositions and cost curves. As the cost curves have positive first and second derivatives, this is a mathematical problem with a unique solution.

Outputs from the Cross-Optimization Module are optimal CO_2 (for conventional vehicles and PHEV, REEV) or energy consumption (for BEV, FCEV) reduction per segment and powertrain and the corresponding additional manufacturing costs.

The DIONE Energy Cost Module is used to calculate fuel and energy costs. For each powertrain and segment, the WLTP energy consumption (MJ/km) is derived from the CO_2 emission reduction (to comply with the targets) using specific energy conversion factors.

The fuel and energy cost per powertrain and segment is calculated taking into account the specific energy consumption, vehicle mileage and fuel costs (EUR/MJ fuel). Vehicle mileages per segment and powertrain as well as mileage profiles over vehicle lifetime are based on PRIMES. Costs of conventional fuels, and electricity and hydrogen are aligned with PRIMES outputs for the respective scenarios. They are discounted and weighted by powertrain / segment activity over vehicle age.

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

Main assumptions made for the costs assessment by DIONE are presented in **Table 31**.

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

Table 31: Main assumptions made for the costs assessment by DIONE

Element	Sub-category	Assumption	Notes
Discount Rate, %[68]	Societal	4%	This social discount rate is recommended for Impact Assessments in the Commission's Better Regulation guidelines[69].
	End user (cars)	11%	Consistent with the EU Reference Scenario 2020
	End user (LCVs)	9.5%	Consistent with the EU Reference Scenario 2020
Period/age, years	Lifetime	15	
	First end-user	0-5	
	Second end-user	6-10	
Capital costs		% sales weighted average from DIONE	Average marginal vehicle manufacturing costs (including manufacturer profit margins) calculated by DIONE for a given scenario.
Depreciation			Based on CE Delft et al. (2017)[70]
Mileage profile	Total, and by age profile		The overall mileage is distributed over the assumed lifetime of the vehicle in the analysis, according to an age-dependant mileage profile estimated based on PRIMES-TREMOVE
Mark-up factor	Cars	1.40	Used to convert total manufacturing costs to prices, including dealer margins, logistics and marketing costs and relevant taxes. Consistent with values used in previous IA analysis[71,72]. The mark-up for LCVs excludes VAT, as the vast majority of new purchases of LCVs are by businesses, where VAT is not applicable.
	LCVs	1.11	

[68] The discount rates are consistent with the Reference Scenario 2020

[69] http://ec.europa.eu/smart-regulation/guidelines/tool_54_en.htm

[70] CE Delft and TNO (2017) Assessment of the Modalities for LDV CO_2 Regulations beyond 2020 (report for the European Commission, DG CLIMA) - https://ec.europa.eu/clima/sites/default/files/transport/vehicles/docs/ldv_co2_modalities_for_regulations_beyond_2020_en.pdf

[71] TNO, AEA, CE Delft, Ökopol, TML, Ricardo and IHS Global Insight (2011) Support for the revision of Regulation (EC) No 443/2009 on CO_2 emissions from cars (report for the European Commission, DG CLIMA) - https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/cars/docs/study_car_2011_en.pdf

[72] AEA, TNO, CE Delft, Öko-Institut (2009) Assessment with respect to long term CO_2 emission targets for passenger cars and vans (report for the European Commission, DG CLIMA) - https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/2009_co2_car_vans_en.pdf

O&M costs	By LDV segment, powertrain type.	% sales weighted average of updated O&M costs.	The calculation of the O&M costs is based on the assumptions made in PRIMES-TREMOVE. These are based on the TRACCS project database and have been revised in light of new evidence with respect to the costs for electrified powertrain types. The O&M costs are subdivided into three main components: (1) annual insurance costs, (2) annual maintenance costs, (3) other ownership costs, mainly including fixed annual taxes. The maintenance and insurance costs comprise the largest shares of the overall total O&M costs. The O&M cost assumptions used are based on recent estimates for maintenance and insurance costs[73]. No assumption is made on the evolution of the O&M costs over time, due to lack of available quantitative data.
VAT % rate		20%	Used to convert O&M costs including tax, to values excluding tax for social perspective.

13.2.2 Macroeconomic models (E3ME and GEM-E3)

13.2.2.1 Introduction

Two macroeconomic models have been used, representing two main different schools of economic thought. E3ME is a macro-econometric model, based on a post-Keynesian demand-driven non-optimisation non-equilibrium framework. GEM-E3 is a general equilibrium model that draws strongly on supply-driven neoclassical economic theory and optimising behaviour of rational economic agents who ensure that markets always clear[74].

Using multiple models with different strengths and weaknesses in representing the complexity of the economic system may lead to different conclusions, but this will help making fully informed policy decisions, as long as the key mechanisms behind the differences are well understood[75].

GEM-E3 assumes that capital resources are optimally allocated in the economy (given existing tax "distortions"), and a policy intervention to increase investments in a particular sector (e.g. energy efficiency) is likely to take place at the expense of limiting

[73] Sources: Aviva. (2017). Your car insurance price explained. Retrieved from Aviva: http://www.aviva.co.uk/car-insurance/your-car-price-explained/; FleetNews. (2015). Electric vehicles offer big SMR cost savings. Retrieved from FleetNews: http://www.fleetnews.co.uk/fleet-management/environment/electric-vehicles-offer-big-smr-cost-savings; UBS. (2017). Q-Series: UBS Evidence Lab Electric Car Teardown – Disruption Ahead? UBS Global Research. Retrieved from https://neo.ubs.com/shared/d1BwmpNZLi/

[74] Market clearance in GEM-E3 is achieved through the full adjustment of prices which allow supply to equal demand and thus a ‘general’ equilibrium is reached and maintained throughout the system.

[75] https://www.e3me.com/developments/choice-of-model-policy-analysis/

capital availability, as a factor of production, for other profitable sectors ("crowding out" effect). In other words, in GEM-E3, the total effect on the economy depends on the net effect of core offsetting factors, particularly between positive improved energy efficiency and economic expansion effects (Keynesian multiplier), on one hand, and negative economic effects stemming from crowding out, pressures on primary factor markets and competitiveness losses, on the other hand. A very detailed financial model has been added to GEM-E3 to represent the banking system, the bonds, the borrowing and lending mechanisms, projecting into the future interest rates of equilibrium both for public sector finance and for the private sector. This changes the dynamics of crowding out effects as opposed to standard computable general equilibrium (CGE) models without a banking sector.

E3ME does not adhere to the 'general' equilibrium rule; instead demand and supply only partly adjust due to persistent market imperfections and resulting imbalances may remain a long-run feature of the economy. It also allows for the possibility of non-optimal allocation of capital, accounting for the existing spare capacity in the economy[76]. Therefore, the level of output, which is a function of the level of demand, may continue to be less than potential supply or a scenario in which demand increases can also see an increase in output.

13.2.2.2 E3ME

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

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

The economic structure of E3ME is based on the system of national accounts, as defined by ESA95. In total there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment and international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

For the analysis presented in Section 6, the E3ME is calibrated to the Primes output for the main three scenarios representing different levels of ambition of CO2 emission standards. The PRIMES scenarios are based on a MIX policy scenario context and therefore consider the effect of different polcies acting on transport (see methodological paper referred to in Section 13.1)

The labour market is also covered in detail, with estimated sets of equations for labour demand, supply, wages and working hours. For the assessment of employment impacts across the different sectors, labour intensities (number of persons per unit of output) are based on Eurostat Structural Business Statistics (sbs_na_ind_r2). As a starting point, the labour intensity of battery manufacture (which is included in the electrical equipment manufacturing sector) at the EU level is around 3 jobs per €1 million output, compared to a labour intensity of around 5 jobs per €1 million output in the wider electrical equipment

[76] The degree of adjustment between supply and demand and the resulting imbalances are derived from econometric evidence of historical non-optimal behaviour based on the extensive databases and time-series underpinning the E3ME macro-econometric model.

manufacturing sector. The labour intensity of the automotive sector (excluding the battery manufacturing) is about 3.5 jobs per €1 million output, reflecting a high labour intensity for manufacture of vehicle parts and engines (5 jobs per €1 million output) but lower labour intensity for the assembly of the vehicle itself (less than 2 jobs per €1 million output). The model also accounts for labour productivity improvements (i.e. the ratio of sectoral employment to gross output over the projection period), based on PRIMES projections for output by sector and CEDEFOP projections for employment by sector.

13.2.2.3 GEM-E3

The GEM-E3 model has been developed and is maintained by E3MLab/ICCS of National Technical University of Athens[77], JRC-IPTS[78] and others. It is documented in detail but the specific versions are private. A full description of the model is available at https://ec.europa.eu/jrc/en/gem-e3/model

The model has been used by E3MLab/ICCS to provide the macro assumptions for the Reference scenario and for the policy scenarios. It has also been used by JRC-IPTS to assess macroeconomic impacts of target setting based on GDP per capita.

The GEM-E3 model is a multi-regional, multi-sectoral, recursive dynamic computable general equilibrium (CGE) model which provides details on the macro-economy and its interaction with the environment and the energy system. It is an empirical, large scale model, written entirely in structural form. GEM-E3 allows for a consistent comparative analysis of policy scenarios since it ensures that in all scenarios, the economic system remains in general equilibrium. In addition it incorporates micro-economic mechanisms and institutional features within a consistent macro-economic framework and avoids the representation of behaviour in reduced form. The model is built on rigorous microeconomic foundations and is able to provide in a transparent way insights on the distributional aspects of long-term structural adjustments. The GEM-E3 model is extensively used as a tool of policy analysis and impact assessment. It is updated regularly using the latest revisions of the GTAP database and Eurostat statistics for the EU Member States.

The version of the GEM-E3 model used for this Impact assessment features a significantly enhanced representation of the transport sector. The enhanced model version is referred to as GEM-E3T. The model is detailed regarding the transport sectors, representing explicitly transport by mode, separating private from business transport services, and representing in detail fuel production and distribution including biofuels linked to production by agricultural sectors.

GEM-E3 formulates separately the supply or demand behaviour of the economic agents who are considered to optimise individually their objective while market derived prices guarantee global equilibrium, allowing the consistent evaluation of distributional effects of policies. It also considers explicitly the market clearing mechanism and the related price formation in the energy, environment and economy markets: prices are computed by the model as a result of supply and demand interactions in the markets and different market clearing mechanisms, in addition to perfect competition, are allowed.

GEM-E3 has a detailed representation of the labour markets being able to project effects on employment. Labour intensities for 2015 were calculated by dividing the full time jobs by the value of production of each sector. The economic and employment data are

[77] http://www.e3mlab.National Technical University of Athens.gr/e3mlab/
[78] https://ec.europa.eu/jrc/en/institutes/ipts

from the Eurostat database. For 2015, the direct labour intensity for conventional vehicle is 3.6 person per million output (excluding the number of persons required to produce all the intermediate inputs, which are accounted for in the respective sectors), while for electric vehicles it is 2.8 person per million output (excluding the number of persons required to produce all the intermediate inputs, which are accounted for in the respective sectors). Labour intensity projections are based on the results of the GEM-E3 that includes sectoral production and employment by 5-year period until 2050.

14 ANNEX 5: REGULATORY CONTEXT

14.1 Main elements of Regulation (EU) 2019/631

CO_2 target levels

EU fleet-wide CO_2 emission targets are set to apply for five-year periods, i.e. for the years 2020 to 2024 (taken over from the previous Regulations), 2025 to 2029 and, from 2030 onwards, both for newly registered passenger cars and newly registered light commercial vehicles (vans).

EU fleet-wide targets

The 2025 and 2030 targets are defined as a percentage reduction from the EU fleet-wide target in 2021, as shown in **Table 32**.

Table 32: EU fleet-wide CO2 targets

EU fleet-wide CO_2 targets (% reduction from 2021 starting point)		
	2025	**2030**
Passenger Cars	15%	37.5%
Vans	15%	31%

The 2021 starting point is based on the average of the specific emission targets for all manufacturers in that year. However, in order to ensure the robustness of the starting point, the calculation is using the 2020 emission values as measured in the test procedure (WLTP) instead of the emission values declared by the manufacturers. The measured 2020 WLTP emission values will be reported by manufacturers in the course of 2021 and the 2021 starting point as well as the 2025 and 2030 WLTP target levels (g CO_2/km) will be published by the Commission by 31 October 2022 (Article 9(3) of Regulation (EU) 2019/631).

Annual specific emission targets for manufacturers

Each year, a specific emission target is set for each manufacturer on the basis of the applicable EU fleet-wide target and taking into account the average mass of the manufacturer's fleet of new vehicles registered in that year. The specific emission targets are determined on the basis of a limit value curve, which means that manufacturers of heavier vehicles are allowed higher average emissions than manufacturers of lighter vehicles. The curve is set in such a way that where all manufacturers comply with their specific emission targets, the EU fleet-wide target is achieved[79].

From 2025, the vehicle test mass will be used as the utility parameter instead of the mass in running order , in order to better reflect the actual mass of the vehicles.

Excess Emission Premiums

If the average specific emissions of a manufacturer exceed its specific emission target in a given year, an excess emission premium is imposed. The premium is set to 95 euro per gram of CO_2 per kilometre exceedance for each vehicle in the manufacturer's fleet of new vehicles registered in that year.

[79] Under the assumption that the average mass of the fleet is equal to the reference mass (M_0) used for the limit value curve in that year. That reference mass is adjusted every three years (every two years from 2025 onwards) to take into account the evolution of the average fleet mass over time.

Transition from NEDC test procedure to WLTP

Until 2020, the monitoring of the tailpipe CO_2 emissions of cars and vans and their assessment against the emission targets was based on measurements using the New European Driving Cycle (NEDC) test[80]. Since 1 September 2017, the NEDC has been replaced by the Worldwide Harmonised Light Vehicle Test Procedure (WLTP), which has been designed to better reflect real driving conditions in order to provide more realistic fuel consumption and CO_2 emissions values. The WLTP type approval test is fully applicable to all new cars and vans since 1 September 2019 and WLTP-based manufacturer CO_2 targets apply from 2021 onwards.

