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To:	Ms Thérèse BLANCHET, Secretary-General of the Council of the European Union
No. Cion doc.:	SWD(2025) 1058 annex
Subject:	PART 2/2 COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT REPORT Accompanying the document Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2019/631 as regards CO_2 emission performance standards for new light duty vehicles and vehicle labelling and repealing Directive 1999/94/EC

Delegations will find attached document SWD(2025) 1058 annex.

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Strasbourg, 16.12.2025
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PART 2/2

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Regulation of the European Parliament and of the Council

amending Regulation (EU) 2019/631 as regards CO2 emission performance standards for new light duty vehicles and vehicle labelling and repealing Directive 1999/94/EC

{COM(2025) 995 final} - {SEC(2025) 995 final} - {SWD(2025) 1057 final} - {SWD(2025) 1059 final}

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ANNEX 1: PROCEDURAL INFORMATION

1. LEAD DG, DECIDE PLANNING/CWP REFERENCES

The Directorate-General for Climate Action is the lead service for the preparation of the initiative (PLAN/2025/1582[1] and PLAN/2025/1583[2]) and the work on the impact assessment.

2. ORGANISATION AND TIMING

An inter-service steering group (ISG) was set up in 2025 with the participation of the following Commission Services and Directorates-General: SG, LS, BUDG, ECFIN, EMPL, ENV, ESTAT, GROW, JRC, JUST, MOVE, REGIO, RTD, TAXUD, TRADE, COMP.

The ISG met a first time on 12 June 2025 and again on 10 November 2025, when the draft impact assessment was presented.

3. CONSULTATION OF THE RSB

The Regulatory Scrutiny Board received the draft version of the present impact assessment report on 3 December 2025. Following its examination, the Board issued a 'Positive with reservations' opinion on 10 December 2025.

The Board's raised the following key issues and these were addressed in the revised impact assessment report as indicated below.

RSB key issues	**Response**
(1) The problem, its magnitude and underlying causes are not clearly defined. The underlying causes for the slow uptake of ZEVs and the risk and consequences of not meeting the CO_2 targets are not sufficiently analysed.	The intervention logic has been improved by reformulating several problems and adding more details in their description and that of the drivers behind them, including on the root causes of the perceived risks. See sections 2.1 and 2.2
(2) The report is not sufficiently clear and evidence-based on the range of considered options and the choice of options.	The choice of options and their combinations has been better explained, also by adding clearer references to the views expressed by stakeholders. See notably section 5.2.5
(3) The combined effects of the measures are not sufficiently assessed.	Additional analysis has been provided as regards the impacts of the combinations of

[1] Revision of the CO_2 emission standards for cars and vans (Regulation (EU) 2019/631)
[2] Revision of the Car Labelling Directive 1999/94/EC

It is not clear how and to what extent the initiative will address challenges related to the competitiveness of industries in its scope and their ability to invest in transition.	options considered, and the impact on competitiveness. See section 6.3 and Annex 5
(4) The assessment of costs and benefits is incomplete. The analysis on proportionality is not sufficient.	The costs and benefits analysis has been expanded and the results used for the comparison of the options. The findings as regards proportionality have been better explained. See sections 6 and 7

4. 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 with the PRIMES and PRIMES-TREMOVE models. This analysis was complemented by applying other modelling tools, such as GEM-E3 (for the macro-economic impacts) and the JRC DIONE model developed for assessing impacts at end user and societal level.

Monitoring data on CO_2 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.

Additional details are provided in Annex 4.

ANNEX 2: STAKEHOLDER CONSULTATION (SYNOPSIS REPORT)

1. INTRODUCTION

The following relevant stakeholder groups have been identified:

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

The Commission sought feedback from stakeholders through the following elements:

- a call for evidence and a public on-line consultation (from 7 July until 10 October 2025);
- 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, an overviuew of the additional comments provided by respondents and the feedback to the call for evidence are presented below.

2. PUBLIC CONSULTATION

An on-line public consultation was carried out between 7 July and 10 October 2025 on the EU Survey website[3]. The consultation covered both the review of the LDV CO_2 standards Regulation and the review of the Car Labelling Directive.

The analysis of the replies follows the structure of the original questionnaire.

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 1115 replies, of which 77% (841) were from EU citizens, and one (0.1%) response came from a non-EU citizen. Industry respondents contributed the next highest number, as 120 (11% of the total) responses were from a company / business, of which 57 (5%) were from SMEs, and a further 76 (7%) replies came from business associations. In the following text, 'large industry' refers to responses from large companies (i.e. those that are not SMEs) and business associations grouped together. Over half of the business associations, and nearly a third of the companies, that responded were

[3] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14765-Revision-of-the-CO2-emission-standards-for-cars-and-vans_en

from the supply sector. Half of the 10 responses from public authorities (1%) came from national bodies covering five Member States, with the remaining responses being from individual cities (three), a region (one) and a city network[4]. The remaining 4% of responses were split between NGOs (14, 1%), academic/research institutions (12, 1%), consumer organisations (9, 1%) and 'other' (10, 1%), with the remaining four (0.4%) coming from trade unions. The breakdown by category is presented in Table 1.

Table 1: Distribution of respondents by category

Category	**Number of respondents**	**Percentage of total number of respondents**
EU citizen	859	77%
Of which from Italy	*805*	*72%*
Non-EU citizen	1	0.1%
Company/business	120	11%
Of which SMEs	*57*	*5%*
Of which electricity supply sector	*5*	*0.4%*
Of which fuel suppliers	*30*	*3%*
Of which manufacturers	*18*	*2%*
Business association	76	7%
Of which electricity supply sector	*11*[5]	*1%*
Of which fuel suppliers	*23*[6]	*2%*
Of which manufacturers	*4*[7]	*0.4%*
Public authority	10	1%
NGO (Non-governmental organisation)	14	1%
Academic/research institution	12	1%
Consumer organisation	9	1%
Trade union	4	0.4%
Other	10	1%
Total	**1,115**	**100%**

The majority of responses came from respondents based in Italy (80%, 894), followed by Germany (6%, 72), Belgium (4%, 46), France (2%, 23), Spain (1%, 12), the Netherlands (1%, 7). No responses were received from seven Member States: Croatia, Cyprus,

[4] Belgium, Ireland, Italy, Latvia and Spain.
[5] Representing EU level and national associations from Belgium, France, Germany and the Netherlands.
[6] Representing EU level and national associations from Finland, France, Germany, Italy, Portugal, Spain and Sweden.
[7] Representing EU level and national associations from Italy and Germany.

Denmark[8], Estonia, Lithuania, Malta and Romania. In addition, responses were received from stakeholders in other countries, including the United Kingdom (1%, 11).

The high number of responses from citizens from Italy (805) compared to 54 replies from citizens from other EU countries suggested that there was at least one campaign in Italy to encourage people to respond to the consultation. Consequently, responses from Italian citizens have been treated and reported upon separately.

Respondents were asked to rank a list of ***needs that the Regulation should address***. For the ranking questions, a response was considered to have the first, second or third 'highest score' if it received the first, second or third highest number of first and second rankings combined. The "need to reduce CO_2 emissions from road transport in line with the climate neutrality objective" scored the highest, as it was ranked either first or second by nearly half of Italian citizens (45%, 360 out of 805) and a majority of the remaining respondents (59%, 184 out of 310). The second highest scoring need amongst Italian citizens was "increased investments in innovative zero-emission technologies", as this was ranked either first or second by a third of Italian citizens (34%, 271 out of 805). The need to "strengthen the competitiveness and industrial leadership of the EU automotive industry" was the second highest scoring amongst the remaining respondents (38%, 117 out of 310). For those respondents elaborating on other measures that might be needed, the most common response from around 35 industry respondents, particularly from fuel suppliers, was to take a life cycle/technology neutral approach that allowed for the consideration of carbon neutral, or renewable, fuels.

The survey asked respondents to rank ***market barriers that existed for the further uptake of zero emission vehicles***. Limited affordability, as a result of the high purchase price, received the highest score, both amongst Italian citizens (39%, 312 out of 805) and the remaining respondents (47%, 146 out of 310). Other high scoring barriers were "limited availability of recharging and refuelling infrastructure", both from Italian citizens (33%, 266 out of 805) and the other respondents (25%, 77 out of 310), "fossil fuel subsidies", especially from Italian citizens (38%, 303 out of 805), and "high price of electricity" and "lack of adequate information or misinformation", especially from the other respondents (23% (70 out of 310) and 22% (69 out of 310)).

Respondents were given the opportunity to suggest other markets barriers than those listed in the survey. Of the 68 additional suggestions from non-Italian citizens, around one third (24) mainly industry (and particularly fuel suppliers) respondents mentioned the lack of ability to use other means of reducing CO_2 emissions from road transport, such as carbon neutral fuels. In addition, various industry respondents mentioned uncertainty around different aspects of battery electric vehicles (BEVs), including their total cost of ownership (nine), their residual value (four) and inability to meet the needs of all of customers (seven).

When asked to rank ***additional measures needed to make zero emission car and vans more attractive to customers and businesses***, the highest scoring measure amongst Italian citizens was "EU coordinated incentive schemes for ZEV purchase" (37%, 298 out of 805) followed by "measures to lower the cost of vehicle batteries" and "social leasing schemes

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[8] A separate response was submitted by the Danish Government.

targeting lower-income users" (both 33%, 266 out of 805). Amongst the remaining respondents, the highest score was for "EU coordinated incentive schemes for ZEV purchase" (34%, 106 out of 310), followed by a favourable fiscal regime (29%, 91 out of 310).

Amongst the non-Italian citizens providing additional information (63) or explaining their response (137), 27 industry respondents, particularly fuel suppliers called for measures to support the introduction of renewable or carbon-neutral fuels, with other industry respondents calling for support for particular fuels, such as biomethane or hydrogen, in view of their potential to reduce CO_2 emissions from ICE vehicles. Some additional measures on BEVs were suggested, including measures to strengthen consumer confidence in second-hand BEVs (22, including industry, consumer organisations and NGOs), to make BEVs more affordable (seven, particularly NGOs and companies involved in electricity supply) and to have a local content requirement (a manufacturer and a couple of trade unions). A number of consumer organisations and NGOs called for social leasing and incentives targeting smaller BEVs in order to enable more people to buy BEVs. Among Italian citizens, many raised potential issues with electric cars, variously arguing that a focus on electric cars ignored the emissions from electricity production, that other fuels would be more appropriate or that measures should not interfere with the market. On the other hand, some proposed measures in support of electric cars, including measures to bring down the costs of both car purchasing and electric vehicle charging, as well as the importance of the latter being more widely available, faster and more convenient, were raised.

Respondents were asked for their views on the "***additional measures [that] should be set up to ensure a socially acceptable and just transition towards zero-emission mobility***". Responses typically re-iterated comments made in responses to previous questions.

In response to a question on the ***additional measures needed to promote a resilient and sustainable automotive value chain in Europe***, respondents identified "further promoting the use of sustainable renewable fuels in internal combustion engine vehicles" (Italian citizens: 41%, 328 out of 805 and other respondents: 43%, 133 out of 310) and "stable long term industrial strategy for the value chain" (Italian citizens: 35%, 284 out of 805 and other respondents: 37%, 114 out of 310) as the most important ones. For Italian citizens, the third highest scoring measure was "stronger research and innovation investments in the European automotive sector" (34%, 273 out of 805), while for other respondents this was "incentivise investments into an EU battery value chain" (28%, 86 out of 310).

Using the opportunity to provide additional information or to explain their response, many fuel suppliers called for measures to create the right framework conditions to de-risk investment in renewable fuel production. NGOs and academics called for an environmental label, or European Eco-score system, to demonstrate the environmental performance of vehicles. Some industry respondents called for support for research and development/innovation. Amongst Italian citizens, there were calls for the abandonment of the target, a focus on other fuels, more incentives and support for research and innovation. The importance of investing in, incentivising or even legislating the recycling of batteries was also mentioned mainly by industry respondents in order to improve circularity.