The WLTP test is likely to result in increased type approval CO_2 emission values for most vehicles, but the increase will not be evenly distributed between different manufacturers. This means that it is impossible to determine one single factor to translate NEDC into WLTP CO_2 emission values. A correlation procedure and a methodology for translating individual manufacturer CO_2 targets has therefore been put in place[81]. Based on the 2020 NEDC and WLTP monitoring data, the WLTP-based specific emission target for each individual manufacturer will be determined. The 2021 specific emission targets will be published by the Commission in October 2022[82].

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

A ZLEV is defined as a passenger car or a van with CO_2 emissions between 0 and 50 g/km. In order to incentivise the uptake of ZLEV, a “one-way” or “bonus-only” crediting system is introduced from 2025 on. This means that the specific CO_2 emission target of a manufacturer will be relaxed if its share of ZLEV, expressed as a percentage of its total number of vehicles registered in a given year, exceeds the benchmarks set out in the Regulation, and summarised in the table below (**Table 33**).

Table 33: ZLEV benchmarks

ZLEV benchmarks (% ZLEV in new vehicle fleet)		
	2025-2029	**2030-**
Passenger cars	15 %	35 %
Vans	15 %	30 %

A one percentage point exceedance of the benchmark level will increase the manufacturer’s CO_2 target (in g CO_2/km) by one percent. This target relaxation is capped at a maximum of 5%.

[80] The EU fleet-wide CO_2 targets set in Regulation (EU) 2019/631 for 2020 (95 g CO_2/km for cars and 147 g CO_2/km for vans) are based on the NEDC emission test procedure.

[81] Commission Implementing Regulations (EU) 2017/1152 and 2017/1153 and Commission Delegated Regulations (EU) 2017/1499 and 2017/1502. For the purpose of the analytical work supporting this impact assessment, the conversion factors from NEDC to WLTP emission values have been taken from the JRC Science for Policy Report "From NEDC to WLTP: effect on the type-approval CO_2 emissions of light-duty vehicles" (Tsiakmakis, S., Fontaras, G., Cubito, C., Anagnostopoulos, K., J. Pavlovic, Ciuffo, B. (2017), https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/nedc-wltp-effect-type-approval-co2-emissions-light-duty-vehicles)

[82] The data, on the basis of which the annual targets are calculated, has to be submitted by Member States in the year following that for which the targets apply, e.g. the 2021 monitoring data needed for calculating the 2021 targets, shall be submitted by Member States by the end of February 2022. Following a verification of the correctness of the data, the Commission shall confirm and publish the 2021 targets by 31 October 2022.

For calculating the share of ZLEV in a manufacturer's fleet to be compared against the benchmark levels, an accounting rule applies, which gives a greater weight to ZLEV with lower emissions:

- For both cars and vans, a zero-emission vehicle (ZEV) is counted as one ZLEV.
- For other ZLEV, the accounting rule differs between cars and vans:
  - A car emitting 50 g CO_2/km is counted as 0.3 ZLEV, while a van emitting 50 g CO_2/km is counted as 0 ZLEV.
  - Vehicles emitting more than 0 and less than 50 g/km are counted on the basis of a linear scale between the corresponding values. For example, a car and a van emitting 25 g CO_2/km will be counted as 0.65 and 0.5 ZLEV, respectively.

In addition, during the period 2025 to 2030 and for cars only, a multiplier of 1.85 is applied for counting ZLEV registered in a Member State with a ZLEV share in its new car fleet below 60% of the EU average in 2017, and with less than 1,000 ZLEV (cars) newly registered in that year[83]. Where, in any year between 2025 and 2030, the ZLEV share in such a Member State's fleet of newly registered cars exceeds 5%, vehicles registered in that Member State shall no longer be eligible for the application of the multiplier in the subsequent years.

Pooling, exemptions, derogations

Pooling offers the possibility for several manufacturers to be considered together as a single manufacturer for the purpose of meeting a common target. Pooling between car and van manufacturers is not possible. Pooling can be applied for by manufacturers, which are part of a group of connected undertakings, but also by other manufacturers.

Car and van manufacturers registering less than 1000 new vehicles per year are exempted from meeting a specific emission target.

For **"small volume" car and van manufacturers**, i.e. those registering between 1,000 and 10,000 cars or between 1,000 and 22,000 vans per year, it is possible to apply for a derogation from their "default" specific emission targets.

In 2019, 12 car manufacturers benefitted from this derogation, two of which had less than 1,000 registrations and could thus have been exempted instead[84]. Two van manufacturers[85] were granted such derogations in 2019. Four other eligible van manufacturers[86], did not apply for the derogation as they complied with their 'default' specific emissions target.

"Niche" car manufacturers, i.e. those registering between 10,000 and 300,000 new cars per year, may benefit from a derogation target until the year 2028. In the years 2025 to 2028, the derogation target for those manufacturers will be 15% below the 2021 derogation target, which is 45% below their emissions in the reference year 2007.

Eco-innovations

[83] CZ, EE, EL, LT, LV, MT, PL, SK, SI, RO

[84] Some manufacturers registering less than 1,000 new cars per year have continued to apply for derogations since EU derogations are required to avoid penalties when selling vehicles on the Swiss market (this may change under new Swiss legislation which is currently under preparation)

[85] Piaggio and Ssangyong

[86] Hyundai Pool (1 636 vans registered), Isuzu (13 102 vans registered), Jaguar Land Rover (1 868 vans registered) and Mitsubishi Pool (9 391 vans registered).

Manufacturers may benefit from fitting their vehicles with innovative emission reduction technologies for which the emission savings are not (or only in part) covered by the WLTP emission test procedure. In order to be eligible, such technologies have to be approved as “eco-innovations” by a Commission Decision. The manufacturer’s average specific emissions in a calendar year may be reduced by the emission savings obtained through such eco-innovations up to a maximum of 7 g CO_2/km.

Efficiency improvements for air conditioning systems will become eligible as eco-innovation technologies as of 2025. The possibility for the Commission to adjust the cap of 7 g CO_2/km is also foreseen in the Regulation.

Governance

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

In-service verification of CO_2 emissions

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

Deviations found in the CO_2 emissions of vehicles in-service shall be reported to the Commission, who shall take them into account for the purpose of calculating the average specific emissions of a manufacturer.

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

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

In order to ensure the real-world representativeness of the CO_2 emissions determined using the WLTP type approval procedure, and prevent the gap between type approval emissions and real-world emissions to increase, the Commission shall, from 2021 on, regularly collect data on the real-world CO_2 emissions and fuel or energy consumption of light-duty vehicles using OBFCM.

The Commission shall monitor how that gap evolves between 2021 and 2026. On that basis, the Commission shall assess the feasibility of a mechanism to adjust the manufacturer’s average specific CO_2 emissions as of 2030.

The detailed procedures for collecting and processing the data are set out in a Commission Implementing Regulation [87]. Subject to the consent of the vehicle owner, real world data will be collected by manufacturers when the vehicle is brought in for service or repairs, and by Member States during the roadworthiness tests. The first data

[87] Commission Implementing Regulation (EU) 2021/392 on the monitoring and reporting of data relating to CO_2 emissions from passenger cars and light commercial vehicles pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council

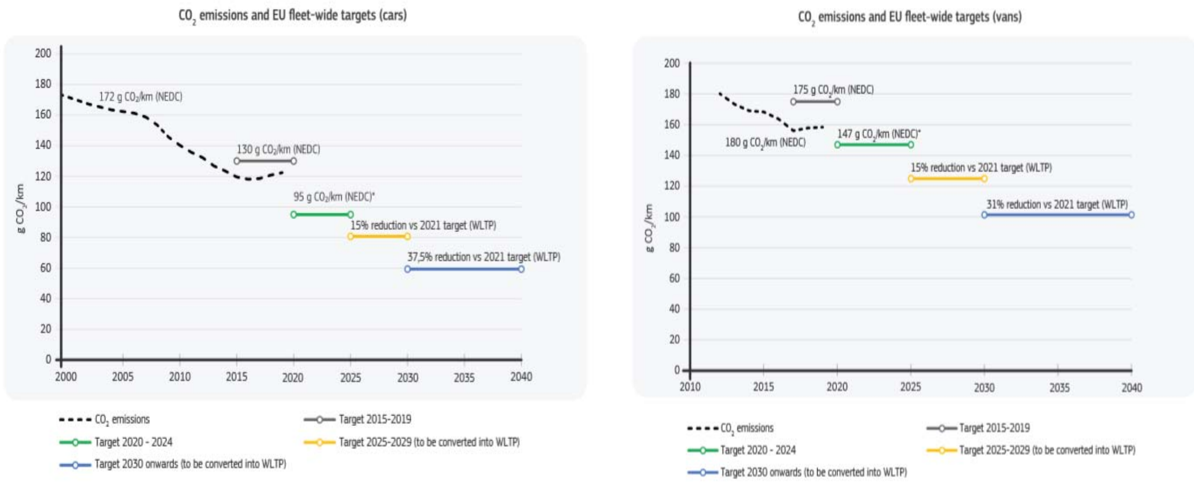
to be collected will be from new vehicles registered in 2021, and a first limited dataset is expected to become available in April 2022. The Commission will publish the data and present the differences between the real world average CO_2 emissions and fuel or energy consumption and the corresponding average type approval values at the level of the manufacturer fleet.

If appropriate, the Commission may adopt a legislative proposal to put an adjustment mechanism in place and/or to adapt the procedures for measuring CO_2 emissions to reflect adequately the real world CO_2 emissions of cars and vans.

14.2 Implementation of Regulation (EU) 2019/631 and its predecessors

Figure 26 provides an overview of the trends in the average EU fleet-wide CO_2 emissions of new cars and vans until 2019 and the applicable EU fleet-wide emission targets.

Figure 26: Average specific emissions of new cars and vans (g CO_2/km) and applicable EU fleet-wide CO_2 targets



This shows that the CO_2 emission standards have been a driver for the improvement of the efficiency of new vehicles over the past decade. However, the average CO_2 emissions of newly registered cars has increased in the last years before the stricter 2020 targets started applying, in particular due to a shift from diesel to petrol cars and the increasing number of registrations of sport utility vehicles (SUVs)[88].

In contrast, in 2020, a very different development has taken place in the car market as a stricter EU fleet-wide target started to apply, which, in combination with COVID-19 recovery measures taken by many governments, has led to a spectacular increase in the registrations of new zero- and low-emission vehicles (see **Figure 27** below). In the EU, the number of registrations of new zero- and low-emission vehicles has been the highest in Germany, France, Netherlands Italy and Sweden. Registrations of new zero- and low-emission vehicles has been particularly high in Norway as well[89].

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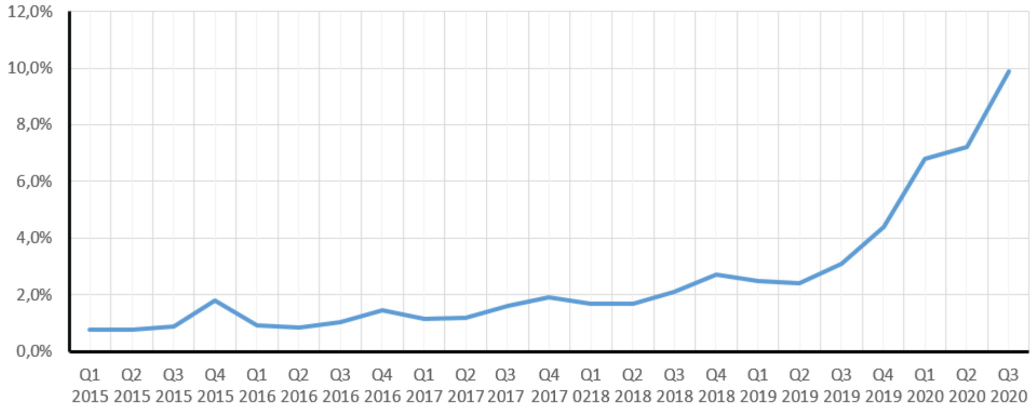
[88] EEA, Report of the provisional monitoring data for 2019 under Regulation (EU) 2019/631 https://www.eea.europa.eu/highlights/average-co2-emissions-from-new-cars-vans-2019; SUVs are typically heavier and have more powerful engines and larger frontal areas – all features that increase fuel consumption

[89] https://www.acea.be/uploads/press_releases_files/20210204_PRPC_fuel_Q4_2020_FINAL.pdf

Figure 27: Quarterly evolution of new electric passenger cars as a percentage of total new EU registrations[90]

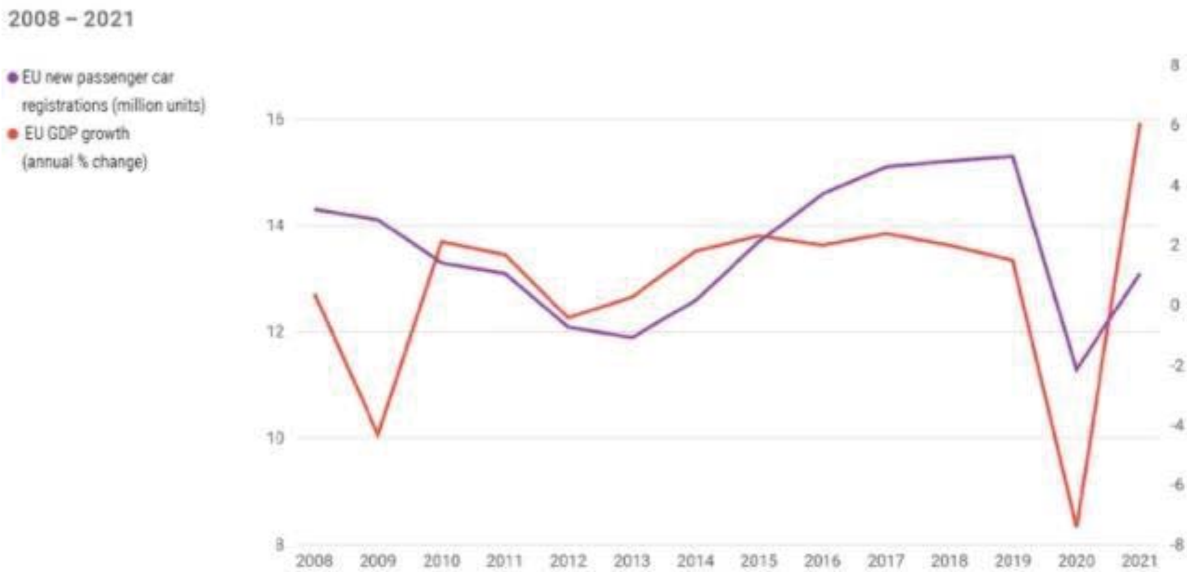


[90] The figure is based on the quarterly reports from ACEA on battery electric, plug-in hybrid electric and fuel cell electric vehicles registered in EU-28 (for 2020: EU-27, without UK). Registrations in a few smaller Member States may not be included due to a lack of data reported. To note that the number of fuel cell electric vehicles registered is very limited. Further details: https://www.acea.be/statistics/tag/category/electric-and-alternative-vehicle-registrations

15 ANNEX 6: IMPACTS OF COVID-19 ON AUTOMOTIVE SECTOR

The COVID-19 pandemic has heavily impacted the automotive sector world-wide, posing unprecedented challenges for the industry as a whole. In EU-27, registration of new passenger and commercial vehicles dropped by respectively -23.7% and -18.9%, with a trend following the GDP curve in the European Union (see **Figure 28** below, which shows that a close correlation between GDP and car registrations over the period in the EU, contrary to what happened during the previous 2008-2009 crisis with average GDP decline: -6.4% over 2020 in EU-27)[91]. For passenger cars, 9.9 million units were sold in 2020, which represents a drop of 3 million units compared to 2019[92]. For commercial vehicles, 1.7 million units were sold over the same period (i.e. 401,000 units less).

Figure 28: New passenger cars and GDP growth in the EU 2008-2021 (source: ACE, IHS Markit, European Commission DG ECFIN)



This has to be placed in the broader context of the economic crisis worldwide both from the demand- and supply-side perspectives. The automotive market weighs heavily on global manufacturing and on economies with a high exposure to this sector.

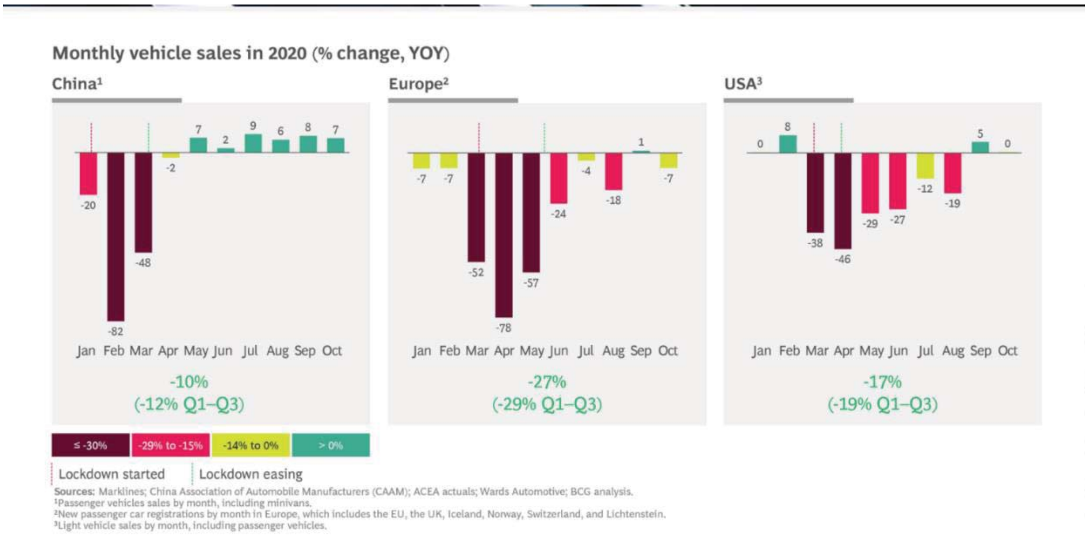
The global GDP has contracted by 4.2% in 2020. After an unprecedented sudden shock in the first half of 2020, the economy has recovered gradually in the third quarter as containment measures relaxed, allowing businesses and household spending to resume. Still, the global GDP in the second quarter of 2020, was 10% lower than at the end of 2019, which was immediately reflected in car sales globally.

Global sales of vehicles have fallen under 77 million units in 2020, down from 89.7 million units in 2019 with a previous peak of 94.3 million units in 2017 following 10 years of continuous growth (in 2020, 17.3 million less vehicles have been sold and 15 million units less have been produced compared to 2019)[93].

[91] Eurostat – newsrelease Euroindicators 17/2021 (2 February 2021)
[92] ACEA, January 2021
[93] IHS Markit, December 2020

The impact on sales and recovery pace differed for each key regional bloc and automotive market, respectively in China, Europe and the USA, as reflected in **Figure 29** below, also depending on the disease progression, overall sanitary situation and of the status and level of lockdown measures.

Figure 29: Monthly sales in 2020 (% change, Yoy) vs. GDP growth forecast in China, Europe and USA (source: BCG)



In Autumn 2020[94], economic forecasts projected that the EU economy would contract by 7.4% in 2020[95] before recovering with growth of 4.1% in 2021 and 3% in 2022[96]. All economic aggregates have been significantly impacted by the pandemic evolution and the containment measures with a direct effect on the automotive industry: for instance, a decline in consumer spending was foreseen in May 2020, up to 40% -50%, with numerous second- and third- order effects[97]. Beside decreasing sales and demand, this resulted in massive losses, liquidity shortages and changes in customers' behaviours. This was compounded by the already rapidly advancing technology shift in a competitive environment which required significant investment and strategic realignments.

In the EU, the economic consequences materialised through three main channels. First, the partial or full shut down of entire sectors due to the measures put in place to contain contagion has severely disrupted service sectors, including transport and mobility. Second, such disruptions also affected production and distribution activities and the access to extra-EU supply chains. Third, the consequent loss of income led to diminishing demand. Mobility patterns and customers behaviours have been also significantly modified in the long run.

Impact on transport services –As a consequence of global lockdown measures due to the COVID-19 crisis, mobility fell by an unprecedented amount in the first half of 2020[98]. Road transport in regions with lockdowns in place dropped between 50% and

[94] The automotive contributes indeed globally to an estimated 4% of all GDP output but also to a major part of the R&D expenses worldwide (83,34 Billion EUR in 2019) and of the turnover (2.66 Trillion EUR in 2019) of the manufacturing industry (Crescendo Worldwide Report Automotive 2020-2021)

[95] GDP decreased finally by 6.4% over 2020 in EU-27, see above footnote 1

[96] European Commission - European Economic Forecast Autumn 2020, Institutional Paper 136 (November 2020)

[97] Mc Kinsey - The-impact-of-COVID-19-on-future-mobility-solutions (May 2020)

[98] Compared to the period between 3 January and 6 February 2020 - before the outbreak of the pandemic in Europe - average mobility in the EU was about 17% lower in the fourth quarter of 2020, and declined further (to -26%) in January 2021. This compares to -25% and -9% on average in the second and third

75%, with global average road transport activity almost falling to 50% of the 2019 level by the end of March 2020. Immediately after the crisis outbreak, public-transit ridership has fallen 70 to 90% in major cities across the world, and operations have been significantly impacted by uncertainty and strict hygiene protocols—such as compulsory face masks and health checks for passengers, or restricting the number of riders in trains and stations to comply with space requirements. Ride hailers have also experienced declines of up to 60 to 70 percent, and many micro-mobility and carpooling players have suspended their services. As well, fleet leasing and car rental have been hit harder than most by the travel bans to stem the spread of COVID-19.

Road freight transport has been significantly and negatively impacted by the epidemic outbreak, at global level and in Europe in particular. Sales in the land transport sector (which also includes freight and passenger rail transport in addition to road transport) in the EU and other Western European countries contracted by 10.3% in 2020, in real terms[99].

The greatest disruption occurred during the first wave of the pandemic in spring 2020 but the sector recovered from the summer, with the lifting of border closures and the return of business activity and household consumption. However, the activity underwent another slowdown as the virus spread for a second time and many countries in the region were forced to implement new guidelines, partially closing economies once more. The impact through the year was greater for international than for domestic transport. A difference according to the transported products can also be observed, with the trade in pharma and ICT products having remained significant through last year. As an exception, e-commerce and last-mile delivery have increased, which seems to correspond to a long term trend.

Standstill in production and supply disruption – The impact of the COVID-19 crisis has been sudden and universal. For Original Equipment Manufacturers (OEM), initial concerns over a disruption in Chinese parts exports quickly pivoted to large-scale manufacturing interruptions across Europe. Global production stopped and the supply chain was critically disrupted. The most immediate and visible effect in the traditional automotive sector was subsequently the standstill of many OEM and supplier factories.

The COVID-19 pandemic has had a severe impact on Europe’s vehicle manufacturing sector[100]. During the first half of 2020 alone, EU-wide production losses (cars and vans) due to COVID-19 amounted to 3.6 million vehicles[101], worth around €100 billion and around 20% of the total production in 2019. These losses were the result of both factory shutdowns (especially during the 'lockdown' months of March, April and May) and the fact that production capacity did not return to pre-crisis levels once the lockdown measures have been eased[102].

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quarters of 2020, respectively. See: European Economic Forecast – Winter 2021 (Interim) – European Commission Institutional Paper 144 February 2021 – also Google Mobility Index and Finish Ministry of Finance – Economic Effects of the COVID-19 Pandemic – Evidence from Panel Data in the EU Discussion papers – Publications of the Ministry of Finance – 2021:11

[99] IHS Markit

[100] SWD (2020) 98 final

[101] ACEA

[102] https://www.acea.be/news/article/interactive-map-covid-19-impact-on-eu-auto-production-first-half-of-2020

Approximately, 24 million less vehicles are expected to be produced globally between 2020 and 2022 [103]. The industry would thus be hit two times harder by the coronavirus pandemic than during the 2008-2009 financial crisis: indeed, benchmarked against pre-COVID 19 forecasts made in January 2020, COVID-19 led to over 12 million units of losses.

At the height of the crisis, over 90 percent of the factories in China, Europe, and North America closed. With the stock market and vehicle sales plummeting, automakers and suppliers have laid off workers or relied on public intervention, particularly short-time work schemes and similar arrangements to support paying employees.

Several carmakers[104] had to be bailed out due to liquidity problems. The massive use of furlough schemes did not prevent the announcement of several plant closures/job losses[105] at manufacturer or supplier level.

Most factories and plants have reopened and relaunched production after the first lockdown and have remained in operation.

Impact on demand – The sanitary COVID-19 crisis also had a direct impact on consumer demand and distribution channels. The exogenous shock of the pandemic has indeed exacerbated the already present downshift in the global demand. Dealers were subject to regulations imposing an immediate closure of showrooms and retail network. For customers, the impact was multifaceted as people, facing financial uncertainty, reduced their purchasing, stayed home and postponed major investments. The confidence indicator of the Transport-Mobility-Automotive Ecosystem was one of the most hit[106] amongst all EU Industrial Ecosystems. Significantly the purchase intent for both new cars and used cars remains low across all countries in the Union, with the least impact in France (e.g. new car purchase intent decrease by -11% (France), -21% (Germany) and -25% (Italy) compared to pre-COVID-19 crisis intent whereas used car purchase intent decreased respectively by 11% (France), -31% (Germany) and -28% (Italy)). There was still a positive net impact in maintenance and repair.

Consequently, the **automotive market**, that was already on a downward trend, facing structural challenges (CO_2, pollutant emissions, electrification), was hard-hit and suffered an unprecedented 23.7%[107] decrease of passenger car sales in 2020. It is expected that COVID-19 will negatively affect sales volumes for years to come.

In April 2020 alone, vehicle sales in Europe dropped by around 80% compared to the same period in 2019 (see **Figure 30**). It also followed a decline of sales and production over the previous period in 2019-2018: car sales had seen their steepest year-over-year decline in 2019 (-4%)[108] since the 2008/2009 financial crisis as consumer demand from the U.S. to China softened.

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103 IHS Markit, December 2020

104 FCA and Renault received state aid under the Temporary Framework to support the economy in the context of the coronavirus outbreak.

105 Examples include plants operated by car manufacturers such as Nissan, Renault, Bridgestone, Continental, etc.

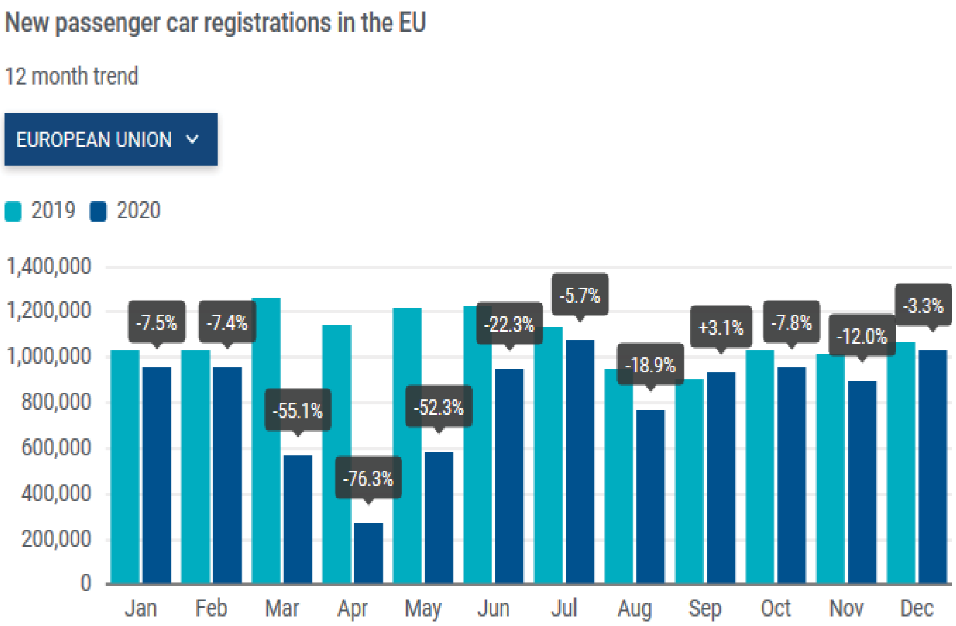
106 SWD(2020)98 final Chart 1 Confidence Indicator of EU industrial Ecosystems; Current and Expected Supply and Demand Factors, April 2020 – Confidence Indicator for Mobility-Transport-Automotive -35

107 ACEA, 2020

108 IHS Markit, December 2020

- **Passenger Cars:** Demand for new vehicles slumped during the peak of the crisis, with new registrations of passenger cars down 32% in the first 8 months of 2020 compared to the previous year[109].