Support for ***keeping the 2035 CO_2 emissions targets for cars and vans unchanged*** varied significantly amongst the respondents. Whereas only 19% (144 out of 775; 30 no responses) of Italian citizens wanted to keep the 2035 targets unchanged, this the case for a majority of the other respondents (52%, 132 out of 255; 55 no responses). Also, most academics, NGOs and those involved in the electricity supply sector called for the targets to be maintained in their current form, in order to provide certainty for investors and industry, as well as to ensure that the EU's climate neutrality targets could be met.

The respondents answering "No" to the question "should the EU keep targets on 2035 CO_2 emission level for cars and vans unchanged" were asked what ***should be changed***. For both cars and vans, the highest scoring response amongst Italian citizens was for the ***100% target to be postponed*** (for cars: 38%; 242 out of 630; one no response[9]; for vans: 39%; 243 out of 627; four no responses). For the remaining respondents, the highest scoring answer was 'Other' (for cars: 48%; 53 out of 111; for vans: 44%; 49 out of 112; 12 and 11 no responses, respectively). In clarifying what 'other' change they would suggest, many fuel suppliers and vehicle manufacturers (large and small) called for a technology neutral approach and/or the use of a lifecycle approach (LCA), arguing that this would allow industry to meet the CO_2 reduction targets taking account of a wider range of technologies, such as renewable fuels and biofuels. Some industry respondents argued that the current targets would otherwise not be achievable, given the slower than expected uptake of BEVs.

The survey asked respondents to indicate their level of agreement with statements ***regarding the need for additional flexibilities from 2030 to help CO_2 target compliance***. A majority of Italian citizens (69%, 454 out of 712; 93 no responses), SMEs (27 out of 41; 16 no responses) and large industry (62 out of 85; 54 no responses) *disagreed*[10] with the statement "There is no need for additional flexibilities". A majority of the public authorities (four out of five; four no responses), 'Other' respondents (including NGOs, consumer organisations and trade unions; 25 out of 43; six no responses) and non-Italian citizens (25 out of 45; 10 no responses) *agreed*[11] that there was no need for additional flexibilities.

In terms of the ***additional flexibilities needed***, only amongst large industry stakeholders were more respondents in favour of than against both a three-year averaging for 2030-2032 (35 out of 74 in favour; 18 against; 65 no responses) and a five-year averaging for 2030-2034 (45 out of 72; 18 against; 67 no responses). More SMEs were in favour of a five-year averaging for 2030-2034 than against (15 out of 37; 14 against; 20 no responses). Amongst other groups, more respondents were ***against*** averaging than were for it, with a majority of non-Italian citizens and 'Other' respondents (including NGOs, consumer groups and trade unions) ***against*** both three- and five-year averaging (non-Italian citizens/three year: 29 out of 45, 10 no responses; non-Italian citizens/five year: 30 out of 43, 12 no responses; Other/three year: 27 out of 42, seven no responses; Other/five year: 29 out of 40, nine no responses). A majority of both large industry (54 out of 74; 65 no responses), SMEs (21

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[9] The number of 'no responses' in this paragraph refers to those who did not respond to the follow-up question about what should be changed. Those who either answered "Yes" to the initial question, or did not respond to the initial question, are not included in the numbers as they were not asked the follow-up question.

[10] So responded "strongly disagree" or "rather disagree".

[11] So responded "strongly agree" or "rather agree".

out of 38; 19 no responses) and Italian citizens supported the introduction of additional flexibilities (56%; 286 out of 642; 163 no responses).

Respondents were given the opportunity to further ***specify*** their replies. Supporters of multi-annual averaging underlined the importance of such flexibility, while those against argued that it would be delaying the implementation of the targets.

Respondents were asked for their views on the ***role of plug-in hybrids (PHEVs) and electric range extended vehicles (EREVs) in the CO_2 emission standards for cars and vans***. A majority of SMEs (34 out of 51; six no responses) and large industry (69 out of 103; 36 no responses), and half of Italian citizens (50%, 368 out of 731; 74 no responses), indicated that the usefulness of PHEVs and EREVs should be recognised also in the longer-term. On the other hand, a majority of public authorities (four out of six; four no responses), non-Italian citizens (35 out of 50; five no responses) and 'Other' respondents (25 out of 43; six no responses) replied that there should be a limited role for PHEVs and EREVs as a result of their limited environmental benefit.

Respondents were given the opportunity to provide ***additional views on the role of plug-in hybrids and range extended vehicles***. Supporters of PHEVs and EREVs argued that they contributed to CO_2 emission reductions, that they would be play a role if carbon-neutral fuels were more widespread, and that they were important for journeys that were not currently possible with a BEV. Others noted that PHEVS and EREVs supported the existing value chain and made use of existing skills in ICE vehicles. Opponents argued that PHEVs and EREVs emitted more in the real world than they did on the test cycle, and so were little more than a short-term, transition technology.

Respondents were asked ***which sustainable renewable fuels should have a role in the CO_2 emission standards for cars and vans***. A majority of Italian citizens (77%, 598 out of 774; 31 no responses), SMEs (48 out of 55; two no responses) and large industry (98 out of 122; 17 no responses) indicated that sustainable renewable fuels should have a role. Amongst large industry, a majority of manufacturers supported sustainable renewable fuels having a role (13 out of 17; four no responses), while only those involved in the electricity supply sector (11 out of 12; three no responses) replied that sustainable renewable fuels should ***not*** have a role. A majority of public authorities (four out of seven; three no responses), non-Italian citizens (34 out of 51; four no responses) and 'Other' stakeholders (24 out of 43; six no responses) also believed that sustainable renewable fuels should ***not*** have a role, including a majority of NGOs (12 out of 14; zero no responses).

Respondents were then asked for their views on ***which fuels should have a role***. The highest scoring response amongst Italian citizens was "advanced biofuels and renewable fuels of non-biological origin" (43%; 346 out of 805), while amongst large industry (53%, 74 out of 139) and SMEs (40%, 23 out of 57) this was "other fuels". "Other fuels" was also the highest scoring response amongst fuel suppliers, both large ones (80%, 33 out of 41) and SMEs (75%, nine out of 12), and amongst manufacturers (38%, eight out of 21).

When asked to specify ***which 'other' fuels*** should play a role, the most common response (raised by 34 mainly industry respondents, particularly fuel suppliers) was all fuels that are compliant with the sustainability and minimum GHG saving criteria set out in the Renewable Energy Directive (EU) 2018/2001 (RED). Five fuel suppliers called for all fuels complying with the definition of CO_2 -neutral fuels proposed by the Working Group on Monitoring Methodologies (WGMM) to be considered, while the consideration of fuels of biological origin was called for by seven industry respondents. Italian citizens offered a range of other options, of which petrol and/or diesel, fuels of biological origin, hydrogen and LPG/methane were the most popular, with many also noting that any fuel that reduced emissions should be considered.

In general, those who supported the use of other fuels argued that all routes to reduce CO_2 emissions from transport should be considered, whereas those who opposed the use of other fuels argued that such fuels did not deliver the same level of emissions reductions as electricity, for example, and/or that other sectors needed the limited e-fuels and/or biofuels that were available.

Respondents were asked about the ***design of the mechanism to include sustainable renewable fuels in the CO_2 emission standards for cars and vans***. Common responses were for the definition of a new vehicle class for vehicles that only use CO_2 neutral fuel (CNF; 26 times, mainly industry respondents, particularly fuel suppliers), to use a carbon correction factor (CCF) in the Regulation to reflect the fuel mix (64 times, mainly industry respondents, particularly fuel suppliers) or for the use of LCA and/or a technology neutral approach (32, mainly industry respondents, particularly fuel suppliers), or some combination of these.

Respondents were asked to indicate their level of agreement with a number of statements regarding the ***impacts of sustainable renewable fuels playing a role in the CO_2 emission standards for cars and vans***. A majority of large industry (81%, 96 out of 118, 21 no responses), SMEs (70%, 35 out of 50, seven no responses) and Italian citizens (59%; 431 out of 725, 80 no responses) ***agreed*** that this would provide for a more technology neutral approach. Amongst large industry respondents, manufacturers also ***agreed*** (71%, 12 out of 17; four no responses), whereas the electricity supply sector was the only one for which a majority of respondents ***disagreed*** with this (82%, nine out of 11; four no responses). Five out of six public authorities responding to the question (four gave no response) and a majority of non-Italian citizens (57%, 27 out of 47; eight no responses) also ***disagreed*** with the contribution of such fuels to technology neutrality.

This pattern was reversed for each of the other statements, each of which focused on a potential negative impact of a greater role for sustainable renewable fuels. For example, a majority of non-Italian citizens (24 out of 45; 10 no responses) ***agreed*** that the inclusion of sustainable renewable fuels would come at the expense of the availability of those fuels for other sectors or transport modes that have more challenges to decarbonise, whereas a majority of large industry ***disagreed*** (88 out of 119, 20 no responses). Similarly, a majority of non-Italian citizens (29 out of 48; seven no responses) ***agreed*** that the inclusion of sustainable renewable fuels could weaken the long-term certainty needed for investments in zero emission technologies, whereas a majority of large industry ***disagreed*** (91 out of 120, 19 no responses).

Respondents were asked how the ***revenues from excess emissions premiums should be used***. The highest scoring response amongst Italian citizens (43%, 349 out of 805) was that the revenues should be used to support the companies and regions most affected by job losses or value chain restructuring, followed by support for the zero-emission transport transition (27%, 215 out of 805). The latter was the highest scoring option for the use of revenues amongst the remaining respondents (37%, 116 out of 310), followed by 'Other' (23%, 70 out of 310).

If a respondent indicated 'other', they were asked to specify what this should be. Common responses mentioned the installation of BEV charging infrastructure, consumer incentives to purchase BEVs and support for the development of low carbon fuels. Some respondents called for the premiums to be removed, which was by far the most common response amongst Italian citizens.

Vehicle labelling

In response to a question asking for views on the ***potential harmonisation of the label***, at least two thirds of respondents from all of the main categories of stakeholders agreed with the statement that "the label design should be the same in all Member States", including 80% of Italian citizens (558 out of 700, 105 no responses) and 86% of the other respondents (160 out of 186, 124 no responses). Nearly all large industry respondents (93%; 54 out of 58, 81 no responses) and around three quarters of SMEs (71%, 27 out of 38, 19 no responses) supported the same label design being used in all Member States. All public authorities (seven out of seven, three no responses) and the majority of 'Other' respondents[12] (34 out of 40, nine no responses) also agreed that there should be the same label design in all Member States.

Respondents were asked for views on the importance of ***including four specific pieces of information for zero emission vehicles on the label***, specifically: energy consumption, electric range, charging time and battery capacity. A majority of respondents from each stakeholder sub-category considered that it was important to include each of these pieces of information. The inclusion of 'energy consumption' was deemed important by around three-quarters of respondents, including amongst Italian citizens (80%, 506 out of 721, 81 no responses), other stakeholders (83%, 156 out of 188, 122 no responses), and SMEs (74%, 28 out of 38, 19 no responses). When asked to rank the most important ***additional information that should be displayed on the label***, 'real-world fuel or energy consumption' received the highest score amongst both Italian citizens (30%, 244 out of 805) and other respondents (28%, 87 out of 310). 'Lifecycle CO_2 emissions' received the second highest score in both cases (Italian citizens: 27%, 221 out of 805; other stakeholders: 22%, 674 out of 310).

At least two thirds of all types of stakeholders agreed with all of the statements in relation to the ***use of information channels and digital tools***. When asked whether the 'label should be shown at the point of sale', 69% (398 out of 686, 119 no responses) of Italian citizens and 78% (142 out of 181, 129 no responses) of other stakeholders agreed. The lowest level of agreement was 67% (24 out of 36, 21 no responses) amongst SMEs. A larger share of respondents from all stakeholder groups agreed that the 'label should be accessible online', including 83% (596 out of 715, 90 no responses) of Italian citizens, which was the lowest share of any stakeholder group, and 90% of other respondents (164 out of 183, 127 no responses). The majority also agreed that the 'label should include a

[12] NGOs, consumer groups and trade unions

weblink to other relevant information', including 72% of Italians (494 out of 683, 122 no responses), which was the lowest share of agreement alongside SMEs (26 out of 36, 21 no responses), and 80% of other stakeholders (143 out of 179, 131 no responses).