Figure 30: New passenger car registrations in the EU 2020 vs. 2019 (monthly registrations – source: ACEA)



Spain posted the sharpest drop (-32.3%), followed closely by Italy (-27.9%) and France (-25.5%), while full-year losses were significant but less pronounced in Germany (-19.1%).

Despite uncertainties in the near term, demand still showed some signs of recovery after the summer 2020, with new registrations higher in September by 3.1% (cars) and 13.3% (vans) compared to 2019. New car registrations in Germany, EU's largest market, were 8.4% above levels of September 2019[110], with impressive growth in all electrified segments, thanks in particular to government stimulation measures aimed at electric and hybrid vehicles. However, demand declined again in October, with EU-wide registrations down 7.8% in October. New restrictions put in place in several EU countries in autumn 2020, due to the resurgence of the virus, put the recovery of economies under question.

The downwards trend continued for the whole October- December period despite incentives and recovery packages: in December, high, double-digit losses were seen in countries such as France (down 11.8%), Italy (down 14.7%), Portugal (down 19.6%). Germany showed the best performance, with a solid gain of 9.9%, followed by Spain, with a tiny loss of 0.01%.

All other segments have been impacted with un-even performances and recovery trends from one EU Member State to the other:

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[109] https://www.acea.be/press-releases/article/passenger-car-registrations-32.0-eight-months-into-2020-5.7-in-july-and-18

[110] https://www.kba.de/DE/Presse/Pressemitteilungen/2020/Fahrzeugzulassungen/pm23_2020_n_09_20_pm_komplett.html?nn=646300

- **New light commercial vehicles (LCV) up to 3.5t**: From January to December 2020, new van registrations declined by 17.6% across the European Union, standing at 1.4 million units. Spain recorded the sharpest drop (-26.5%) so far this year, while losses were less strong in France (-16.1%), Italy (-15.0%) and Germany (-12.2%).

In November, demand for new light commercial vehicles in the EU remained stable (-0.5%) compared to same period in 2019, whereas it weakened in December 2020 compared to December 2019 (-6%). Results in the EU's top four markets were mixed: in November 2020, registrations in Italy and Germany were positive, growing by 10.3% and 6.2% respectively, while LCV demand contracted in Spain (-8.1%) and France (-3.8%). In December 2020, registrations fell by 10.4% and 2.3% respectively in Italy and France, while Germany (+2.5%) and Spain (+1.6%) recorded modest gains.

- New heavy commercial vehicles (HCV) of 16t and over: all through 2020, 198,352 new heavy commercial vehicles were registered across the European Union, a decline of 27.3% compared to 2019. Despite the 2 last months' positive performance, each of the 27 EU markets recorded double-digit drops so far this year, including Germany (-26%), France (-25.8%) and Spain (-22.1%).

The two last months of the year showed positive results: in November 2020 alone, the EU market for heavy trucks improved, with new registrations up by 6.0% to 20,620 units. Central European countries (+28.6%) largely contributed to this result. Among the largest Western European markets however, only Italy (+28.5%) managed to post growth. During the month of December, 16,839 new heavy commercial vehicles were registered across the EU, a year-on-year rise of 11.8%. Central European markets continued to provide a strong boost to this growth; Poland, one of the leading markets, saw a 48.4% increase in heavy-truck registrations in December 2020. Among the largest Western European markets, Germany also made a sizeable contribution (+27.4%), followed by Spain (+8.3%) and France (+2.6%).

- **New medium and heavy commercial vehicles (MHCV) over 3.5t**: 2020, registrations of new trucks declined sharply across the European Union including in the four major markets: France (-24.1%), Germany (-24.0%), Spain (-21.7%) and Italy (-14.0%). This contributed to a cumulative decline of 25.7% to a total of 247,499 trucks registered in 2020.

In December 2020, demand for new medium and heavy trucks posted a solid growth (+7.1%) following a modest upturn (+3.7%) in November 2020, benefiting from the positive performance of the heavy-duty segment (which makes up the bulk of total truck demand). As for the biggest EU markets, Germany saw the highest percentage growth (+12.3%), followed by Spain (+3.8%) and France (+2.9%). By contrast, MHCV registrations slid fell slightly in Italy (-1.8%)

- New medium and heavy buses & coaches (MHBC) over 3.5t: from January to December 2020, EU demand for buses and coaches contracted by 20.3%,, counting 29,147 new registrations in total. Among the largest EU markets, Spain (-35.9%) and Italy (-24.9%) ended the year in negative, while losses were more limited in France (-10.8%) and Germany posted a slight growth over the same period (+0.4%).

In December 2020, new bus and coach registrations in the EU increased by 13.4% compared to December 2019. With the exception of France (-20.9%), all major EU markets gave a significant boost to the overall performance of the region: Italy (+13.4%), Germany (+22.1%) and Spain (+60.9%) in particular.

Impact of Incentives and recovery packages - Member States and the Commission announced a series of measures to support the economic recovery of the private sector, including the automotive segment. Noticeably, the recession was finally not as deep as expected in 2020[111] despite reintroduction and tightening of containment measures by Member States in response to the 2nd wave. Stimulus packages and recovery measures have also been instrumental for attenuating the recession.

Lessons have been learned from the 2008-2009 crisis in this respect[112]: electric vehicle targeted measures have been designed in countries such as Austria, France, Germany, Greece, Italy, Romania and in the Netherlands whereas other measures already in place and targeting also clean vehicles (e.g. *bonus malus* in Sweden) have been continued. They were all cornerstones of the respective demand stimulus packages, aimed at stimulating the recovery of the automotive sector, in particular through demand and supply of zero and low emission vehicles and recharging infrastructure.

These measures may have contributed to avoiding steeper drops in demand of vehicles in the EU: indeed, contrary to other markets, the electric passenger car markets in Europe has increased since the outbreak of the COVID-19 pandemic. On the contrary, in March and April when mobility was most limited in many European countries, electric vehicles still recorded high registration shares, up to 12% in France and Italy, as shown in **Figure 31** below. Even with fluctuations over 2020, electric passenger car registrations recorded all-time highs.

Up to the end of May, before the introduction of the first recovery packages, this was likely partially a result of more favourable taxes or cost benefits for electric vehicles in markets. After June 2020, electric passenger car shares have rebounded the most in France and Germany after a slight downfall since April 2020. Both countries introduced recovery packages for electric car purchases in June, which had a positive effect on consumer choices. There seems to be similar effects with the Spain's program MOVES II introduced in June 2020 as well as with the stimulus packages in Austria, Spain (RENOVE 2020 Program), and Italy, introduced after June 2020, as well as in other EU Member States having introduced similar measures (Greece, the Netherlands, Romania - see figure below).

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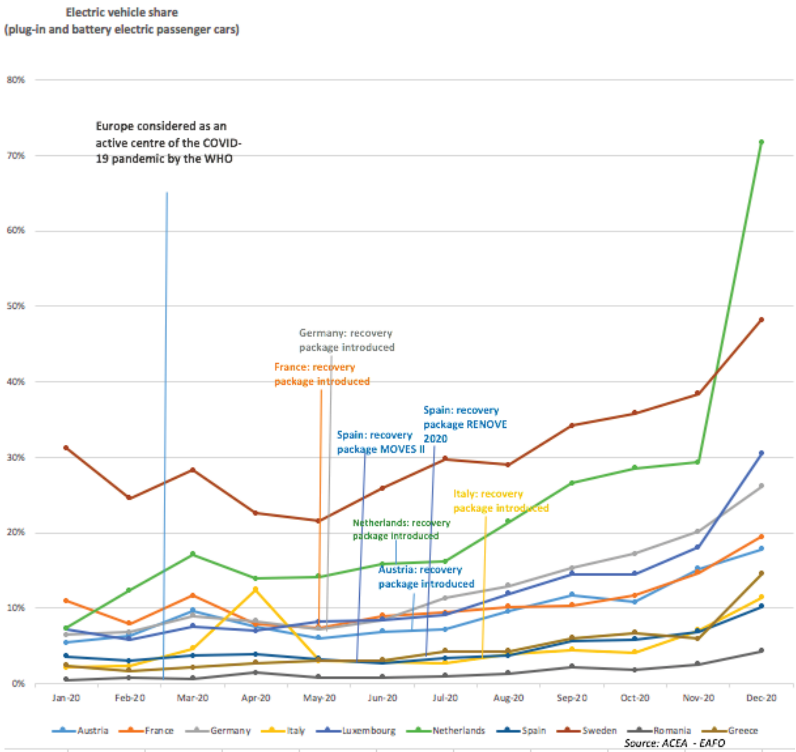
[111] See Winter 2021 Economic Forecast: A challenging winter, but light at the end of the tunnel (https://ec.europa.eu/commission/presscorner/detail/en/ip_21_504)

[112] International Council on Clean Transportation – Briefing (May 2020) – Green Vehicle Replacement Programs as a response to the COVID-19 crisis: Lessons learned from past programs and guidelines for the future; Georg Bieker, Peter Mock

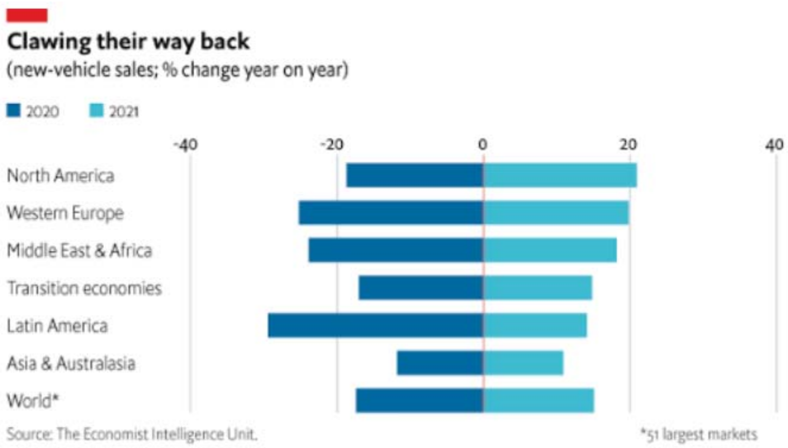
Figure 31: Electric Vehicle shares in the EU and EU Member States' Recovery packages (Summer 2020)



Outlook and perspectives

Global new-vehicle sales (**Figure 32**) will return to double-digit growth in 2021, but will fail to recover fully[113]. EU economy would barely return to pre-pandemic levels in 2022[114].

Figure 32: New Vehicle Sales 2020-2021 (source: The Economist Intelligence Unit)



As regards new vehicle sales, a recovery of demand in the EU at the same level as 2019 is foreseen by 2023[115]. It is anticipated that the unprecedented shift away from fossil fuel vehicles, in favour of low- emission or electric vehicles will continue and that Europe's share of global Electric Vehicle market will keep increasing. Global Electric Vehicle

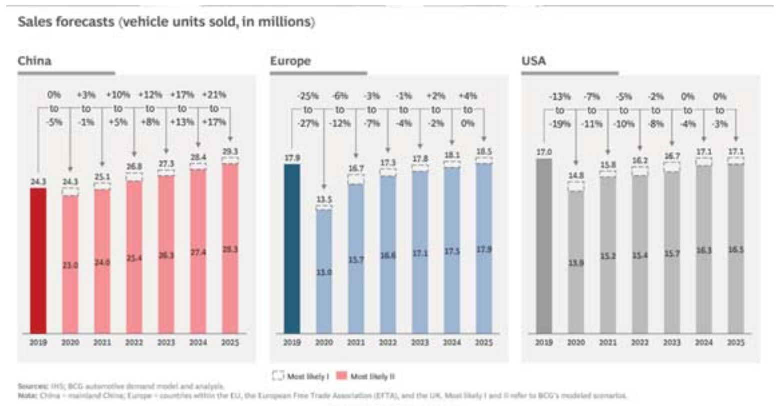
[113] The Economist Intelligence Unit – Industries in 2021 (Automotive)
[114] European Commission Winter 2021 Economic Forecast
[115] BCG COVID-19's Impact on the Automotive Industry (December 2020)

sales are expected to rise sharply in 2021, to around 3.4 million units, supported by the above-mentioned government incentives, and new launches.

Figure 33 illustrates the perspectives of recovery in China, USA and Europe[116]:

- A significant demand rebound was recorded in China already, with 2020 corresponding to 23.6 million units, down by 4.9% compared to 2019. 2021 forecast is set at 24.9 million units (+5.6% compared to 2020).
- Despite adverse COVID-19 trends, the automotive demand should continue to recover in the USA, supported by OEM and dealer incentives, online sales, government stimulus and improving economics. A positive trend of demand should continue in 2021 with a forecast of 16 million units for 2021 (+10% compared to 2020). Risks remain, notably from weak fleet sales and tight inventories; restocking efforts, which remain vulnerable to any further potential virus restrictions.
- European recovery prospects are mixed, with worrying virus resurgences, varied economic and stimulus support, ongoing restrictions and uncertainties as regards the sanitary situation (potential third wave). It is anticipated that the Western and Central European automotive demand for 2021 achieves 15.3 million units for 2021, with a 11% growth compared to 2020. Governmental support measures should be maintained in the EU Member States with major automotive markets (e.g. France, Germany, Italy, Spain).

Figure 33: Sales forecast for China, EU and USA (2019-2025-source BCG, IHS)



Impact on mobility patterns and behaviour

Many uncertainties also exist on how the COVID-19 crisis may affect future mobility, from the capacity of governments and companies to promote transport electrification to what consuming and behavioural changes could potentially be expected from it. The long-lasting impact of the crisis may differ significantly though from other earlier crisis circumstances, particularly 2008-2009 as the automotive industry was already facing multiple huge transformations across global markets when hit by the pandemic outbreak.