When asked about the ***scope of the Directive***, more citizens and industry respondents thought that it was important to retain the scope of the Directive (so to only cover new passenger cars) than considered it important to expand this (Italians: 49% important, 329 out of 671, 34% unimportant, 231, 134 no responses; other citizens: 51% important, 19 out of 37, 32% unimportant, 12, 18 no responses; SMEs: 49% important, 17 out of 35, 29% unimportant, 10, 18 no responses; and large industry: 49% important, 20 out of 41, 41% unimportant, 17, 98 no responses). A majority of both public authorities and 'Other' respondents (which includes NGOs, consumer groups and trade unions) considered that it was ***important to expand the current scope*** (public authorities: 71%, five out of seven, three no responses; Others (including NGOs and consumer organisations): 72%, 26 out of 36, 13 no responses).

There was no majority from any stakeholder group that considered extending the scope to 'cover all second-hand passengers' cars was important. 'Others', which includes NGOs, consumer groups and trade unions, was the group with the largest share that considered ***extending the scope to all second-hand cars to be important*** (46%, 16 out of 35, 14 no responses), with SMEs having the lowest share considering it to be important (26%, nine out of 35, 22 no responses). On the other hand, a majority of both Italian citizens (53%, 350 out of 657, 148 no responses) and SMEs (19 out of 35, 22 no responses) considered extending the scope to all second-hand cars ***not to be important***.

3. ADDITIONAL COMMENTS PROVIDED BY RESPONDENTS

While supporting the ***target of eventually reducing CO_2 emissions from cars and vans by 100%***, some **manufacturers** expressed concern about the current timescales. ACEA (vehicle manufacturers' trade association) commented that the 2030 and 2035 targets were not attainable without regulatory adjustments, while ANFIA (Italian manufacturers' association) called for a rethinking of the "unachievable" targets. VW, Toyota and Honda called for a longer transition to the 100% reduction target, given the current market conditions, trends and/or global geopolitics. BDI (Federation of German Industries) and UNITI (German fuel retailers) called for "lifting the ban on internal combustion engine vehicles". On the other hand, several respondents underlined the importance of maintaining the 2035 targets, including the French and Danish Authorities, the City of Stockholm, E-Mobility Europe (Europe's e-mobility sector), ChargeUp Europe (EV charging operators), Charge France (French EV charging operators), T&E (environmental NGO), BDEW (German Federal Association of Energy and Water Management), the *Institut Mobilités en Transition* (IMT-Iddri), and Zero (Portuguese NGO). One electric van manufacturer (Flexis) called for both the 2030 and 2035 targets for vans to be maintained. Eurocities called for an increase in the stringency of the 2030 target, as well as for an interim target for 2027, to ensure that the LDV CO_2 emission standards Regulation was in line with the EU being net zero by 2050. They also called for the phase out of fossil-fuelled vehicles by 2035, and for Member States to be allowed to set an earlier target. E-Mobility Europe, T&E and Zero called for annual CO_2 emission reduction steps.

As regards ***additional flexibilities facilitating target compliance***, ACEA, ANFIA, VW, Toyota and Honda called for multi-annual averaging of emissions for cars between 2028 and 2032. ACEA and VW called for the same approach to be applied to vans. ACEA and VW also called for a less stringent 2030 van target to reflect the lower-than-anticipated uptake of BEVs. Toyota called for both the 2030 and 2035 targets for vans to be adjusted. VDA (the German manufacturers' trade association) called for a two-year phase-in period for both the 2030 and 2035 targets and for the 2035 target for vans to be adjusted to 90%. CLEPA (automotive suppliers) called for a three-year average or phase in for both 2030 and 2035. From 2030, CLEPA also called for the definition of a "new electrified vehicle category" that would include advanced PHEVs and EREVs meeting specified criteria. BDI suggested that certain PHEVs should be considered to be zero emission. The Portuguese NGO Zero called for banking and borrowing to be allowed.

ACEA, VDA, ANFIA, VW, Toyota, CLEPA, BDI, IG Metall (German metalworkers union) and Bosch called for ***the PHEV utility factor to be maintained at the level set in Euro 6e-bis***. On the other hand, E-Mobility Europe, ChargeUp Europe, T&E, Charge France, BDEW, ECTRI (transport research institutes), IMT-Iddri and Zero argued that PHEVs should not be given special consideration as they have high real-world emissions. The French Authorities and the Danish Government supported the revision of the utility factor to reflect real-world PHEV CO_2 emission performance.

In their additional contributions, many respondents involved with the supply of fuel or components to the automotive sector called for ***flexibility to include different types of fuel***. The eFuel Alliance, ePure (renewable ethanol), AECC (emissions control devices), CLEPA, Assopetroli/Assoenergia (Italian energy distributors), Assogasmetano (Italian methane distributors) and Bosch each called for three specific measures: the definition of a new class of vehicle that can only use CNF; to use a CCF in the Regulation to reflect the fuel mix; and for the use of LCA. Other stakeholders supported the use of a CCF, alongside one of these other measures, e.g. AECDR (dealers and repairers) supported the use of a CCF alongside an LCA, and the Network for Sustainable Mobility, Saipol (French sustainable biofuels producer), Shell (fuel company) and BDI called for a CCF alongside the definition of a CNF vehicle category. Others called for the use of a CCF as part of a technology-neutral approach (EWABA (Waste-based & Advanced Biofuels), AGU (Automotive Grade Urea Cefic (chemical industry) sector group), AME (vehicle dealers and repairers), ZDK (Germany dealers and repairers) and UNEM (Italian petroleum industry)). UNITI and INEOS Grenadier also called for LCA.

Other stakeholders commented explicitly on the use of CNF. The Network for Sustainable Mobility, AGU, CLEPA and Repsol (fuel company) each called for CNF to be defined in the LDV CO_2 standards Regulation in the same way as it is defined in the RED. Shell suggested that after 2035, CNF-only vehicles should be considered as a zero-emission as long as their supply was matched by a corresponding volume of CNF, while Repsol called for technology neutrality and for CNF cars to be considered as zero emission. Others called for more support for renewable/CNF fuels as part of a technology-neutral approach (CLECAT (freight forwarders), Johnson Matthey and IRU (commercial operators)).

Other contributions called for explicit recognition of certain fuels. Johnson Matthey called for a recognition of the strategic role of hydrogen, OG Clean Fuels called for biomethane to be recognised as a CNF, Federmetano (owners of CNG and LNG refuelling stations in

Italy) for the recognition of bioCNG and bioLNG as CNF and GDFS (gas distributors) called for a LCA to ensure technology neutrality. CSIAM (French automotive industry) and AECDR called for the potential benefit of synthetic and e-fuels to be recognised.

Many of the additional responses received from vehicle manufacturers also mentioned fuels. ACEA, VW, Toyota, Honda and Ferrari all called for a technology-neutral approach with consideration of e-fuels, and, with the exception of Ferrari, also for a coefficient or credit reflecting the renewable fuels on the market. VDA called for a greater role for CNF. ANFIA supported the definition of a CNF vehicle category and the use of a CCF in the Regulation.

On the other hand, E-Mobility Europe, T&E, IMT-Iddri and Zero each called for maintaining the tailpipe-based approach to measuring emissions without mechanisms to account for renewable fuels. The French and the Danish Authorities are against the integration of sustainable biofuels, with the latter arguing that, if sustainable e-fuels were included, they should be an option, not a requirement.

ACEA and Toyota called for the level of the ***excess emissions premiums*** to be modified so that it should not exceed whichever is the lowest of either the current rate of EUR 95 g/km or the average price of an allowance under the EU's emission trading scheme (ETS 1) in a given compliance year. Bosch called for an alternative compensation mechanism, such as a fund into which manufacturers contribute and which would be used to support strategic investments in the battery chain in Europe. AECDR and ZDK called for the premiums to be abolished.

As regards ***vehicle labelling***, ACEA (EU car manufacturers' association), T&E (transport and environmental NGO) and EV100 (representing companies committed to decarbonising their vehicle fleets) each called for the Directive to become a Regulation, so that there was a ***harmonised approach*** across the EU. T&E also called for an EU-wide database to facilitate the development of comparative tools, monitoring and enforcement. AIG and ZAW (European and German advertising industry) supported the harmonisation of the label, but called for manufacturers to be able to voluntarily include additional information to help them differentiate their brand. Ireland also supported the harmonisation of the label, based on the colour-coded format of the EU energy label.

ACEA called for the ***information included on the label*** to be taken from the CoC, and for the consideration of existing tools for data exchange, such as those used by EReg. They argued that WLTP-based information was sufficient for the label, at least in the short-term, although in the long-term the inclusion of other information, including based on a lifecycle approach could be an option. However, ACEA considered the inclusion of TCO to be problematic, as a result of the uncertainties that drive costs.

Lucid (BEV manufacturer) proposed using an 'Energy Efficiency Index' to distinguish between car classes for the purpose of the label. Mobivia (company involved in automotive equipment, maintenance and repair) called for the inclusion of a 'repairability index', in-use noise and air pollution emissions and lifetime carbon footprint of the vehicle on the label. CRECEMOS (Spanish renewable fuels value chain) called for a label for vehicles that are only able to use carbon-neutral fuels, for the inclusion of information on fuel consumption in different scenarios and of a vehicle's lifecycle carbon footprint.

E-Mobility Europe (Europe's e-mobility sector) called for the label to be based on an EU-wide vehicle 'eco-score' system, which could include energy efficiency and electric range measured under the WLTP, the carbon footprint of the battery, embedded carbon emissions of steel and aluminium and the level of recycled materials.

Ireland called for ensuring that the label remains applicable when the majority of new cars were electric.

The city of Hamburg (from the perspective of a market surveillance authority) noted that enforcing the existing rules of the Directive was already a challenge, so the inclusion of additional information, which would not be taken from the CoC would be a concern. They also called for the inclusion of the Vehicle Identification Number (VIN) on the label to support market surveillance authorities. While supporting the inclusion of carbon footprint information, they underlined that this information had to be able to be easily verifiable. They also called for information from the tyre label to be integrated into the car label.

T&E called for the limits for each label class to be defined on the basis of real-world information. They also called for the inclusion of information on a vehicle's carbon footprint, local content, certified battery state-of-health, real world charging information, TCO and air pollutants. T&E also called for a country-specific part of the label to include information on taxes, incentives and driving restrictions. EV100 called for the inclusion of information on real world energy/fuel consumption based on OBFCM data, TCO, battery capacity and health data, embedded carbon footprint and/or local content information and air pollutants on the label. T&E and EV100 called for the class system underlying the main visual on the label to distinguish between ZEVs and non-ZEVs, with the best three rating reserved for BEVs, differentiated by the carbon footprint of their materials, which would favour smaller BEVs that are more affordable.

In relation to the use of ***communication channels and digital tools***, many stakeholders underlined the importance of consumers researching their car purchase online and making decisions before they visited a car showroom. ACEA argued that there was a need for a customer-focused approach to displaying the information in the most appropriate form online. T&E and EV100 called for harmonised information to be provided on all communication channels and points of sale, including promotional content, comparative tools and manufacturers' websites. T&E also called for harmonised information to be provided in the car. AIG, ZAW and BDZV (German newspaper and digital publishers) called for the label to be available at the point of sale, either physically or online, and in technical promotional material, but ***not*** in advertisements. Ireland called for the expansion of the Directive to all promotional materials, including print, broadcast and digital media, as well as billboards and electronic displays. Ireland also supported replacing the fuel economy guide with a digital means of accessing this information. They also underlined that enforcement – particularly relating to digital advertising – was challenging and so proposed integrating the Directive into the EU's Market Surveillance framework. This was also proposed by the city of Hamburg.

ACEA questioned the added value of ***extending the scope of the legislation*** to cover new vans, arguing that commercial buyers were better informed than private car buyers about the fuel consumption of vehicles, while also noting that obtaining accurate information for multi-stage vans was difficult. They also considered there to be negligible added value in extending the scope to used vehicles and noted the challenges of obtaining accurate data for such vehicles. T&E and EV100 called for the legislation to apply all second-hand cars. Ireland supported the extension of the scope to new vans and second-hand cars. The city of Hamburg underlined that, if the scope was extended to second-hand cars, a database was needed to facilitate market surveillance.

4. REPLIES TO THE CALL FOR EVIDENCE

4.1. Call for evidence for the revision of the LDV CO_2 emission standards Regulation

Twenty-four responses to the call for evidence for the revision of the LDV CO_2 emission standards Regulation were also submitted as part of the public consultation and so are covered in Section 2 of this Annex. This Section analyses the other responses to the call for evidence.

BMW argued that since the 100% CO_2 emissions reduction target for 2035 was set, actual market developments, specifically the market share of BEVs and wider issues (including volatile energy prices and dependence on imported critical materials) have not matched regulatory expectations, resulting in a risk of market distortions, declining sales and an ageing fleet. Consequently, they called for a revision of the CO_2 targets to reflect the market reality, the incentivisation of the integration of BEVs into the energy system and an acknowledgement of the purchase price of lower carbon materials. Specifically, BMW also called for the introduction of a carbon correction factor (CCF) for renewable and low carbon fuels that are compliant with the Renewable Energy Directive (RED) and support for vehicles certified as only able to use RED-compliant, carbon neutral fuels (CNFs) through digital monitoring and verification. They also called for maintaining “realistic” utility factors for PHEVs beyond 2025. In the longer-term, BMW called for comprehensive carbon accounting based on life cycle assessment (LCA) and technology neutrality.

Stellantis underlined that it fully supported ACEA’s submission (submitted and covered as part of the OPC) and noted that experience in Norway suggested that electrifying light commercial vehicles (LCVs) was challenging. Consequently for 2025 to 2029, they called for extending the averaging period for the LCV reduction target to five years and introducing credits to give more weight to electric LCVs when determining manufacturers’ emissions. For 2030 to 2034, they also called for five-year averaging, alongside an adaptation of the target. For this same period for passenger cars, Stellantis again called for five-year averaging, as well as super-credits for electric vehicles with “smaller-than-average” batteries. They also emphasised the importance of enabling conditions, specifically access to affordable, available and convenient charging, both at home and in public.

PFA (French automotive industry) underlined that consumers were not buying BEVs at the level needed, which risked shrinking the market and undermining the viability of the French automotive sector. They called for the adoption of an LCA-based approach. For LCVs, they called for five-year averaging for 2025 to 2029, the introduction of super-credits for fully electric LCVs and for the 2030 target to be adjusted to -30% based on five-year averaging. In addition, for LCVs, PFA wanted to see rewards for manufacturers’ investments in decarbonisation, the slope to be adjusted to ensure that lightweight LCVs contribute positively and an easing of the requirements applicable to larger (category N2) LCVs. For cars, they also supported a five-year averaging between 2028 and 2032, and for manufacturers' investments in decarbonisation to be rewarded, particularly in relation to accelerating fleet renewal. PFA also called for the introduction of a super-credit for small BEVs with a battery capacity of 60 kWh or less. In order to restore "technological freedom", they sought the introduction of a CCF, the creation of a new ZEV category for "CNF only", the maintenance of the PHEV utility factor at the Euro 6e-bis level and the establishment of a ZEV-PHEV category for PHEVs equipped with fast charging and having a minimum electric range. PFA also called for the definition of a European content requirement for vehicles, and for this to be integrated into relevant legislation, including the CO_2 standards. Finally, they underlined the importance of accelerating the deployment of BEV charging infrastructure, not least by strengthening the Alternative Fuels Infrastructure Regulation (AFIR), and for targeted incentives and subsidies to improve the TCO of BEVs.

Auto SAP (Czech automotive industry) outlined the challenges that the industry was facing, not least the rate of uptake of BEVs and the challenges that this poses to meeting the CO_2 reduction targets. For cars, they called for a five-year averaging for the 2030 target between 2028 and 2032 and the suspension of increases to the PHEV utility factor beyond the Euro 6e-bis level, as well as for a lower threshold (15%) and no cap for the ZLEV incentive for 2025 to 2029, and for a higher threshold (35%) and no cap for the period 2030-2034. Relating to fuels, Auto SAP wanted to see the creation of a CNF only vehicle category that counted as a ZEV, as well as the introduction of a Renewable Fuels Coefficient based on the EU average mix. They also called for super-credits for BEVs with small battery capacities and energy efficient BEVs, making detailed proposals for both. Finally, Auto SAP sought the gradual, voluntary introduction of an LCA-based approach, legislative reviews in 2029 and 2033 and for any negative slope to be set to zero to avoid the penalisation of heavier BEVs.

ANFAC (Spanish automotive industry) highlighted the different geopolitical and market situation that exists now compared to when the current targets were set. They argued that the 2030 reduction target was unattainable and so called for revisions to the regulatory framework. They underlined that these must ensure the affordability of BEVs and ensure fair competition between manufacturers with different vehicle portfolios, while maintaining the commitment to electrification. ANFAC called for flexibilities to encourage smaller BEVs, a simplification of monitoring and reporting procedures and for the maintenance of a strong European value chain.

UNRAE (foreign vehicle manufacturers operating in Italy) underlined the importance of technology neutrality, so that the use of renewable fuels and advanced technologies were able to complement electrification. They also called for the goal of decarbonisation to be pursued in an economically sustainable and socially equitable way. UNRAE also underlined the importance of providing accessible and affordable charging infrastructure and of giving support to the market. They also called for consistency between different EU regulation and for the revision to be based on widespread consultation and evidence.

Lucid (BEV manufacturer) argued that the 2035 zero emission target protected European competitiveness and so the target should be maintained, as the transition to BEVs will occur and it was important to provide a stable regulatory environment to support investment. Furthermore, they argued that hybrids, e-fuels and other low carbon fuels were not solutions, as they involved burning fossil fuels, wasting electricity and contributing to air pollution.

Horse (powertrain manufacturer) underlined the importance of a technology neutral approach and the need for a LCA approach. They called for the introduction of a CCF to reflect lifecycle emissions, for a CNF fuel to be defined as one that delivers a GHG reduction of at least 70% and for vehicles using CNF to be considered as a ZEV in the context of the CO_2 emission standards Regulation.

EBA (European Biogas Association) noted that the focus of the CO_2 emission standards on tailpipe emissions overlooked the decarbonisation potential over the whole vehicle lifecycle, particularly of renewable fuels of biological origin that are compliant with the sustainability criteria of the RED. Consequently, they called for the CO_2 emissions standards Regulation to consider the important role of biogases and biomethane in decarbonising road transport, and for these fuels to be monitored and verified according to Union-wide standards. EBA called for a formal recognition of CNF as an integral part of the EU's road transport decarbonisation strategy, arguing that this would help to support the EU's competitiveness. They underlined the importance of a well-to-wheel (WTW) approach for assessing emissions and called for the introduction of a CCF and a dedicated vehicle category for vehicles powered exclusively by CNF.

EBB (European Biodiesel Board) called for a technology neutral approach in order to recognise all potential solutions for decarbonising transport, including biofuels. Specifically, they called for the implementation of a new category of vehicle powered exclusively by CNF and the introduction of a CCF to reflect the benefits of biofuels and other RED-compliant fuels.

MVaK (advanced biofuels producers) called for a technology-inclusive approach that recognised sustainable fuels alongside electrification. In particular, they called for a technology-neutral definition of CNF, based on that in the RED, the introduction of a CCF and for a dedicated category for vehicles powered exclusively by CNF and for these vehicles to be considered a ZEV.

UPEI (independent energy and mobility suppliers) called for a technology-inclusive definition of CNF based on the RED and WGMM (Working Group on Monitoring Methodologies of CNF) definitions, the introduction of a CCF based on a WTW approach, and for a new category of vehicle exclusively powered by CNF.

There was also support for similar interventions from national associations and companies working on different fuels.

BDBe (German bioethanol producers) called for the recognition of CNF in the CO_2 emissions standards Regulation, based on the approach set out by the WGMM, to ensure a technologically neutral approach that enabled the achievement of the Regulation's objectives within a realistic timeframe. In order to take account of the contribution to emissions reduction of CNF, they wanted to see the adoption of a WTW approach. BDBe concluded by underlining the risks of taking an approach that relied on a single technology, namely electrification.

CRECEMOS (Spanish renewable fuels value chain) noted that electrification would play an important role in decarbonising road transport, but underlined that relying solely on it was risky and called for more attention to be paid to the use of CNF in ICEVs. They sought a move to an approach based on WTW and LCA. Specifically, CRECEMOS called for the removal of the de facto ban on ICEVs, the establishment of a carbon-neutral vehicle category that counted as a ZEV and for consideration of the WGMM methodologies for certifying and tracking the use of CNF.

The USGBC (developing export markets for US bioproducts) called for the CO_2 emission standards Regulation to not only focus on electrification, but also ICEVs running on low carbon fuels, including sustainable bioethanol. They wanted to see an emphasis on technological neutrality, which defined a CNF in the same way as the RED.

NGV Italy (Italian gas-powered transport) and Federauto (Italian auto concessionaries) both argued that focusing on electrification was not compatible with decarbonising road transport. They both underlined that the BEV market was not developing as it had been anticipated and that the BEV charging network was not yet sufficient. As a result, both called for the introduction of a CCF to take account of WTW and LCA emissions, giving a higher priority to the potential role of renewable fuels and removing the excess emissions premiums, as manufacturers were not solely responsible for meeting the CO_2 emission reduction targets.

Moeve (Spanish renewable fuels and BEV charging company) called for the ambition of the CO_2 emission standards Regulation to be maintained, although with a shift to a technology-neutral approach. In this context, they wanted to see the creation of a new vehicle category of vehicle that uses CNF, defined as any RED-compliant fuel, and the introduction of a CCF.

Raizen (Brazil-based bioenergy producer) underlined the importance of technology neutrality, drawing on experience in Brazil, in order to allow all low carbon technologies to compete based on their lifecycle performance.

EDF (electricity company) called for maintaining the current approach, as this would boost the competitiveness of EU manufacturers, empower consumers and strengthen energy sovereignty. They underlined that PHEVs had higher costs and lower environmental benefits than BEVs, and that alternative fuels, including hydrogen, delivered less CO_2 reduction for higher costs.

Iberdrola (renewable energy company) called for the current approach to be maintained to ensure regulatory certainty, but noted that the deployment of charging infrastructure needed to be strengthened and that measures were needed to support the affordability and uptake of ZEVs.

Atlante (charging infrastructure developer) also called for maintaining the 2035 zero emission target, and for only recognising alternative fuels as transitional, in order to support investment planning for the companies involved, to maintain confidence in the stability of EU Regulation and to maintain the EU's leadership in the global transition to BEVs.

AKL (Finnish motor trades and repairs) underlined the importance of a technology neutral approach that made use of e-fuels to deliver the necessary emissions reductions, alongside the continued promotion of BEVs. They also noted that there was a need to strengthen consumer demand for low emission vehicles and for more charging infrastructure.

VFAS (Swiss car trade) called for a weakening of the targets for both cars and LCVs (to reach a 75% reduction for cars, and a 66% for vans, by 2040), as well as for lower rates for the excess emissions premiums and for a two-year phase-in period for all targets.

Mobilians (French mobility services) also called for technology neutrality and for the introduction of a CCF to recognise the role of other energy carriers alongside BEVs. They underlined the importance of a simplification of monitoring and reporting by using digital tools, and for the vans CO_2 emissions standards to acknowledge their different use cases and infrastructure needs compared to cars. Mobilians also wanted to see more incentives and tax breaks, as well as a robust charging network, to support the uptake of BEVs.

NLA (Nordic Logistics Association) called for the removal of regulatory barriers to the uptake of battery electric vans, specifically the fact that electric-powered vans that have a total permissible laden weight between 3,501-4,250 kg are subject to rules for small trucks. They wanted to see the raising of the weight threshold for electric-powered vans from 3,500 kg to 4,250 kg to address this concern, which would help to increase the market uptake of heavier electric vans. In addition, they underlined the importance of subsidies and incentives, rolling out charging infrastructure and adequate grid capacity.