Still, beside challenges and economic immediate downturn, the COVID-19 has undoubtedly led to an acceleration of the twin transition in the automotive sectors and to some positive outcome:

- **There is evidence already that the current crisis will not slow down the current ongoing move to electrification**. On the contrary, industry and

[116] IHS (2021)

technological innovation experts expect the crisis to become a catalyst for the transformation. Experts anticipate that "*the next two or three years will be weak years for sales of still-prevalent ICE (internal combustion engine) vehicles on traditional technology platforms."* And *"demand for the current car lineup will be sluggish due to economic impairments and, at the point demand recovers, customers will return to a more favourable environment for xEVs (battery electric and plug-in hybrid) and demand 2023/2024 state-of-the-art technology*."[117]

- **Reinforced individual mobility**: in the short term, the COVID-19 crisis has raised the importance of safety and the sense of security for consumers. There is thus anecdotal evidence that car ownership will remain very important for individuals in a market which remains on the rise overall. On the other hand, long lasting trends to be noted towards more flexible models of use, financing and subscriptions of cars, and mobility, also with effects on automotive after-sales.
- **Powertrain electrification**: Demand and supply were already shifting towards electric and electrified vehicles, driven by CO2 regulation and technological progress, e.g., improved battery chemistry, increased range, high-performance charging.
- **Digitalisation of automotive sales and services**: Consumer trends are changing the way we buy and drive cars and consume mobility, e.g., connected cars, assisted driving.
- **e-Commerce.** Widespread confinement has given a massive boost to e-commerce and home deliveries. More people are shopping online, accelerating a pre-existing long-term trend which should last.
- **Last mile delivery and autonomous cargo transportation.** Companies involved in last mile delivery, which were quite active prior to the pandemic crisis, are set to gain from the Retail, e-commerce and logistics companies should increase investment in technologies and innovation. The positive impact of the crisis on the long-term e-commerce trend should also drive more investment in autonomous driving tech and complete solutions for goods deliveries, in particular for last mile delivery.
- **Customer experience and dealership tools.** During this period there was a push towards pure online sales and contactless deliveries. Customers will likely benefit from less friction in the sales process. Customer behavioural shift towards more online is expected to last, as it parallels other shopping experiences. Most dealers and repair shops are trying to adapt extremely
- **Push to cross-sectorial innovation towards smart and green mobility.** Combined with strengthened smart charging station infrastructure and innovation in battery technologies, there will be opportunities for uptake of advanced technologies and new entrant technologies and new entrant players with new business models and consumers opportunities at stake (e.g. Vehicle to Grid, Smart grids).

[117] Arthur D Little (2020)

16 ANNEX 7: INTRODUCTION, PROBLEMS AND DRIVERS – COMPLEMENTARY INFORMATION

16.1 Introduction – information on batteries and raw materials

Accelerating electrification will further increase demand for batteries and battery raw materials[118]. Lithium, cobalt, and natural graphite (three of the main raw materials used for the production of EV batteries) are listed as critical raw materials with an increased risk of supply[119]. Raw materials used for EV batteries are sourced dominantly from non-EU countries due to current gaps in EU capacity. There are a number of EU initiatives (such as the recently adopted proposal on the Batteries Regulation[120]) to address these concerns by focussing on developing a resilient EU value chain and increasing EU sourcing, ensuring sustainable sourcing from non-EU countries, as well as increasing circularity of battery raw materials[121].

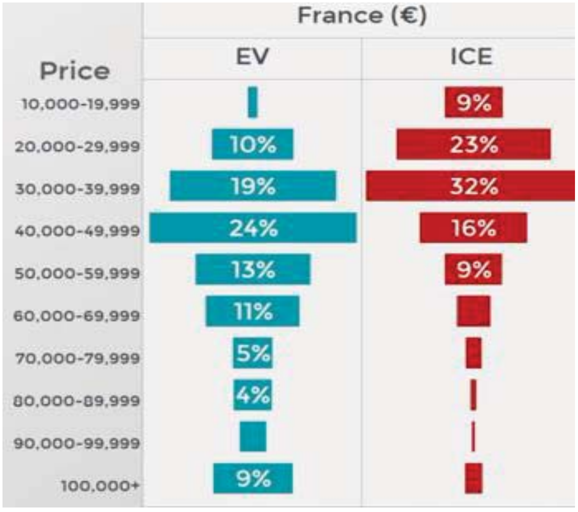
Meanwhile, the EU battery market is already mobilising for the ramped up production of EV batteries. If this takes places on schedule, battery supply could meet demand already in 2021, and even surpass European demand in the mid-2020s[122]. The European Battery Alliance has announced the aim to invest €15 billion in securing the domestic sourcing and processing of raw materials necessary to boost the EU production of batteries[123]. With battery technology evolving, less raw materials are expected to be needed to produce each kWh of an EV battery, along with recycling further mitigating raw material needs (especially from 2035 onwards with more cars coming to their end of life).

16.2 Driver 2: Market barriers and market failures hampering the uptake of zero-emission vehicles

As illustrated in **Figure 34** below, current prices of ZEV are still significantly above those of comparable ICEV and there is little offer at the lower end of the price range.

[118] World Economic Forum and Global Batteries Alliance (2019) 'A vision for a sustainable battery value chain in 2030: Unlocking the potential to power sustainable development and climate change mitigation'
[119] Study on the EU's list of Critical Raw Materials (2020)
[120] COM(2020) 798/3
[121] COM (2020) 474 final (Communication on Critical Raw Materials)
[122] Transport & Environment (2021), *From dirty oil to clean batteries*
[123] https://ec.europa.eu/commission/presscorner/detail/en/speech_21_1142

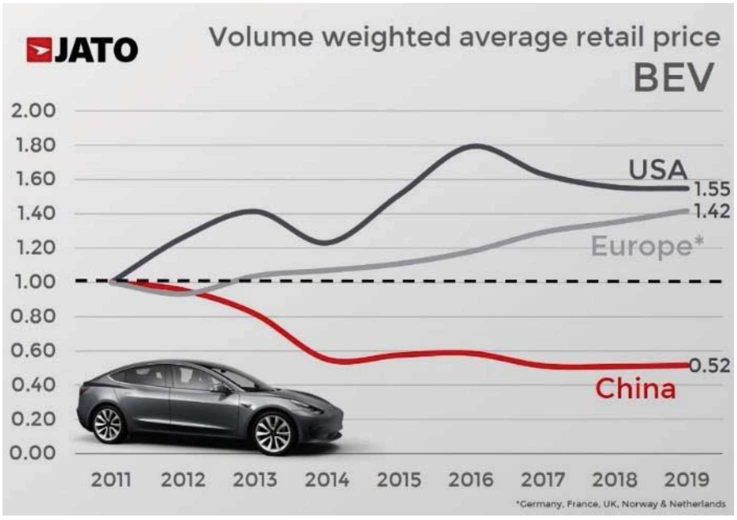
Figure 34: Distribution of new Electrified Vehicles (EV) and Internal Combustion Engine Vehicles (ICE) sold in France across different price classes[124].



JATO also noted that ZEV retail prices have not been falling over the past years. As illustrated in **Figure 35**, only in China battery electric cars became more affordable during the last decade, mostly due to government incentives, and the launch of small and very cheap models.

In Europe, the average Battery Electric Vehicles (BEV) price increased by more than 40% as manufacturers were focusing on premium and larger mid-size cars, leaving very few offerings in the entry-level segments. The average retail price (excluding any kind of incentive) of BEV sold in Europe and the US in 2019 was 58% and 52% higher than in China, respectively.

Figure 35: Evolution of BEV average retail prices in Europe, China and the US (2011 = 100%)[125]



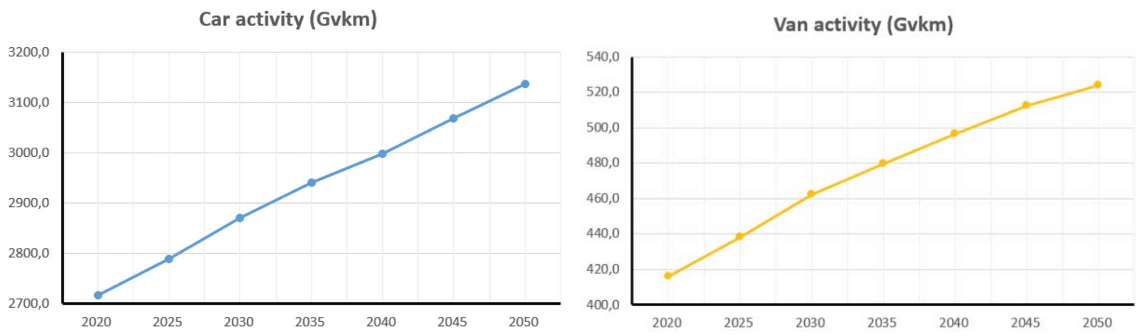
124 From https://www.jato.com/ev-prices-have-been-growing-during-the-last-8-years/

125 https://www.jato.com/ev-prices-have-been-growing-during-the-last-8-years/

16.3 Driver 3: Activity is increasing in the light-duty vehicle sector

Figure 36 below represents the increase in activity projected during the period 2020-2050 for cars and vans.

Figure 36: Cars and vans activity in the Baseline scenario (2020-2050)[126]



[126] Source: Baseline scenario in the Climate Target Plan

17 ANNEX 8: ADDITIONAL INFORMATION CONCERNING THE ASSESSMENT OF THE ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS OF THE DIFFERENT POLICY OPTIONS

17.1 Economic impacts of options regarding CO_2 target levels (TL)

17.1.1 Methodology

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

(i) Net economic savings from a societal and end-user perspective

These savings are calculated as the difference, between the policy options and the baseline, of the total costs, averaged over the EU-wide new vehicle fleet of cars and vans registered in 2030, 2035 or 2040. The total costs include the capital costs, the fuel or electricity costs, and the operation and maintenance (O&M) costs of the vehicles.

The savings from a societal perspective is the change in average costs over the lifetime (15 years) of a new vehicle without considering taxes and using a discount rate of 4%. In this case, the costs considered also include the external cost of CO_2 emissions (WTW).

The savings from an end-user perspective are presented for the first user (first five years after first registration) and the second user (years 6-10). In these cases, taxes are included and a discount rate of 11% (cars) or 9.5% (vans) is used. The calculation also takes account of the residual value of the vehicle (and the technology added) with depreciation.

(ii) Costs for automotive manufacturers

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

(iii) Energy system impacts

In view of the links between the CO_2 standards for cars and vans and the energy system, impacts of the TL options on the final energy demand and electricity consumption have been analysed, also considering the links with the revision of the EU ETS as well as the Energy Efficiency and Renewable Energy Directives.

(iv) Investment in alternative fuels infrastructure

The investments needed for recharging and refuelling infrastructure have been analysed, to ensure consistency with the revision of the Alternative Fuels Infrastructure Directive.

(v) Macro-economic impacts, including employment

17.1.2 TCO-second hand user

Figure 37 shows the average net savings (EUR per vehicle) resulting from the CO_2 emission standards from a second end-user perspective, considering that second users on average purchase the vehicle after 5 years of use and resell it after 10 years. **Figure 38** shows the effect of the interaction with the other policies of the 'fit for 55%' package, in particular the EU ETS and RED.

Figure 37: Average net economic savings from a TCO-second user perspective (EUR/vehicle) resulting from the CO_2 emission standards (in a MIX policy scenario context) (cars (l) and vans (r))

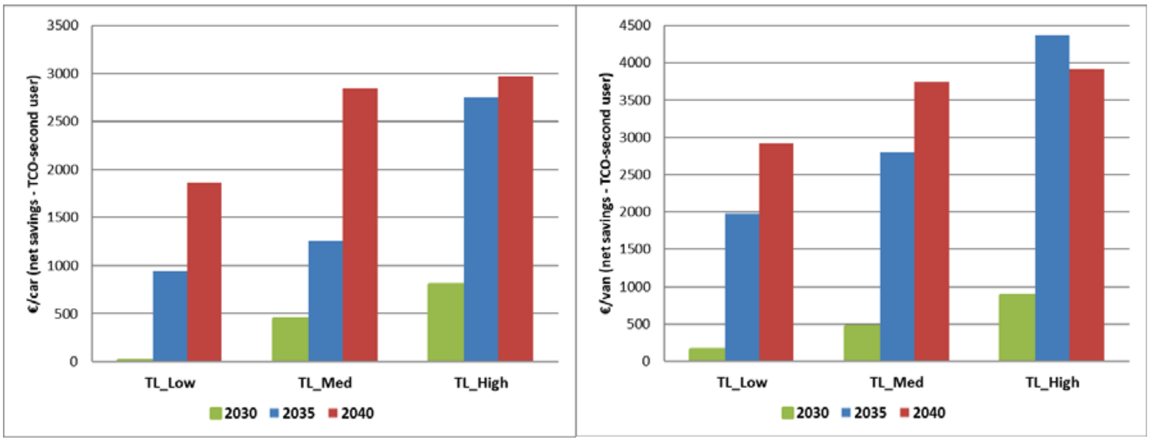
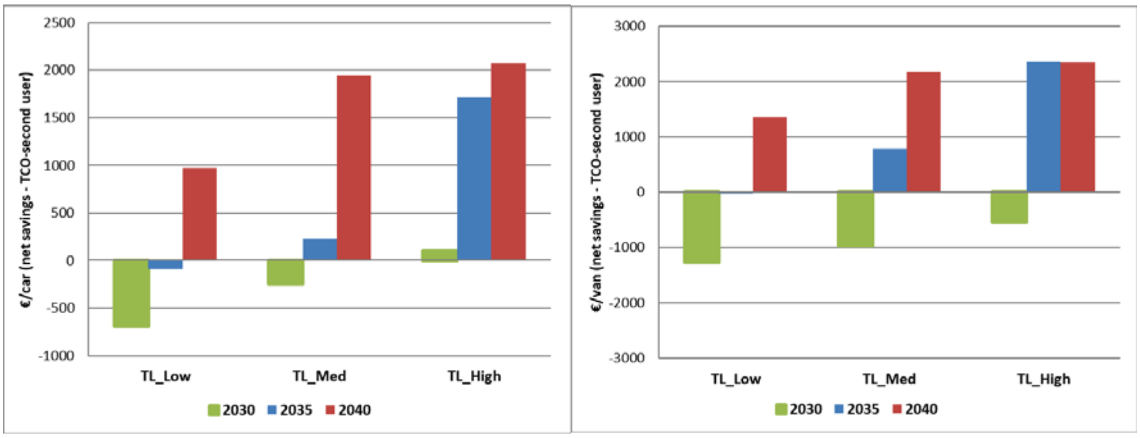


Figure 38: Average net economic savings in TCO-second user (EUR/vehicle) resulting from the combination of policies (cars (l) and vans (r))



17.1.3 Macro-economic impacts, GEM-E3 sectoral results

Table 34 below show the sectoral impacts (sectoral output and employment) of the scenarios analysed through the GEM-E3 model (see Section 6), in percentage changes with respect to the baseline. The sectoral impacts are shown for the loan-based variants. They are driven by the switch between different vehicle technologies and fuels. Production and employment of the electric vehicles sector increases compared to baseline in all variants. Sectors producing the respective products and services for the operation and maintenance of these vehicles, such as electricity and batteries, increase their output and employment. For the sectors which supply fuels for road transport, the production is found to decrease, especially in the scenario with higher penetration of BEVs, displacing ICEVs and limiting the fuels use.