VW Stahl (German Steel Association) called for the consideration of the production phase of vehicles in the CO_2 emission standards Regulation, through the inclusion of a super-credit to encourage manufacturers to increase the share of low emission steel produced in the EU that they use in vehicle manufacture. They underlined that the verification of the related emission savings should be transparent and based on the Low Emission Steel Standard.

DIHK (German chambers of commerce and industry) underlined that companies would generally not want to see further adjustments or tightening of the CO_2 emission standards. They called for a technology-neutral and market-driven approach that supports different low and zero carbon options on equal terms, including sustainable, locally produced biogas, synthetic fuels and green hydrogen, as well as for an examination of how the rules could be simplified to reduce administrative burden.

VDMA (German Engineering Federation) argued that the current targets were unrealistic and so called for the CO_2 emissions standards to be more technologically open to include a role for PHEVs and ICEVs using e-fuels beyond 2035. They wanted a WTW approach to be used to determine a vehicle's CO_2 emissions and asked for a freezing of the PHEV utility factor at 2025 levels.

Digital Trade 4 EU (supporting digitalisation) called for the CO_2 emissions standards Regulation to be linked to digital product passports to enhance compliance and reduce administrative burden.

ZVEI (German electrical and digital industry) highlighted the importance of maintaining the current legislative framework and the current targets, as they considered that this provided sufficient lead time for the transition and noted that the increased number of new ZEV registrations in the EU during the first half of 2025 demonstrated the effect of the targets. ZVEI also called for the inclusion of an e-fuel powered vehicles as a ZEV for the purpose of the CO2 emissions targets. They also highlighted the importance of expanding charging infrastructure and of having support measures to encourage ZEV uptake.

WKO (Austrian Federal Economic Chamber) wanted to see a technologically neutral approach that allowed for the inclusion of PHEVs and ICEVs powered by certified CNF. They also called for an adjustment to the 2035 target, given that BEV technology and charging infrastructure are not likely to be sufficiently developed in the 2030s, and a recognition that new battery electric vans should be affordable for SMEs, so as not to adversely affect their competitiveness. WKO want the CO_2 standards Regulation to set a pragmatic path towards the use of CNF by recognising a vehicle powered exclusively by e-fuels as a ZEV, maintaining the PHEV utility factor at the Euro 6e-bis level and transitioning to an LCA approach.

Ingevity (a chemicals company) called on a revision of the Euro 7 emissions standard to be undertaken alongside the review of the CO_2 emission standards, if the latter review weakened the CO2 reduction targets.

The OECC (Spanish Office for Climate Change) underlined that the targets should remain unchanged in order to ensure long-term security and predictability. They argued that the role of PHEVs should be limited, as their real-world fuel consumption and emissions were higher than their test cycle values, although they did see a role for 100% renewable fuels of non-biological origin in applications that were difficult to electrify or where it was important to accelerate decarbonisation. However, they believed that such fuels should be used exclusively, rather than blended, as it would not be possible to ensure the carbon footprint of blended fuels. The OECC also called for revenues from excess emissions premiums to be used to support BEVs, as these were the most mature and cost-efficient decarbonisation technology.

The German region of Bavaria called for the CO_2 emission standards, particularly the targets, to be adapted so as not to cause lasting damage to the EU automotive sector. They wanted a framework to be developed for the inclusion of vehicles that exclusively used CNF, and for a broader technology neutral approach that ensured that PHEVs and range extended vehicles were able to be used in the long term. Bavaria also called a reduction in administrative burden, appropriate consideration of a vehicle's entire CO_2 footprint and the development of a competitive and affordable charging network for electric and hydrogen vehicles.

The Italian region of Lombardy wanted an urgent review of the CO_2 emission reduction targets and for the 2035 targets to be amended to reflect the role of alternative fuels, particularly biofuels, in reducing emissions. They also called for an urgent review of the excess emissions premiums, as well as for the application of the principle of technology neutrality and the application of LCA.

VZVB (German consumers) called for the maintenance of the existing targets, arguing that weakening them would delay the transition and leave consumers to pay the price, both economically and ecologically. They wanted to see BEVs having to meet weight-independent efficiency standards from 2030, that would operate in the same way as the CO_2 emissions standards (with a proposed fleet-wide target of 16 kWh/100 km), with penalties for manufacturers that exceed these limits, in order to encourage smaller, more efficient models. VZVB also called for mandatory reporting of lifecycle emissions to replace the current voluntary approach, so that this could be used as the basis of setting threshold values for the entire lifecycle of a vehicle, and its individual components.

UVE (Portuguese BEV users) underlined the importance of maintaining the current targets, arguing that this was important to meet climate targets and to ensure the competitiveness of the European automotive industry. They cautioned about extending the role of alternative fuels, arguing that hydrogen was inefficient compared to direct electrification, that producing e-fuels had a high energy intensity and that biofuels risked taking land away from fuel production and did nothing to reduce air pollution. UVE also called for a strengthening of targets for the deployment of fast- and high-power charging infrastructure and incentives and fiscal measures to support BEV uptake.

DUH (German environmental and consumer NGO) strongly rejected calls for weakening the current targets, or for increased flexibility, particularly in relation to the inclusion of biofuels or synthetic fuels and preferential treatment for PHEVs or range extended vehicles. They argued that crop-based biofuels had major lifecycle emissions, and even advanced biofuels risked displacement effects and often failed to meet sustainability criteria in practice. DUH underlined that synthetic e-fuels were around 6.5 less efficient than direct electrification. In relation to PHEVs, they noted that studies had shown that these vehicles emit a lot more in the real world than their WLTP values would suggest, and so supported the adoption of a utility factor that better reflected real world emissions. DUH argued that the current 2035 targets were achievable and, if anything, the Commission should assess whether there should be more ambitious interim targets. While acknowledging the importance of promoting smaller, more efficient vehicles, they argued that any ‘small car credit’ should have strict limits and not offset sales of high emission vehicles.

IASTEC (sustainable drivetrain and technology research) called for the revision of the CO_2 standards Regulation to include an ambitious CCF, the introduction of a new class of ICEV that uses CNF and to postpone the 100% reduction target from 2035 to 2040.

4.2 Call for evidence for the revision of the Car Labelling Directive

Automotive Mobility Europe (AME, dealers and repair shops) and Mobilians (French mobility services) called for the ***label to be produced upstream***, arguing that the party that places a vehicle on the market was best placed to ensure that the information on the label was accurate, complete and consistent. AME and Mobilians also supported ***harmonisation***, both of the physical label and a VIN-linked page accessible via a QR code with information about the vehicle that users and dealers could access throughout the vehicle’s lifetime. AME and Mobilians cautioned about including information on the label that had the potential to mislead customers and call for the inclusion of a ***repairability criterion***. While supporting the ***extension of labelling requirements to used vehicles***, AME and Mobilians noted that the source of the data and the allocation of responsibilities would need to be clear. They also cautioned against any approach that delayed sales or imposed disproportionate costs on SMEs.

AKL (Finnish motor trade and repairs) underlined that the review of the Directive needed to address the ***varying implementation across the EU***, which has decreased its effectiveness and efficiency, potentially leading to higher costs for industry. AKL called on avoiding a paper label, as information is available **digitally**.

EDF (electricity company) called for the label to be based on ***real-world emissions*** data and for the ***highest energy classes to be reserved for electric vehicles***.

Iberdrola (renewable energy company) called for the ***harmonisation*** of the label across Member States and for ***information on ZEVs to be included***, such as their energy consumption, range, charging time and battery durability.

EGCA (advanced carbon and graphite materials) called for the inclusion of ***lifecycle emissions on the label***, as this would help underline the benefits of using European graphite in batteries and potentially increase the market for EU battery material producers. They also called for information from the battery passport to be included.

DIHK (German chambers of commerce and industry) considered that the label had limited effects on consumer choices, and called for the Commission to consider ***withdrawing the Directive*** if its impact was not sufficient. In order to reduce administrative burden, if the Directive is retained, its requirements should be ***harmonised***. DIHK opposed the inclusion of air pollutant values, carbon content of key materials or TCO, as the latter varies constantly. If ***used vehicle***s were included in the scope of the legislation, DIHK cautioned against including new metrics on the label. Finally, they called for the removal of the requirement to provide printed material.

The Swedish Energy Agency underlined the importance of including ***information on lifecycle emissions*** on the label and for the label to be ***colour-coded*** and ***based on a vehicle's energy efficiency***, as this allows for differentiation between electric vehicles. They also called for the inclusion of more ***detailed information on PHEVs***, including on their energy use in both electric and fuel mode. They also called for the inclusion of a QR code on the label, as well as potentially in other marketing contexts, with a link to a ***vehicle specific 'product information sheet'***, as is done under the EU's energy labelling scheme, . and for the possibility to include ***information on repairability, durability, warranties*** and other factors that potentially contribute to a longer vehicle lifespan.

BEUC (European consumers' organisation) called for a labelling Regulation applying to both ***new and second-hand cars*** that defines a ***standardised label*** to be used in all Member States. They also called for the development of an ***EU-wide database***, potentially based on the existing real-world CO_2 values dataset. BEUC underlined the importance of providing the basic information on a car's real-world environmental performance to customers ***on all promotional content***. They see the car label becoming a passport that accompanies a vehicle over the course of its lifetime, in the same way as the Environmental Vehicle Passport. They supported the use of a ***label design based on the EU's energy label for products***, indicating a car's test cycle and real-world CO_2 emissions performance. They called for the ***best three categories*** of the label to be reserved for BEVs and hydrogen powered cars, with ZEVs distinguished by an overall 'eco-score', and for a country-specific section of the label to include information about national incentives, taxes and driving restrictions. Finally, BEUC proposed the ***inclusion of a QR code*** with a link to complementary, vehicle-specific information, similar to Belgium's 'Car Pass'.

BZVB (German consumers' organisation) called for an EU-wide ***harmonised label***, with clearly defined and uniform energy classes based on a vehicle's ***absolute energy consumption***. They also called for electric cars to be classified into ***energy efficiency classes*** based on their specific energy consumption, and also for meaningful and comparable information on ***charging performance*** to be included on the label. BZVB argued that ***real-world information*** should be used for the label, rather than WLTP values. While underlining that a label should be kept simple, they proposed the creation of a ***digital product passport*** for vehicles, accessible via a QR code on the label, where information on the battery, resource consumption, repairability and disposal could be found, as well as potentially lifecycle information. BZVB also called for an ***extension of the scope*** to all new cars, including long-term rentals, and used cars.

U.Di.Con (Italian consumers) noted that consumers had a right to receive clear, reliable and comparable information. They also called for a gradual harmonisation of the label amongst Member States to ensure that all consumers receive the same information.

DUH (German environmental and consumer NGO) supported the adoption of a ***uniform colour-coded label across the EU*** based on the EU label for energy-related products, , and based on absolute measurements. They called for the classification of BEVs to be based on ***electricity consumption*** (including charging losses) and for ICEVs on CO_2 emissions. For PHEVs, they called for two classes, one based solely on the electric mode, and the other based solely on the ICE mode, both using the same classification as for BEVs and ICEVs, respectively. DUH called for relying on real-world values, but rejected the use of lifecycle information as they considered that this was too complex and not understandable to consumers. They also proposed that the ***classification limits be tightened*** by around 10% every three years and for maximum fuel consumption limits to be set for cars to be allowed onto the EU market. DUH also supported ***extending the scope*** of the Directive to cover used cars, vans and individually approved vehicles They also called for cost information to be included, as well as a repairability index, while also supporting access to the Circularity Vehicle Passport via a QR code. DUH also called for the inclusion of energy consumption information and CO_2 emissions in all ***advertising material distributed electronically***, and in online advertisements. Finally, they called for the inclusion of ***market surveillance*** in the Directive and for associated annual reporting requirements for Member States.