Table 34: EU27 production by sector

EU27 production by sector (in % change from Baseline)				
Sectors	**Scenario**	**2030**	**2035**	**2040**
Electric vehicles	MIX55_LSTD	1.2	2.5	4.3
	MIX55	4.5	7.8	12.2
	MIX55_HSTD	7.6	27.9	14.6
Transport Equipment (excl. EVs)	MIX55_LSTD	-0.3	-0.7	-1.2
	MIX55	-1.2	-2.2	-3.5
	MIX55_HSTD	-1.9	-8.4	-4.2
Batteries	MIX55_LSTD	1.3	2.8	5.1
	MIX55	4.8	8.9	14.3
	MIX55_HSTD	8.2	31.7	18.1
Fossil Fuels	MIX55_LSTD	0.0	-0.3	-1.6
	MIX55	-0.2	-0.7	-3.5
	MIX55_HSTD	-0.2	-2.1	-5.2
Electricity	MIX55_LSTD	0.0	0.1	0.4
	MIX55	0.2	0.3	1.2
	MIX55_HSTD	0.2	0.9	1.5
Clean fuels (H2, Clean Gas, P2X, Biofuels)	MIX55_LSTD	0.0	1.0	8.5
	MIX55	-0.2	0.3	5.6
	MIX55_HSTD	-0.3	-1.9	-0.4
Other sectors	MIX55_LSTD	0.01	0.02	0.05
	MIX55	0.05	0.06	0.16
	MIX55_HSTD	0.07	0.29	0.20
EU27 employment by sector (in % change from Baseline)				
Sectors	**Scenario**	**2030**	**2035**	**2040**
Electric vehicles	MIX55_LSTD	1.3	2.5	4.4
	MIX55	4.6	7.9	12.6
	MIX55_HSTD	7.8	28.5	15.0
Transport Equipment (excl. EVs)	MIX55_LSTD	-0.3	-0.7	-1.1
	MIX55	-1.1	-2.2	-3.3
	MIX55_HSTD	-1.8	-8.1	-4.0
Batteries	MIX55_LSTD	1.3	2.8	5.0
	MIX55	4.9	8.7	14.2
	MIX55_HSTD	8.3	31.7	16.8
Fossil Fuels	MIX55_LSTD	0.0	-0.2	-1.1
	MIX55	0.0	-0.5	-2.9
	MIX55_HSTD	-0.1	-1.4	-4.5
Electricity	MIX55_LSTD	0.0	0.1	0.4
	MIX55	0.2	0.3	1.2
	MIX55_HSTD	0.2	0.9	1.5
Clean fuels (H2, Clean Gas, P2X, Biofuels)	MIX55_LSTD	0.0	0.4	2.54
	MIX55	0.0	0.2	1.93
	MIX55_HSTD	0.0	-0.4	0.55
Other sectors	MIX55_LSTD	0.03	0.03	0.13
	MIX55	0.10	0.11	0.37
	MIX55_HSTD	0.14	0.55	0.39

17.2 Social Impacts of options regarding CO_2 target levels (TL) –Assumptions and Methodologies

17.2.1 Introduction and data used

The analysis of the social impacts takes into account particular characteristics of consumers from different income groups and is aimed to highlight when and how these particularities have implications in terms of impacts on consumers' welfare. The whole analysis was performed by Ricardo for the European Commission[127].

Income groups

To analyse the potential impacts of different scenarios on consumers, they are split into several consumer groups according to income (five income quintiles)[128]. Each group is characterised in terms of economic characteristics, such as average annual income, average savings[129], interest rates they face, discount rates used for intertemporal analysis; as well as driving behaviour (in this case average annual mileage). **Table 35** shows the average annual disposable income and savings by income quintile expressed in EUR 2020[130]. Within each income quintile, the mean was chosen as the input to the modelling (instead of the median) as it synthetizes the information contained in every observation, so it is more representative of the class as a whole and, by design minimizes prediction errors.

Table 35: Average disposable income and savings by income quintile, EUR 2020

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Average disposable income (EUR 2020)	10,419	18,139	25,228	36,439	55,147
Average savings	1,003	5,513	16,716	55,259	104,234

Source: Ricardo, based on (Eurostat, 2015) and (European Central Bank, 2017)

Access to financing

As **Table 35** shows, consumers in lower income quintiles have lower savings, on average. That is why, to purchase a vehicle, lower income groups are first, more likely to need a loan, and second, more likely to request larger loan amounts, leading to higher loan to income ratios. As lower income limits the capacity to quickly repay the loan, these households will likely need loans with longer maturities.

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127 Ricardo report (to be published)

128 https://ec.europa.eu/eurostat/cache/metadata/en/ilc_esms.htm

129 Average savings reflect total financial assets of each income quintile and include deposits (sight and saving accounts), mutual funds, bonds, shares, money owed to the households, value of voluntary pension plans and whole life insurance policies of household members, and other financial assets items (ECB, 2017).

130 Original data has been sourced from Eurostat and corresponds to year 2015, as the most recent year available with information on average disposable income by income quintile. Ricardo has converted year 2015 data to year 2020 assuming a 2% annual growth rate in average income. This growth rate reflects the observed average growth rate (CARG) in household income over the last decade in EU27 countries.

Importantly, they are also likely to have overall higher debt to assets or debt to income ratios and are less likely to be a homeowner. This translates to, on average, lower credit scores for lower income groups, and higher interest rates as a consequence[131].

Table 36 shows the assumptions on average annualised percentage rate (APR or average interest rate) for different income groups. These assumptions were made using the information on average interest rates for consumption loans across Euro-area Member States published by the ECB[132] and the information from a benchmark of EU Member States online car loan price comparators[133]. Although not all the tools are perfectly comparable, most of them report the best interest rate available on the market and number of different financing options available, based on the requested loan amount, loan maturity and the borrower's credit score, reflected directly in the inputs or through the loan conditions.

Table 36: Interest rate distribution and assumed averages by income quintile

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Assumed average	12.5%	10.0%	7.5%	5.0%	2.5%

Source: Ricardo, based on benchmark of online comparison tools

Great variability of interest rates is observed inside and across different Member States, and future rates may be influenced by different factors[134]. Although the observed ranges were acknowledged, for the purposes of modelling, it was assumed that the interest rate declines monotonously with the income, that is Q1 faces an interest rate of 12.5% and each next quintile sees an interest rate which is 2.5% lower than the previous quintile. This equal-spacing assumption with respect to the interest rate makes the results more illustrative as it avoids placing Q1 and Q2 too closely together and decreases the distance between Q4 and Q5.

Discount rate

Lower income households or individuals are shown to value the present more, when compared to higher income groups[135]. There is no common understanding or a general rule on how to translate differences in individual preferences over time into subjective discount rates. In line with the approach of the EU Reference Scenario 2020, differentiated discount rates are used to analyse different consumer groups (e.g. 11% for cars and 9.5% for vans, acknowledging the difference between households and firms or self-employed professionals).

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131 Although there should not necessarily be causal relationship between credit score and household income, in practice, a strong correlation is observed between these two variables according to the results of 'The Household Finance and Consumption Survey' (European Central Bank, 2017).

132 https://www.euro-area-statistics.org/bank-interest-rates-loans?cr=eur&lg=en&page=0&charts=M..B.A2B.I.R.A.2250.EUR.N+M..B.A2B.F.R.A.2250.EUR.N+M..B.A2B.I.R.A.2250.EUR.N&template=1

133 The information from the following online comparison tools has been collected between 30 November and 9 December 2020:
https://prestiti.segugio.it/prestito-migliore/miglior-prestito-auto.asp
https://finanzas.kelisto.es/prestamos-personales
https://finance.lelynx.fr/credit-consommation/simulation/credit-auto/simulation-credit-auto/comparateur/
https://www.vergleich.de/autokredit-vergleich.html

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

135 Samwick, A. (1998). Discount rate heterogeneity and social security reform. Journal of Development Economics, 57(1): 117-146; and Gustman, A. a. (2005). The social security early entitlement age in a structural model of retirement and wealth. Journal of Public Economics, 89(2-3): 441-463

The academic literature suggests that utility discount rate is higher for the first income quintile (estimates point around 15%), because in general they are composed by more impatient individuals who value current consumption more. The opposite would be true for the 5th quintile individuals, whose discount rate is estimated at 5%. In line with the literature, our methodology assumes a private discount rate of 16% for 1st quintile individuals, 6% for the 5th and applies a linear interpolation for the quintiles in between, being 11% the average. **Table 37** shows subjective discount rate assumptions by income quintile, based on the negative relationship between household income and the discount rate.

Table 37: Subjective discount rate assumptions by income quintile[136]

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Discount rate	16%	13.5%	11%	8.5%	6%

Other assumptions

Mileage assumptions are presented in **Table 38**. Average mileage is assumed to be 13,000 km/year. Although there is no EU statistics on annual mileage by household income, it is recognised internationally that higher income households make more trips and travel more miles than lower income households and the differences are substantial[137].

Assuming higher annual mileages for high income households is also consistent with user group statistics. By economic characteristics of the income groups described above and anticipating the conclusions of affordability analysis, lowest income households are most likely to represent 3rd users, medium income households - 2nd users, and high-income households – 1st users, with 2nd and 4th quintiles falling in between. For this analysis constant mileage assumptions per income group were used to be able to analyse potential choices of a single representative consumer, deciding between different powertrains, segments, user group from subjective point of view.

Table 38: Annual mileage assumptions

	Mileage (km/ year)
ALL	13,000
Q1	8,000
Q2	10,500
Q3	13,000
Q4	15,500
Q5	18,000

[136] Based on: Samwick, A. (1998). Discount rate heterogeneity and social security reform. Journal of Development Economics, 57(1): 117-146; and Gustman, A. a. (2005). The social security early entitlement age in a structural model of retirement and wealth. Journal of Public Economics, 89(2-3): 441-463

[137] https://www.bts.gov/archive/publications/special_reports_and_issue_briefs/special_report/2007_10_03/entire

Table 39: Other assumptions

OEM mark-up	**1.4 ***
Ownership duration	5
Savings spent	90%
Maximum loan quota (% of income)	36%
Maximum loan maturity (years)	5

17.2.2 Methodology

The income dimension and the vehicle dimension were analysed jointly, as consumer behaviour differs significantly across income groups with respect to their choices of segment, powertrain and age of the car. It is also important to consider the fact that the vehicle age groups are interconnected through the market for used cars, where 2nd and 3rd users purchase their vehicles from the 1st and 2nd users respectively. All Q1 and half of Q2 are 1st users, half Q2, all Q3 and half Q4 are 2nd users (purchasing from Q1 and half Q2), and half Q4 and all Q5 are 3rd users (purchasing from Q2, Q3 and Q4 2nd users). This is reflected in the assumptions made with respect to purchase patterns across income groups[138].

For the used cars market to function properly, that is to have a balanced supply and demand for all user groups, different user groups should have sufficiently aligned preferences and incentives. Otherwise, either selling or buying party would obtain higher bargaining power over the other party, with potentially positive implications for some income groups and negative for other groups. .

The analysis of the social impacts looks at the impacts of the options considered on different income groups in terms of (i) affordability of vehicles, and (ii) 'subjective TCO'.

Affordability reflects the variety of vehicle choice available to the consumer groups[139]. It is defined in terms of financial capacity for a given income group compared to the vehicle upfront price. A vehicle model/powertrain/segment is thought to be affordable when a household has enough savings and annual income to be able to repay the loan for upfront capital costs in five years, provided that no more than 36% of annual income can be designated to the loan repayment.

Subjective TCO reflects total costs associated to the ownership of the vehicle. It takes into account income group-specific parameters and is considered in relation to average annual income.

First, affordable options are determined and analysed for each income group, user group and powertrain combination. This analysis gives an overview of choice available to each of the income groups, as the function of their financial capacity.

For the affordable options, two key metrics were calculated for each of the combinations of income quintile, vehicle segment, powertrain, user group and year:

[138] It is implicitly assumed that Q1 and Q2 consumers purchasing new cars are more likely to have more than one car in the household, and that not all cars have 3rd users.

[139] Analysis includes four vehicle segments (Small (S), Lower Medium (LM), Upper Medium (UM), Large (L)), six powertrains (SI+Hybrid, CI+Hybrid, SI PHEV, CI PHEV, BEV, FCEV) and three vehicle age groups (1st user, 0-5 years; 2nd user, 6-10 years; 3rd user, 11-15 years).

- **Extra capital costs** are calculated as discounted sum of interest payments for a loan (when the loan takes place) during the whole loan period until its maturity. Loan amount and interest rates vary across income groups.
- **Subjective TCO** is calculated as discounted sum of purchase price or loan payments, operation, maintenance and insurance costs, fuel costs minus residual value of the vehicle at the end of 5-year ownership period.

These two metrics are compared in the baseline scenario and policy scenarios, in order to conclude about the impacts on consumers.

In addition, some other barriers were considered, combining a range of non-monetary factors that are likely to have unequal impacts for different income groups. The factors assessed include unequal access to off-street parking (and home charging), access to information and the level of consumer awareness about potential monetary savings. These factors are analysed qualitatively.

Extra capital costs

For vehicles with higher initial purchase prices, consumers will require access to higher initial capital, which is more limited for lower income groups.

As long as access to finance and financing conditions are linked to household and/or personal income, lower income groups would find it harder to be able to acquire a car due to credit restrictions. That is, some consumers may not be able to afford a vehicle with lower TCO, some will only be able to do so with a loan, and others will have enough savings to cover the full upfront price.

Those who need a loan would also need to pay interests, which in its turn increases total capital costs that the consumers face over the lifetime/ownership period. Extra capital costs were calculated for each of the combinations as follows:

- First, how much each consumer group can **afford to pay upfront** is calculated assuming that up to 90% of household savings can be used for this first payment[140]. This assumption is made to reflect the fact that households tend to keep a minimum buffer of savings in order to be protected in case of unexpected negative shocks.
- Second, how much needs **to be financed** is calculated as the difference between total upfront costs and the part covered by savings.
- Third, **loan maturity** is determined. It is assumed that up to 36% of household income can be used for loan repayment, following common practice by banks with respect to Debt-to-Income ratio[141]. This maximum quota is used to calculate loan maturity, as the number of periods needed to pay the loan given the payment. If calculated loan maturity is more than 5 years, it is concluded that this particular vehicle model cannot be afforded by the corresponding consumer, as the banks usually do not extend car loans for a longer period. Only for the borrowers with excellent credit score, banks offer longer maturities, up to 7 or 8 years[142]. In the

[140] The assumption that less than 100% of savings can be used was made to reflect the fact that some of the savings can be more difficult to mobilise. The lower is this percentage, the higher loans the consumers will request, and the more interest payments they will face, as the consequence.

[141] 36% debt-to-income ratio has been derived from the benchmark among online resources in the EU and the UK.

[142] 5 years loan maturity has been derived from the benchmark among online resources in the EU and the UK.

model, however, average consumers from higher income quintiles do not need these longer maturities.

- Finally, **extra capital costs** are calculated for the cases when the calculated loan maturity is 5 years or less. Income-group specific interest rate is used to calculate total interest paid until the loan matures. The present value of all those interests paid is calculated using social discount rate of 4%. This social discount rate is used in this case in order to be able to compare total extra capital costs across different income groups.

Subjective TCO

A number of parameters need to be adjusted to depart from TCO calculated for average user and aim at estimating TCO as perceived by each particular income group. In addition to differences in mileage, different consumers have different discount rates, reflecting time patience regarding their cash flows. This exercise essentially will allow to compare potential purchase choices of a representative consumer across powertrains, segments and user groups (1^{st}, 2^{nd} and 3^{rd} user).

Subjective TCO was calculated according to standard TCO formula, but with three modifications:

- In addition to capital costs, extra capital costs described above were incorporated. At the end of user life, it is assumed that the vehicle is sold and subtract residual value of the vehicle.
- For variable costs, fuel costs are calculated using user-specific annual mileage.
- User-specific discount rate is used to calculate present value of future loan payments, fuel costs and operation, maintenance and insurance costs. Discount rates are income-group specific in this case, in order to better reflect preferences and decisions of each income group regarding different powertrains. Higher discount rates for lower income groups mean that these groups value future fuel savings less and upfront capital costs more compared to higher income groups.

Non-financial barriers

It has been already mentioned access to credit representing a financial barrier for some income groups and costs associated with home xEV charging being important determinants of TCO. There are, however, also non-financial barriers for xEV uptake for some income groups.

High income groups are more likely to have access to off-street parking, compared to lower income groups. As long as home charging is cheaper than public charging (and it usually is, in part, due to electricity prices and charging profiles, and in part because of the infrastructure costs), lower income groups will not be able to enjoy the TCO savings of xEV vehicles fully, as the part of savings will not be present due to higher electricity costs, compared to households with private parking and charging points.

Other non-financial barriers that may limit uptake of alternative powertrains for lower income households, despite of them being affordable financially and having lower TCO, may include access to information and luck of consumer awareness about potential savings.

17.3 Fuel Crediting System – Assumptions and Methodologies for the economic impacts

Introduction and data used

A cost impact analysis was carried out for the option FUEL2, on the basis of various cost scenarios for low-carbon fuels (LCF), to assess the cost impact for the manufacturer, as well as for the vehicle users and society[143].

Methodology and Assumptions

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

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

To estimate the amount of LCF credits that an OEM needs to buy, a frontloading approach is considered, which ensures that enough credits are available for the entire lifetime of the vehicles. For these calculations, A lifetime mileage of 200,000 km (passenger cars) and 240,000 km (vans) is assumed for all vehicle segments. In the cost calculations, the RFNBO emission factors used are all are significantly better than this compliance threshold.

In order to determine the level of emission savings from additional quantities of LCF, the GHG emission values according to the RED calculation methodology[144] are used, i.e. the emission reduction is calculated from the difference between the respective LCF and the RED fossil comparator of 94.1 g CO_2e/MJ. For the RFNBO, the GHG emission calculation methodology is not yet defined. In order to qualify for LCF emission savings crediting, fuels must at least comply with the RED II crediting threshold. This is a 70% GHG reduction compared to the fossil comparator. In the cost calculations, it is assumed that the RFNBO emission factors are significantly lower than this threshold.

Production costs estimates for biofuels used in the analysis are based on literature review[145], and they consider ranges for different feedstocks and processes.

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[143] Technical support for analysis of some elements of the post-2020 CO_2 emission standards for cars and vans (Ricardo, 2021)

[144] Apart from biomethane (SNG) produced from gasification of wood, where no value is available. For this production route, data is taken from JRC Publications Repository - JEC Well-to-Tank report v5 (europa.eu)-, which employs a similar methodology to REDII.

[145] Sources:

(1) https://www.dbfz.de/fileadmin/user_upload/Referenzen/DBFZ_Reports/DBFZ_Report_11_4.pdf

(2) https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailDoc&id=33288&no=1

(3) https://www.ieabioenergy.com/wp-content/uploads/2013/10/IEA-Biofuel-Roadmap.pdf

(4) https://www.e4tech.com/uploads/files/e4tech/resources/127/E4tech_ICLE_Final_Report_Dec17.pdf

For well-established production routes (FAME, HVO and bioethanol from starch and sugar crops) which are commercially mature, costs estimates are generally consistent across sources, and the same production costs are therefore taken for all three price scenarios.

In the case of advanced biofuels (lignocellulosic bioethanol and gasification + Fischer Tropsch routes for production of gasoline and diesel), as the technology is not commercially mature, a wider range of cost estimates are found in the literature. These are partly driven by assumptions about capital costs but also by differing assumptions about the exact feedstock and price of that feedstock. For these fuels a low and high price are therefore used.

For biomethane, the low cost estimate reflects a typical cost for biomethane produced via an anaerobic digestion route. The high and very high costs reflect production via a gasification route; the latter may be required if use of biomethane (both in the transport sector and to decarbonise gas supply in other sectors) increases significantly in the future as the potential for sustainably produced anaerobic digestion from biomethane may be limited by the availability of waste feedstocks. The costs have been adjusted to 2020 prices where necessary.

Concerning the production costs of RFNBO diesel and petrol, though many of the necessary processes are well developed and are used in industrial processes today, no complete industrial-scale process chain is available today. Demonstration-scale plants exist, and the first small-scale industrial plants are being built. The commissioning of the first large-scale industrial plants capable of producing larger quantities of RFNBO is not expected until the end of the 2020s due to the development and construction times[146] [147]. Accordingly, this type of LCF would only be available for larger emission savings crediting at that time.

The production costs of RFNBO[148] [149] today are multiple times the costs of fossil fuels. Due to decreasing investment costs, especially for electrolysers, increasing process efficiency and decreasing electricity generation costs, the production costs of RFNBO can be expected to decrease significantly over time. However, the expected cost range of different studies and scenarios is considerable, so that ranges are considered in the following cost considerations in order to depict different possible cost developments.

The same assumptions are also used for the user and societal perspective, through the calculation of the total cost of ownership (TCO). This includes not only the technology costs that are decisive for the manufacturer to comply with the CO_2 emission standards and that are reflected in the purchase price of the vehicles, but also the costs that arise during the use of the vehicles. These consist of the costs for the fuel or electricity used as well as O&M costs for insurance, vehicle taxes and vehicle maintenance. The additional technology costs compared to an ICEV, which are caused by either the crediting of emission savings from LCF or an additional BEV, are part the cost comparison from the user's and the societal perspective between the two possible compliance strategies of the

146 Ausfelder, F., & Dura, H. (2019). Optionen für ein nachhaltiges Energie-System mit Power-to-X-Technologien. Nachhaltigkeitseffekte - Potenzial Einsatzmöglichkeiten. Frankfurt am Main.

147 NPM. AG 1 "Klimaschutz im Verkehr". (2020). Werkstattbericht Alternative Kraftstoffe. Klimawirkungen und Wege zum Einsatz Alternativer Kraftstoffe. Berlin.

148 Frontier Economics. (2018). The Future Cost of Electricity-Based Synthetic Fuels. Agora Energiewende; Agora Verkehrswende.

149 Prognos AG. (2020). Kosten und Transformationspfade für strombasierte Energieträger. Endbericht zum Projekt "Transformationspfade und regulatorischer Rahmen für synthetische Brennstoffe".

manufacturer. In these calculations it is also considered that both strategies have the same emission reduction impact for meeting the CO_2 emission standards.

17.4 Life-cycle analysis (LCA) approaches

A study titled "**Determining the environmental impacts of conventional and alternatively fuelled vehicles through Life-Cycle Assessment (LCA)**", was initiated in 2017 as a pilot project requested by the European Parliament. It was undertaken by a consortium led by Ricardo on behalf of DG Climate Action.

The full report and accompanying documents and datasets can be found here: https://ec.europa.eu/clima/policies/transport/vehicles_en#tab-0-1

The aim of the study was to improve the understanding of the environmental impacts of road vehicles and the methodologies to assess them. It had two main objectives:

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

The assessment of impacts included 14 different impact categories, ranging from impacts associated with airborne emissions (e.g. the mid-point indicator GWP for greenhouse gas emissions) to impacts from resource use.

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

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

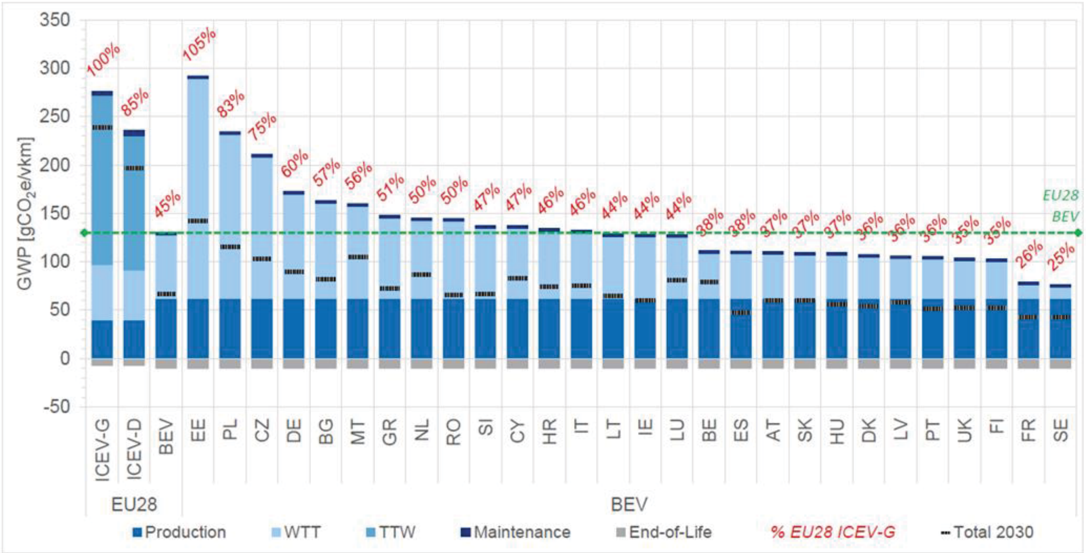
However, the methodology developed is not immediately suited for calculating the individual lifecycle emissions of individual vehicles, which would require an even more detailed and disaggregated approach.

In broad terms, the analysis shows that xEV powertrains have significantly lower environmental impacts across all vehicle types and most impact categories, with BEVs consistently performing better than all other powertrains. The higher impacts in some categories for xEVs (e.g. abiotic resource depletion, minerals and metals) are generally due to the use of particular materials (particularly copper and electronic components). The analysis also demonstrates that xEV benefits in terms of lower environmental impacts vary depending on regional and operational circumstances

The dataset allows for the further investigation of individual impacts, as well as for comparing across different impact categories. This is shown inFigure 39, which illustrates GHG impacts of lower medium cars (market segment C), comparing ICEV (EU average) and BEV (EU and MS averages). It shows that the average EU lifecyle GWP impact of a BEV in 2020 is around 45% of that of a gasoline car (ICEV-G) and 53% of a diesel car (ICEV-D). For all MS except Estonia the BEV scores better than the ICEV. In 2030, the difference becomes even bigger as the electricity mix becomes more decarbonised.

Figure 39: Comparing the GHG impacts of lower medium cars

Figure ES5: Comparison of Lower Medium Car lifecycle GWP impacts for conventional gasoline/diesel ICEVs and BEVs for different EU countries, Baseline scenario. Breakdown shown for new 2020 vehicles, and the total only for new 2030 vehicles.



Notes: Results shown for the lower medium car in the baseline scenario. Production = production of raw materials, manufacturing of components and vehicle assembly; WTT = fuel/electricity production cycle; TTW = impacts due to emissions from the vehicle during operational use; Maintenance = impacts from replacement parts and consumables; End-of-Life = impacts/credits from collection, recycling, energy recovery and disposal of vehicles and batteries. Additional information on key input assumptions and derived intermediate data include the following: a lifetime activity of 225,000 km over 15 years. 2020 BEV battery of 58 kWh, with 300km WLTP range (and with 64 kWh and 460 km WLTP electric range for 2030); an average lifetime EU28 fuel/electricity mix (age-dependant mileage weighted). No battery replacement is needed for BEVs.