ECTRI (transport research institutes) agreed with the results of the Commission's evaluation of the Directive and so called for ***harmonisation*** among Member States, and for the facilitation of access and ***comparison of information on the label using digital tools***. They consider it useful to include on the label lifecycle GHG emissions, power consumption and electric range for BEVs and, for PHEVs, information for both electric and combustion engine modes. ECTRI also noted the potential benefits of including information on TCO, including energy and CO_2 costs, and the expected salvage value.

Oeko-Institut and ICCT submitted a report of a study on the further development of the car label. They recommended ***harmonising*** the label across the EU based on the ***colour-coded format of the existing EU energy label*** and that the metric to be used to allocate vehicles to different classes should be ***final energy consumption***. For PHEVs, they proposed that the final energy consumption rating be displayed separately for ***charge sustaining and charge depleting modes***. They also proposed that other information, such as energy consumption of BEVs in different temperatures, BEV charging speed and CO_2 emissions of PHEVs in charge sustaining mode, was included on the label, with additional information (energy consumption in different driving conditions, air pollutant emissions) being accessible in a ***product information sheet***.

ANNEX 3: WHO IS AFFECTED AND HOW?

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
- Buyers and users of vehicles, both individuals and businesses
- Fuel and energy suppliers
- Vehicle repair and maintenance businesses
- Vehicle dealerships
- Society at large

The below table summarises how these target groups are affected by this policy initiative.

Type of stakeholder	Practical implications
Vehicle Manufacturers	The EU automotive sector has already invested massively in electrification, and committed to invest more than EUR 250 billion by 2030. As the sector is undergoing a structural crisis and its profits having recently reduced (see Driver 3), the flexibilities offered by the initiative will allow vehicle manufacturers to better optimise their portfolio to support safeguarding profits that can be used to invest, including in the transition to zero-emission vehicles. Safeguarding a limited market for vehicles, fitted with an ICE will support manufacturers in optimising their global production output by still producing in Europe such vehicles for both domestic and export markets.
Suppliers of automotive components and materials	Suppliers affected by the shift towards zero-emission mobility, in particular SMEs focused on the ICE value chain, may benefit from more technology openness that safeguards some EU market for those technologies. This could support some investment in this value chain while also providing more time to adapt to the transition, including to mitigate employment impacts and adapt portfolios. Safeguarding a limited market for vehicles fitted with an ICE will support suppliers specialised in the ICE value chain that may keep producing in Europe for both domestic and export markets.
Buyers and users of vehicles, both individuals and businesses	Vehicle buyers would have more options to buy than only zero-emission vehicles even after 2035, allowing them to potentially adapt better their purchase to specific needs. However, this would increase the total cost of ownership.

	Potential vehicle buyers, both of cars and vans, would be better informed about the CO_2 emissions and energy performance of the vehicles offered for sale or lease. Vehicle users would on average experience higher running costs.
Fuels and energy suppliers	There will be increased demand for sustainable renewable fuels in road transport, which will trigger additional investment and opportunities for fuels suppliers. Electricity suppliers may adjust downwards their investment as the market for electric vehicles and related electric energy consumption will be lower than anticipated.
Vehicle repair and maintenance businesses	Vehicles fitted with an ICE requiring more maintenance than BEV, this could moderately affect positively the vehicle repair and maintenance business. OVC-HEV having both electric and ICE powertrains, their needs for repair and maintenance are even greater which will further reinforce the impact.
Vehicle dealerships	Extension of the scope for vehicle labelling to include vans and second-hand vehicles will add some cost. However, the harmonisation across all Member States of the vehicle label will simplify the process, leading to cost reduction and less administrative burden.
Society at large	Citizens could face limited worsened air quality, especially in urban areas, as some new vehicles will still emit air pollutants after 2035. Transport will be overall slightly more expensive than it would have been with only zero-emission vehicles.

2. SUMMARY OF COSTS AND BENEFITS

I. Overview of Benefits (total for all provisions) – Preferred Option		
Description	***Amount***	***Comments***
Direct benefits		
Cost savings for vehicle manufacturers due to change in 2030 target for vans and additional flexibilities	Costs for vehicle manufacturers will decrease by EUR 89 and 41 per car and EUR 172 and 88 per van, in 2035 and 2040 respectively.	
Cost savings for businesses and authorities resulting from harmonisation of vehicle label	Cost savings of EUR 11 million/year for businesses and EUR 4 million/year for national authorities	Vehicle dealers will save costs by using the harmonised label and removal of the requirement of a poster. National authorities will save costs as there is no need anymore for a national label and database.
Flexibility in reaching the targets	Manufacturers are provided with additional flexibility to reach the CO_2 targets, which will allow them to better optimise their product portfolio in the most cost-efficient way, also taking into account potential year-to-year fluctuations in demand for zero-emission vehicles, leading to cumulative savings of 7 billion EUR	
Indirect benefits		
Continued investment opportunities	Manufacturers may continue investing in technologies other than zero-emission powertrains (OVC-HEV, VEEF) for the EU market, which will be useful for specific use case and some export markets.	
Avoided risk of potential fines for vans manufacturers	For vans, the relaxed 2030 target will significantly reduce the risk of manufacturers having to pay high fines.	

II. Overview of costs – Preferred option							
		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
COMBI_1	Direct adjustment costs	-	TCO for car owners increases by up to EUR 250 for each end user in 2035 and 2040.	-	-	-	-

			TCO for van owners increases by up to EUR 1000 for each end user in 2035 and 2040. From a system perspective, the total costs increase by about 7 bn € (out of which 3 bn€ of environmental externalities)				
	Direct administrative costs	-	-	-	-	-	-
	Direct regulatory fees and charges	-	-	-	-	-	-
	Direct enforcement costs	-	-	-	-	-	-
	Indirect costs	-	-	-	-	-	-
REV_SCF	Direct adjustment costs	-	-	-	-	-	-
	Direct administrative costs	-	-	-	-	-	-
	Direct regulatory fees and charges	-	-	-	-	-	-
	Direct enforcement costs	-	-	-	-	-	-
	Indirect costs	-	-	-	-	-	-

LAB_2	Direct adjustment costs	-	-	For vehicle manufacturers and vehicle dealers: EUR 116 million in the first year of implementation	For vehicle manufacturers and vehicle dealers: EUR 48 million per year	-	-
	Direct administrative costs	-	-	-	-	-	For national administrations: EUR 4 million per year
	Direct regulatory fees and charges	-	-	-	-	-	-
	Direct enforcement costs	-	-	-	-	-	-
	Indirect costs	-	-	-	-	-	-

III. Application of the 'one in, one out' approach – Preferred option(s)			
[M€]	**One-off** (annualised total net present value over the relevant period)	**Recurrent** (nominal values per year)	**Total**
Businesses			
New administrative burdens (INs)			
Removed administrative burdens (OUTs)			
Net administrative burdens*			
Adjustment costs**	For vehicle manufacturers and vehicle dealers: EUR 116 million in the first year of implementation	For vehicle manufacturers and vehicle dealers: EUR 48 million per year	
Citizens			
New administrative burdens (INs)			

Removed administrative burdens (OUTs)			
Net administrative burdens*			
Adjustment costs**		TCO for car owners increases by up to EUR 250 for each end user in 2035 and 2040. TCO for van owners increases by up to EUR 1 000 for each end user in 2035 and 2040.	
Total administrative burdens***			

(*) Net administrative burdens = INs – OUTs;
(**) Adjustment costs falling under the scope of the OIOO approach are the same as reported in Table 2 above. Non-annualised values;
(***) Total administrative burdens = Net administrative burdens for businesses + net administrative burdens for citizens.

3. RELEVANT SUSTAINABLE DEVELOPMENT GOALS

Overview of relevant Sustainable Development Goals – Preferred Option(s)		
Relevant SDG	**Progress towards the Goal**	**Comments**
SDG 3: Good Health and Well-being Ensure healthy lives and promote well-being for all at all ages	Option LAB_2 ensures the provision of information affecting consumers' purchasing behaviour towards vehicles with lower CO_2 emissions, which would also have air quality and hence health benefits. Option COMBI_1 provides reduced pollutant emissions compared to today and improved air quality.	
SDG 9: Industry, Innovation and Infrastructure Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.	Option COMBI_1 provides some flexibility and short-term relief for automotive industry in meeting the CO_2 targets and provides innovation opportunities in the fields of internal combustion engines and sustainable renewable fuels, while maintaining a strong long-term signal to continue the industrial transformation towards low-carbon technologies, battery innovation, and recharging networks.	
SDG 12: Responsible Consumption and Production Ensure sustainable consumption and production patterns.	Option LAB_2 encourages informed consumer choices, which could lead to more sustainable consumption behaviours, and increases transparency on vehicle emissions.	
SDG 13: Climate Action Take urgent action to combat climate change and its impacts	Option COMBI_1 maintains the long term CO_2 emission targets, ensuring that emission reduction and climate objectives will be met, while providing for safeguards on the flexibilities offered to manufacturers, which ensure adequate real-world emission performance.	

ANNEX 4: ANALYTICAL METHODS

The baseline for the assessment is built on a scenario which achieves 87% reduction of net GHG emissions in 2040 (compared with 1990) and climate neutrality in 2050, in line with the 2040 climate target as proposed by the Commission[13].

It takes into account the objectives and policies put forward by Member States in their National energy and climate plans, submitted in 2024 and 2025[14].

Aiming at covering the entire GHG emissions from the EU economy, and combining horizontal and sectoral instruments, the various pieces of legislation mentioned in Chapter 1 strongly interlink, either because they cover common economic sectors (e.g. the road transport sector is currently addressed the CO_2 standards and by renewables policies, but also falls in the scope of the extended ETS, together with the building sector) or by the direct and indirect interactions between these sectors (e.g. electricity supply sector and final demand sectors using electricity, including road transport).

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

This Annex describes the tools used to produce the common baseline (referred to as the 87% scenario), the policy scenarios, and also the key assumptions underpinning the analysis.

1. MODELLING TOOLS USED FOR THE BASELINE

The quantitative results of the assessment can be considered robust. The two different models apply different modelling approaches and perspectives (details are provided below) and provide congruent results from which the same policy related conclusions can be drawn.

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 Law to analyse the increased 2040 mitigation target and the Climate neutrality targets and for the proposal accompanying the Fit for 55 package.

The PRIMES and PRIMES-TREMOVE models are the core elements of the modelling framework for energy, transport and CO_2 emission projections. DIONE then assesses the implications of future road vehicle fleet composition, efficiency and drive patterns on vehicle capital costs, fuel/energy consumption, and total costs of ownership.

[13] COM(2025) 524 final

[14] https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

Additionally, the following model have been used to define the baseline: 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 impacts on agriculture for economic and environmental, biodiversity-related variables. Their description is available in the Impact Assessment supporting the Communication "Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society"[15]

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 2050 (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 and DIONE), agriculture, waste and other non-CO_2 emissions (GAINS), forestry and land use (GLOBIOM-G4M), atmospheric dispersion, health and ecosystems (acidification, eutrophication) (GAINS).

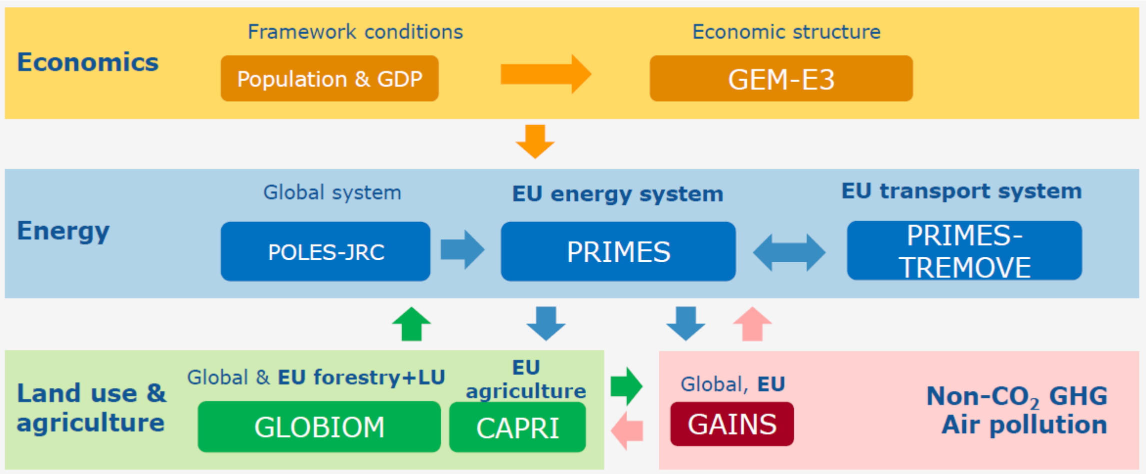
The modelling suite has been continuously updated over the past decade. Updates include the addition of a new buildings module in PRIMES, improved representation of the electricity sector (renewables and storage), more granular representation of hydrogen (including cross-border trade[16]) and other innovative fuels, including the link between carbon dioxide capture and removals with its use for synthetic hydrocarbons, different CO_2 feedstock, etc., improved representation of the heavy duty vehicles, aviation and 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.