The results of the analysis generally confirm the ongoing EU policy approach to move to a more circular economy and the initiatives aimed at developing a sustainable value chain for xEV batteries in Europe and driving down industrial emissions. There are also further opportunities to improve existing policy instruments, e.g. related to battery re-use or recycling, as well as finding ways to further incentivise improvements in the operational energy efficiency of powertrains.

17.5 Announcement by car manufacturers on zero emission vehicles

This annex presents information on recent announcement by car manufacturers, on the basis of publicly available information and sources (see **Table 40** below).

Table 40: Announcement of car manufacturers on zero-emission vehicles

Manufacturer	Announcements	Type of vehicles	Year
Volvo Cars	50% 100%	BEV BEV	2025 2030
Volkswagen group ***Volkswagen*** ***Porsche*** ***Audi***	 *More than 70%* *100%* *100%* *100%*	 *BEV* *BEVBEV, PHEV,* *HEV* *BEV*	 *2030* *2035* *2030* *2033*
General Motors	100%	BEV	2035
Jaguar Land Rover ***Jaguar***	100% *100%*	BEV, PHEV(unclear) *BEV, PHEV*	2030 *2025*
Ford	100% 100%	BEV, PHEV Only BEV	2026 2030
Stellantis	70%	BEV, PHEV	2030
BMW ***Mini***	At least 50% *100%*	BEV *BEV*	2030 *2030*
Nissan	100%	BEV, PHEV, HEV	2030
Renault Group (Renault brand)	65% 90%	ZEV, PHEV, HEV ZEV, PHEV, HEV	2025 2030
Daimler	Up to 25%	BEV	2025
Honda	100%	BEV, PHEV, HEV	2040
Toyota	1 million BEV globally	BEV	2030

Volkswagen Group[150]

- All-electric vehicles expected to exceed 70% of European sales by 2030. To achieve this, Volkswagen will bring out at least one new BEV model every year (according to ACCELERATE Strategy)[151]. Volkswagen will stop selling cars with combustion engines in Europe by 2035[152].
- Audi brand: By the middle of the coming decade, Audi to sell about a million electrified cars each year[153]. Starting in 2026, Audi will only launch new all-electric models on the global market, and will phase out the production of the last internal combustion engines by 2033[154].

[150] https://www.volkswagenag.com/en/news/stories/2020/10/29-climate-measures-of-the-volkswagen-group.html
[151] https://www.volkswagen-newsroom.com/en/press-releases/volkswagen-is-accelerating-transformation-into-software-driven-mobility-provider-6878
[152] https://www.reuters.com/business/sustainable-business/vw-end-sales-combustion-engines-europe-by-2035-2021-06-26/
[153] https://www.audi.com/en/company/strategy.html
[154] https://www.audi-mediacenter.com/en/press-releases/audi-ceo-duesmann-at-berlin-climate-conferenceaccelerated-transition-to-e-mobility-14069

- Porsche brand: all electrified (ZEV, PHEV, HEV) by 2030[155].

Volvo[156]

- Fully electric by 2030, phasing out any car in its global portfolio with an internal combustion engine, including hybrids.
- By 2025, 50% of global sales fully electric cars, rest hybrids.

Stellantis (merger PSA, FCA)

- 70% of the vehicles sold in EU in 2030 electric (including PHEVs)[157].
- The Group has announced that an electrified version (BEV and PHEV) is to be offered for 98 per cent of its models in Europe by 2025. By 2030, there will be at least one battery-electric version for all models[158].

Group Renault

- According to its new Climate Plan[159], the Renault Group plans to sell 65% electrified vehicles (BEV, PHEV, Hybrid Electric Vehicles) of the Renault brand by 2025, and 90% by 2030 (other brands such as Dacia are not covered by this announcement).[160]

BMW

- Fully electric models to account for at least 50 percent of global deliveries by 2030[161].
- Mini brand: MINI to become a fully electric brand by the early 2030s.
- BMW is aiming to have more than seven million EVs on roads by the end of the decade – two-thirds of them being pure-electric. It will launch five pure-electric vehicles by the end of 2021 and additional models in the coming years, resulting in a portfolio of 25 EV models by the end of 2023[162].

Daimler

- 2025: Up to 25 percent of unit sales to be accounted for by all-electric vehicles (depending on the framework conditions)[163].
- Daimler official website states: “We are convinced that diesel will continue to be a fixed element of the drive-system mix in the future, not least due to their low CO_2 emissions. It makes more sense to improve diesel than to ban it, because the

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[155] https://www.bloomberg.com/news/articles/2021-02-07/most-porsche-sales-will-be-electric-vehicles-by-2030-bild-says
[156] https://www.media.volvocars.com/global/en-gb/media/pressreleases/277409/volvo-cars-to-be-fully-electric-by-2030
[157] https://www.electrive.com/2021/04/18/stellantis-reveals-key-details-of-electrification-plans/
[158] https://www.electrive.com/2021/04/18/stellantis-reveals-key-details-of-electrification-plans
[159] https://www.renaultgroup.com/wp-content/uploads/2021/04/rapport-climat-renault-group.pdf
[160] https://fr.media.groupe.renault.com/actualites/renault-group-inscrit-sa-strategie-environnementale-et-societale-au-coeur-de-sa-performance-d46d-e3532.html
[161] https://www.press.bmwgroup.com/global/article/detail/T0327929EN/a-new-era-a-new-class:-bmw-group-steps-up-technology-offensive-with-comprehensive-realignment-%E2%80%93-uncompromisingly-electric-digital-and-circular
[162] From Audi to Volkswagen: How are big carmakers approaching the EV transition? (edie.net)
[163] https://www.daimler.com/sustainability/climate/ambition-2039-our-path-to-co2-neutrality.html

biggest lever for reducing consumption and emissions is still the energy-efficient combustion engine. It will remain the backbone of our mobility for many years to come."[164].

Toyota

- To reduce the CO2 emissions from vehicles by 90 per cent by 2050, compared to the levels in 2010[165]. (Promote the development of next-generation vehicles with low or zero carbon emissions: HEV, PHEV, BEV and FCEV, making conventionally powered models more fuel-efficient).
- By 2030 to annually sell more than 5.5 million electrified vehicles around the world, including more than 1 million zero-emission vehicles (battery electric and fuel cell electric vehicles).

JLR (Jaguar + Land Rover)[166]

- JLR to go entirely electric by 2030 (most likely BEV, PHEV but definition unclear).
- Jaguar brand will be entirely electric by 2025.

Ford

- All electric by 2030[167] (BEV).

General Motors:

- Eliminate tailpipe emissions from new LDVs by 2035[168]

Honda

- All electrified vehicles (BEV, PHEV and HEV) by 2040[169].

Nissan:

- Nissan aims to electrify (BEV, PHEV and HEV) all new models launched in major markets by the early 2030s[170].

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164 https://www.daimler.com/innovation/diesel/en/
165 https://www.toyota-europe.com/world-of-toyota/feel/environment/environmental-challenge-2050
166 https://media.jaguar.com/news/2021/02/jaguar-land-rover-reimagines-future-modern-luxury-design
167 https://media.ford.com/content/fordmedia/fna/us/en/news/2021/02/17/ford-europe-goes-all-in-on-evs.html
168 https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/jan/0128-carbon.html
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18 ANNEX 9: 2030 CLIMATE TARGET PLAN POLICY CONCLUSIONS

The Communication on stepping up Europe's 2030 climate ambition - the Climate Target Plan (CTP)[171] and its underpinning impact assessment are the starting point for the initiatives under the Fit for 55 package.

The plan concluded on the feasibility - from a technical, economic and societal point of view - of increasing the EU climate target to 55% net reductions of greenhouse gases (GHG) emissions by 2030 compared to 1990. It also concluded that all sectors need to contribute to this target.

In particular, with energy supply and use responsible for 75% of emissions, the plan put forward ambition ranges for renewables and energy efficiency, which correspond in a cost-efficient manner to the increased climate target. The climate target plan also established that this increase in climate and energy ambition will require a full update of the current climate and energy policy framework, undertaken in a coherent manner.

As under the current policy framework, the optimal policy mix should combine, at the EU and national levels, strengthened economic incentives (carbon pricing) with updated regulatory policies, notably in the field of renewables, energy efficiency and sectoral policies such as CO_2 standards for new light duty vehicles. It should also include the enabling framework (research and innovation policies, financial support, addressing social concerns).

While sometimes working in the same sectors, the policy tools vary in the way they enable the achievement of the increased climate target. The economic incentives provided by strengthened and expanded emissions trading will contribute to the cost-effective delivery of emissions reductions. The regulatory policies, such as the Renewable Energy Directive (RED), the Energy Efficiency Directive (EED), the Regulation on CO_2 standards for vehicles supported by the Directive on the alternative fuels infrastructure, and the Re(FuelEU) aviation and maritime initiatives, aim at addressing market failures and other barriers to decarbonisation, but also create an enabling framework for investment, which supports cost-effective achievement of climate target by reducing perceived risks, increasing the efficient use of public funding and helping to mobilise and leverage private capital. The regulatory policies also pave the way for the future transition needed to achieve the EU target of the climate neutrality. Such a sequential approach from the CTP to the Fit for 55 initiatives was necessary in order to ensure coherence among all initiatives and a collective delivery of the increased climate target.

With the "MIX" scenario, the impact assessment included a policy scenario that largely reflects the political orientations of the plan.

The final calibration between the different instruments is to be made depending, *inter alia* on the decision on the extension of emissions trading beyond the maritime sector and its terms.

Table 41 below shows the summary of the key CTP findings:

[171] COM (2020) 562 final.

Table 41: Key policy conclusions of the Climate Target Plan

POLICY CONCLUSIONS IN THE CTP	
GHG emissions reduction	• At least 55% net reduction (w.r.t. 1990) • Agreed by the European Council in December 2020 • Politically agreed by the European Council and the European Parliament in the Climate Law
ETS	• Corresponding targets need to be set in the EU ETS and the Effort Sharing Regulation to ensure that in total, the economy wide 2030 greenhouse gas emissions reduction target of at least 55% will be met. • Increased climate target requires strengthened cap of the existing EU ETS and revisiting the linear reduction factor. • Further expansion of scope is a possible policy option, which could include emissions from road transport and buildings, looking into covering all emissions of fossil fuel combustion. • EU should continue to regulate at least intra-EU aviation emissions in the EU ETS and include at least intra-EU maritime transport in the EU ETS. • For aviation, the Commission will propose to reduce the free allocation of allowances, increasing the effectiveness of the carbon price signal in this sector, while taking into account other policy measures.
ESR	• Corresponding targets need to be set in the Effort Sharing Regulation and under the EU ETS, to ensure that in total, the economy wide 2030 greenhouse gas emissions reduction target of at least 55% will be met.
LULUCF	• Sink needs to be enhanced. • Agriculture forestry and land use together have the potential to become rapidly climate-neutral by around 2035 and subsequently generate removals consistent with trajectory to become climate neutral by 2050.
CO2 standards for cars and vans	• Transport policies and standards will be revised and, where needed, new policies will be introduced. • The Commission will revisit and strengthen the CO_2 standards for cars and vans for 2030. • The Commission will assess what would be required in practice for this sector to contribute to achieving climate neutrality by 2050 and at what point in time internal combustion engines in cars should stop coming to the market.
Non-CO2 GHG emissions	• The energy sector has reduction potential by avoiding fugitive methane emissions. The waste sector is expected to strongly reduce its emissions already under existing policies. Turning waste into a resource is an essential part of a circular economy, as is prevention of waste, addressed by both Circular Economy and the Zero Pollution Action Plans. Under existing technology and management options, agriculture emissions cannot be eliminated fully but they can be significantly reduced while ensuring food security is maintained in the EU. Policy initiatives have been included in the Methane Strategy.

Renewables	• 38-40% share needed to achieve increased climate target cost-effectively. • Renewable energy policies and standards will be revised and, where needed, new policies will be introduced. • Relevant legislation will be reinforced and supported by the forthcoming Commission initiatives on a Renovation Wave, an Offshore Energy strategy, alternative fuels for aviation and maritime as well as a Sustainable and Smart Mobility Strategy. • EU action to focus on cost-effective planning and development of renewable energy technologies, eliminating market barriers and providing sufficient incentives for demand for renewable energy, particularly for end-use sectors such as heating and cooling or transport either through electrification or via the use of renewable and low-carbon fuels such as advanced biofuels or other sustainable alternative fuels. • The Commission to assess the nature and the level of the existing, indicative heating and cooling target, including the target for district heating and cooling, as well as the necessary measures and calculation framework to mainstream further renewable and low carbon based solutions, including electricity, in buildings and industry. • An updated methodology to promote, in accordance with their greenhouse gas performance, the use of renewable and low-carbon fuels in the transport sector set out in the Renewable Energy Directive. • A comprehensive terminology for all renewable and low-carbon fuels and a European system of certification of such fuels, based notably on full life cycle greenhouse gas emissions savings and sustainability criteria, and existing provisions for instance in the Renewable Energy Directive. • Increase the use of sustainably produced biomass and minimise the use of whole trees and food and feed-based crops to produce energy through inter alia reviewing and revisiting, as appropriate, the biomass sustainability criteria in the Renewable Energy Directive,
Energy Efficiency	• Energy efficiency policies and standards will be revised and, where needed, new policies will be introduced. • Energy efficiency improvements will need to be significantly stepped up to around 36-37% in terms of final energy consumption[172]. • Achievement of a more ambitious energy efficiency target and closure of the collective ambition gap of the national energy efficiency contributions in the NECPs will require actions on a variety of fronts. • Renovation Wave will launch a set of actions to increase the depth and the rate of renovations at single building and at district level, switch fuels towards renewable heating solutions, diffuse the most efficient products and appliances, uptake smart systems and building-related infrastructure for charging e-vehicles, and improve the building envelope (insulation and windows). • Action will be taken not only to better enforce the Energy Performance of Buildings Directive, but also to identify any need for targeted revisions. • Establishing mandatory requirements for the worst performing buildings and gradually tightening the minimum energy performance requirements

[172] The Impact Assessment identifies a range of 35.5% - 36.7% depending on the overall design of policy measures underpinning the new 2030 target. This would correspond to a range of 39.2% - 40.6% in terms of primary energy consumption.

	will also considered.