The models are linked with each other in such a way to ensure consistency in the building of scenarios (Figure 1)Figure 1. These inter-linkages are necessary to provide the core of the analysis, which are interdependent energy, transport and GHG emissions trends. DIONE receives input from PRIMES and PRIMES-TREMOVE.

[15] SWD(2024) 63 final

[16] 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.

Figure 1: Interlinkages between models



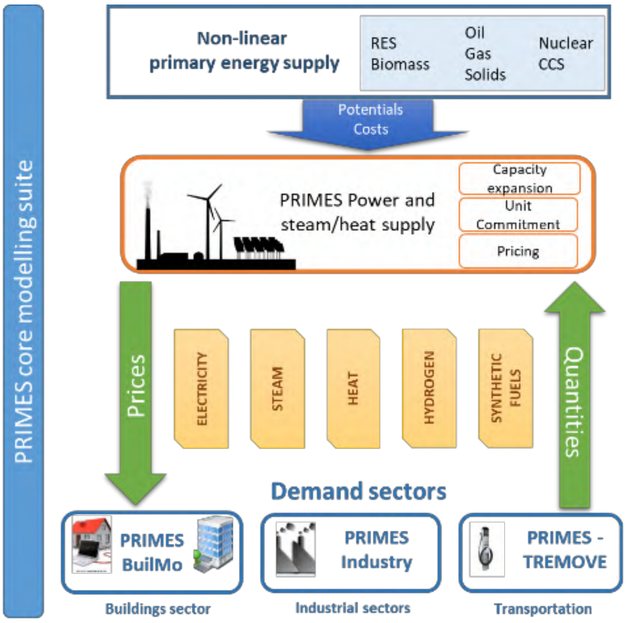
a. ENERGY: THE PRIMES MODEL

The PRIMES model (Price-Induced Market Equilibrium System)[17] 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 2 shows a schematic representation of the PRIMES model.

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

Figure 2: 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, part of Ricardo, originally developed in the context of a series of research programmes co-financed by the European Commission. The model has been successfully peer-reviewed, last in 2011[18]; 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

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

- Technology databases: ODYSSEE-MURE[19], ICARUS, Eco-design, VGB (power technology costs), TECHPOL – supply sector technologies, NEMS model database[20], IPPC BAT Technologies[21]
- Power Plant Inventory: ESAP SA and PLATTS
- RES capacities, potential and availability: JRC ENSPRESO[22], JRC EMHIRES[23], RES ninja[24], 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[25], INSPIRE archive, BPIE[26]), JRC-IDEES[27], update to the EU Building stock Observatory[28]

b. TRANSPORT: THE PRIMES-TREMOVE MODEL

The PRIMES-TREMOVE transport model projects the evolution of demand for passengers and freight transport, by transport mode, and transport vehicle/technology, following a formulation based on microeconomic foundation of decisions of multiple actors. Operation, investment and emission costs, various policy measures, utility factors and congestion are among the drivers that influence the projections of the model. The projections of activity, equipment (fleet), usage of equipment, energy consumption and emissions (and other externalities) constitute the set of model outputs.

The PRIMES-TREMOVE transport model can therefore provide the quantitative analysis for the transport sector in the EU, candidate and neighbouring countries covering activity, equipment, energy and emissions. The model accounts for each country separately which means that the detailed long-term outlooks are available both for each country and in aggregate forms (e.g. EU level).

In the transport field, PRIMES-TREMOVE is suitable for modelling *soft measures* (e.g. eco-driving, labelling); *economic measures* (e.g. subsidies and taxes on fuels, vehicles, emissions; ETS for transport when linked with PRIMES; pricing of congestion and other externalities such as air pollution, accidents and noise; measures supporting R&D); *regulatory measures* (e.g. CO_2 emission performance standards for new light duty vehicles and heavy duty vehicles; EURO standards on 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

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

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[29] modelling community. Part of the model (e.g. the utility nested tree) was built following the TREMOVE model.[30] 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[31]. Excise taxes are derived from DG TAXUD excise duty tables. Other data comes from different sources such as the European Alternative Fuels Observatory (EAFO)[32], research projects (e.g. the Study on New Mobility Patterns in European Cities[33]) and reports.

In the context of this exercise, the PRIMES-TREMOVE transport model is calibrated to 2005, 2010, 2015 and 2020 historical data. Available data on 2023 and 2024 market shares of different powertrain types, energy balances and transport statistics have also been taken into account to semi-calibrate the year 2025.

c. DIONE MODEL (JRC)

The DIONE model suite is developed, maintained and run by the JRC. It has been used for the assessment of capital, fuel/energy and other 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

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

[30] Several model enhancements were made compared to the standard TREMOVE model, 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.

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

[32] https://alternative-fuels-observatory.ec.europa.eu/

[33] Sustainable transport Studies - European Commission

- 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[34] and continuously updated[35]. 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 for 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, and new range and utility factor settings for PHEV were considered, in line with the assumptions made in the baseline and scenarios, by updating the cost curves for advanced electrified vehicles (SI PHEV, SI REEV, CI PHEV, CI REEV, BEV).

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[36], 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, PHEV) reduction per segment and powertrain and the corresponding additional capital 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. Real World energy consumption is calculated by applying powertrain and segment-specific factors[37].

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 JRC analysis of on-board fuel consumption monitoring data. 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.

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[34] 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

[35] Krause, J., Le Corguille, J., Saporiti, F. and V. Arcidiacono, The JRC DIONE model version II – Assessing the costs of road vehicle CO2 emission reduction, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2760/534058

[36] Suarez CJ, Komnos D, Ktistakis M, Fontaras G. 2025 and 2030 CO_2 emission targets for Light Duty Vehicles. JRC Publications Repository 2023. https://doi.org/10.2760/901734.

[37] Komnos D, Smit R, Ntziachristos L, Fontaras G. A comparative analysis of car fleet efficiency evolution in Europe and Australia insights on policy influence. Journal of Environmental Management 2025;373:123313. https://doi.org/10.1016/j.jenvman.2024.123313.

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 2.

Table 2: Main assumptions made for the costs assessment by DIONE

Element	Sub-category	Assumption	Notes
Discount Rate, %[38]	Societal	3%	This social discount rate is recommended for Impact Assessments in the Commission's Better Regulation guidelines[39].
	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	20	
	First end-user	0-5	
	Second end-user	6-10	
	Third end-user	11-15	
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)[40] and updated to 20 years vehicle lifetime.
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 recent data from vehicle on-

[38] The discount rates are consistent with the Reference Scenario 2020

[39] Tool 64 of https://commission.europa.eu/law/law-making-process/better-regulation/better-regulation-guidelines-and-toolbox/better-regulation-toolbox_en

[40] 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

			board fuel consumption[41,42]. measurement.
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[43,44]. 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	
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[45]. No assumption is

[41] Suarez J, Tansini A, Ktistakis MA, Marin AL, Komnos D, Pavlovic J, et al. Towards zero CO_2 emissions: Insights from EU vehicle on-board data. Science of The Total Environment 2025;1001:180454. https://doi.org/10.1016/j.scitotenv.2025.180454.

[42] Tansini A, Marin AL, Suarez J, Aguirre NF, Fontaras G. Learning from the real-world: Insights on light-vehicle efficiency and CO2 emissions from long-term on-board fuel and energy consumption data collection. Energy Conversion and Management 2025;335:119816. https://doi.org/10.1016/j.enconman.2025.119816.

[43] 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

[44] 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

[45] 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-

			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.

For the TCO analysis, the direct economic impacts of the options have been assessed by considering the changes (compared to the baseline) in capital costs, fuel costs, and operating and maintenance (O&M) costs for an "average" new (or used, in the case of second and third vehicle owners) vehicle (car or van), registered in the time periods considered.

An "average" new vehicle of a given year is defined by averaging the contributions of the different segments of small, medium, large vehicles and powertrains by weighting them according to their market penetration as projected. The PRIMES-TREMOVE model projects the new fleet composition in a given year as a result of the need to comply with the requirements of the new policy. Therefore, the different policy options lead to different projected fleet compositions, characterised by different shares of powertrain types in the different market segments. The net savings / costs for an "average" vehicle are calculated as the difference between scenario and baseline of the weighted average of the costs and savings of the different powertrain types and segments, using the projected shares as weights. The cost indicators are used to represent the economic impacts for the new fleet of vehicles over time.

For this analysis, the following indicators have been used:

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

  This indicator reflects the change in costs over the lifetime of 20 years of an "average" new vehicle, without considering taxes and using a discount rate of 3%. In this case, the costs considered also include the external cost of CO_2 emissions (WTW) but does not include taxes.

- Net savings from an end-user perspective, using three different indicators:

  - Total Cost of Ownership (TCO) for the 1st (years 1 to 5), 2nd (years 6 to 10) and 3rd (years 11 to 15) end-user.

  This indicator reflects the change in costs of an "average" new vehicle. In this case, given the end-user perspective, taxes are included and a discount rate of 11% for cars or 9.5% for vans is used.

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/

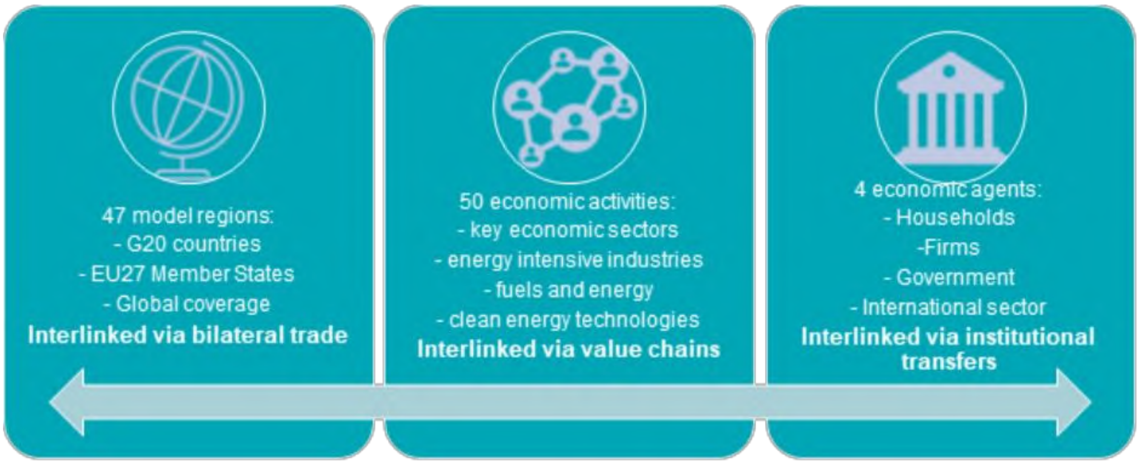
d. GEM-E3 MACROECONOMIC MODEL

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[46].

It 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 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.

The GEM-E3 model has been developed and is maintained by E3Modelling- RICARDO[47], JRC-IPTS[48] and others. It is documented in detail but the specific versions are private. A full description of the model is available at https://www.ricardo.com/media/zt4pgiyu/gem-e3_manual_2017.pdf

Figure 3: GEM-E3 system dimensions



The model has been used by E3Modelling to provide the macro assumptions for the baseline and for the policy scenarios.

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

46 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.

47 https://www.ricardo.com/en/news-and-insights/campaigns/gem-e3

48 https://ec.europa.eu/jrc/en/institutes/ipts

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 model has a global coverage, with 47 regions, where the G-20 countries, EU27 Member States, and major equipment manufacturing or energy exporting countries are represented individually and countries are linked through bilateral trade. All countries are linked through endogenous bilateral trade transactions. The model explicitly represents 50 distinct economic activities, which are interlinked across the production and consumption value chain.

The version of the GEM-E3 model used for this Impact assessment features an explicit representation of clean technology manufacturing sectors and their complete value chain, such as batteries, electric vehicles, PV panels, hydrogen, biofuels and more. Bilateral trade and global market shares of these sectors are represented and dynamically assessed in policy evaluation.

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. Intensities in the use of labour, capital, materials, energy, and other intermediate goods for clean technologies, including batteries, were sourced from the IEA's Special Report on Clean Energy Manufacturing[49]. For several key technologies, the analysis also incorporates a component-level cost breakdown, such as cathodes and anodes for batteries. In the case of electric vehicles (EVs), it draws on academic literature[50] estimating average input intensities for battery electric vehicles (BEVs) based on industry

[49] Advancing Clean Technology Manufacturing – Analysis - IEA
[50] The transition to electrified vehicles: Evaluating the labor demand of manufacturing conventional versus battery electric vehicle powertrains - ScienceDirect

and public data, cross-referenced with reports from organisations such as the International Council on Clean Transportation[51]. Labour costs account for approximately 7% of total manufacturing costs for EVs (compared to 13% of ICEVs) and 10% for batteries.

e. Methodology for the Social Impacts of policy packages

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[52].

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). Each group is characterised in terms of economic characteristics, such as average annual income, average savings[53], interest rates they face, discount rates used for intertemporal analysis; as well as driving behaviour (in this case average annual mileage).

Table 3: Median disposable income and savings by income quintile, EUR 2025

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Disposable income	12,387	23,066	32,452	43,236	66,105
Savings	3,757	9,645	17,764	30,722	83,729

- Source: Ricardo, based on [icw_res_02] Mean and median economic resources of households by income, consumption and wealth quantiles - experimental statistics and Household Finance and Consumption Survey: Methodological report for the 2021 wave

Table 3 shows the average annual disposable income and savings by income quintile expressed in EUR 2025[54]. Within each income quintile, the median was chosen as the input

[51] Update on electric vehicle costs in the United States through 2030
[52] Ricardo report (to be published)
[53] 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).
[54] **Average disposable income**: original data has been sourced from Eurostat and corresponds to year 2020, as the most recent year available with information on average disposable income by income quintile. Ricardo has converted year 2020 data to year 2025 by applying the annual growth rates of disposable income per capita in the EU27 for the years 2020 to 2024 and the compound average growth rate over the 2019-2024 period for the year 2025 [[tec00113] Adjusted gross disposable income of households per capita in PPS]. **Average savings**: original data has been sourced from the European Central Bank and corresponds to year 2021, as the most recent year available with information on net financial assets by income quintile. Original data are Member State-specific and a population-weighted EU27 average was calculated based on available Member State data. Ricardo has converted year 2021 data to year 2025 by applying data on HICP inflation (All-items excluding energy and food) [*Indices of Consumer Prices - ICP*. Retrieved from ICP | ECB Data Portal]. This adjustment was made solely to express values in 2025 price terms, not to assess changes in real

to the modelling (instead of the mean) because it better reflects the central tendency of the data, reducing the influence of extreme values and providing a more accurate representation of the typical household in the quintile.

Access to financing

As Table 3 shows, consumers in lower income quintiles tend to have lower savings. 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.

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[55].

Table 4 shows the assumptions on average annualised percentage rate (APR or average interest rate) for different income groups.

Table 4: Interest rate distribution and assumed averages by income quintile

	1st quintile	**2nd quintile**	**3rd quintile**	**4th quintile**	**5th quintile**
Assumed average	11.6%	9.8%	7.5%	5.3%	4.1%

Source: Ricardo, based on ECB *Bank interest rates - loans to households for consumption*[56]

Great variability of interest rates is observed within Member States, and future rates may be influenced by different factors[57]. To reflect this in the modelling, interest rates were assigned to each income quintile based on empirical evidence. The middle-income group (Q3) is anchored to ECB data on average consumption loan rates (ECB, 2025)[58], while rates for other quintiles are adjusted proportionally based on observed differentials by income (Grunewald et al., 2023) (yahoo! finance, 2025). Specifically, interest rates were assumed to be 30% and 55% higher for the second and first quintiles, respectively, and 30% and 45% lower for the fourth and fifth quintiles. This approach provides a more realistic distribution of borrowing costs across income groups. The non-monotonous pattern[59] is not expected to materially affect the interpretation of results, as the relative differences between quintiles remain broadly consistent.

Discount rate

purchasing power. The HICP-based projection is retained only as a price adjustment factor to align data across years.

[55] 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 Household Finance and Consumption Survey: Methodological report for the 2021 wave].

[56] ICP | ECB Data Portal

[57] 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.

[58] Average of the last six months available, i.e. February to July 2025.

[59] Non-monotonous means that interest rates do not change steadily (i.e., by the same number of percentage points) between each quintile; instead, they vary based on observed patterns.

Lower income households or individuals are shown to value the present more, when compared to higher income groups (Samwick, 1998) and (Gustman, 2005). 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 European Commission's wider modelling and the baseline scenario for the Impact Assessment, 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).

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 an apply a linear interpolation for the quintiles in between, being 11% the average. Table 5 shows subjective discount rate assumptions by income quintile, based on the negative relationship between household income and the discount rate.

Table 5: Subjective discount rate assumptions by income quintile

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Discount rate	16.0%	13.5%	11.0%	8.5%	6.0%

Source: Ricardo, based on Samwick (1998)[60] and Gustman (2005)[61]

Other assumptions

Mileage assumptions are presented in Table 6. Average mileage is assumed to be ~12 000 km/year (over a typical lifetime to end-of-life disposal of ~20 years and 240 000km). 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 (U.S. Bureau of Transportation Statistics, 2012).

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 6: Annual mileage assumptions

	Mileage (km/ year)
ALL	12 000

60 Discount rate heterogeneity and social security reform. Journal of Development Economics, 57(1): 117-146

61 The social security early entitlement age in a structural model of retirement and wealth. Journal of Public Economics, 89(2-3): 441-463. https://doi.org/10.1016/j.jpubeco.2004.03.007

	Mileage (km/ year)
Q1	7 500
Q2	9 500
Q3	12 000
Q4	14 500
Q5	16 500

Table 7: Other assumptions

Other assumptions	
OEM mark-up	1.4
Ownership duration	5
Maximum savings spent	Up to an amount that preserves a 2-month income buffer
Maximum loan quota (% of income)	15%
Maximum loan maturity (years)	5

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 assumed to be 1st users, half Q2, all Q3 and half Q4 are assumed to be 2nd users (purchasing from Q1 and half Q2), and half Q4 and all Q5 are assumed to be 3rd users (purchasing from Q2, Q3 and Q4 2nd users).[62]

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 choices realistically available to the consumer groups[63]. It is defined in terms of financial capacity for a given income group compared to

[62] 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.

[63] 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).

the vehicle upfront price. In this analysis, a vehicle model/powertrain/segment is thought to be affordable if a household has sufficient savings to cover either an upfront purchase or a down payment for a loan, while maintaining a buffer equivalent to two months of disposable income. Additionally, the household must have enough annual income to repay the loan within five years, with loan repayments not exceeding 15% of annual income.

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:

- **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 the 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 the down payment is capped at a level that preserves a savings buffer equivalent to two months of household income. 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 15% of household income can be used for loan repayment.[64] 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[65]. In the 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 3%.[66] 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 (1st, 2nd and 3rd user – covering the first 15 years of an overall average lifetime of ~20 years).

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.

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[64] 15% debt-to-income ratio is a commonly accepted threshold for transport affordability, see for example The social security early entitlement age in a structural model of retirement and wealth. Journal of Public Economics, 89(2-3): 441-463. https://doi.org/10.1016/j.jpubeco.2004.03.007 and Klein, N. J., Palm, M., & Connaughton, S. (2025). Transport Affordability and Automobile Debt in the United States.

[65] 5 years loan maturity has been derived from the benchmark among online resources in the EU and the UK.

[66] As required by the 'Better regulation' toolbox 2023, Tool #64: Discount factors.

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 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 consumer awareness about potential savings.

2. Assumptions on technology, economics and energy prices

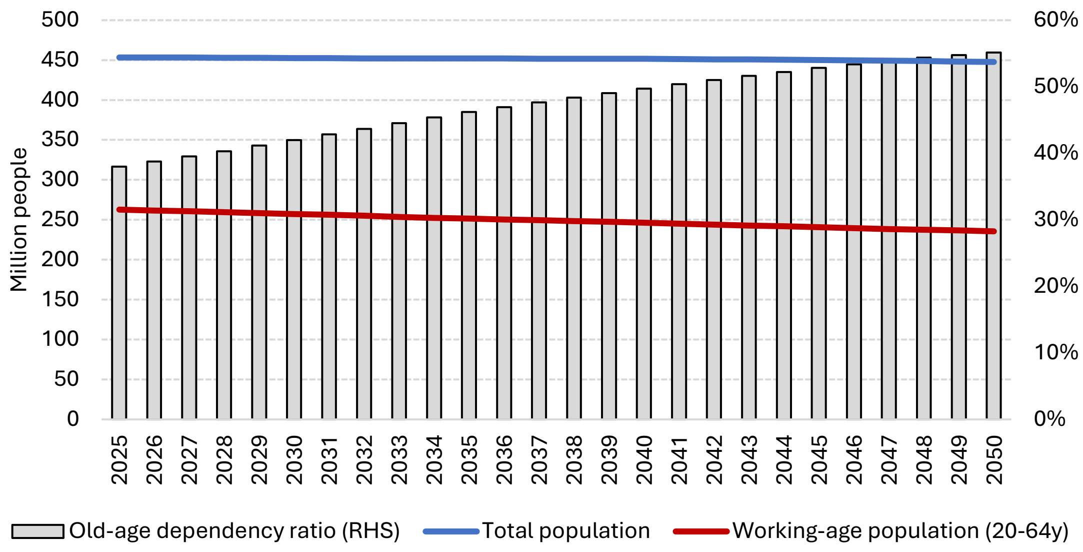
The main assumptions related to economic development, international energy prices and technologies are described below.

a. 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 model and are used to estimate transport activity, particularly relevant for this impact assessment.

Population projections rely on Eurostat's long-term projections (EUROPOP2023). The EU population is projected to remain broadly stable over the projection period to 2050. However, there is a noticeable trend towards the ageing of the population, with a 10% decline in the working-age population aged 20 to 64 between 2025 and 2050 and an increase in the old-age dependency ratio from 38% to 55.2% (Figure 4).

Figure 4: Population assumptions



Source: Eurostat

Economic projections have taken place in an unusually unstable context in the past few years, as the EU and world economies were hit first by the COVID pandemic and second by Russia's war of aggression against Ukraine, with the ensuing sharp increase in international energy prices. The GDP projections for 2025 rely on the Spring Forecast[67] of the Directorate General for Economic and Financial Affairs (DG ECFIN). From 2025 onwards, the GDP growth projections converge to those prepared by DG ECFIN for the 2024 Ageing Report[68]. At EU level, real GDP is projected to be 23% higher in 2030 than in 2015, 39% higher in 2040, and 60% higher in 2050 compared to 2015 (Figure 5).

Projections on the sectoral composition of GDP were prepared using the GEM-E3 computable general economic model. It is projected that the EU economy will continue to become increasingly services-oriented, with the sector's share rising from close to 74% of total gross value added (GVA) in 2016-2020 to around 75% in 2040 and 76% in 2050. While the share of the transport sector in total GVA declined during the COVID pandemic, the projections assume that this was only a temporary phenomenon, and that the sector's share remains broadly constant at close to 5% of the total. This is consistent with recent economic developments.

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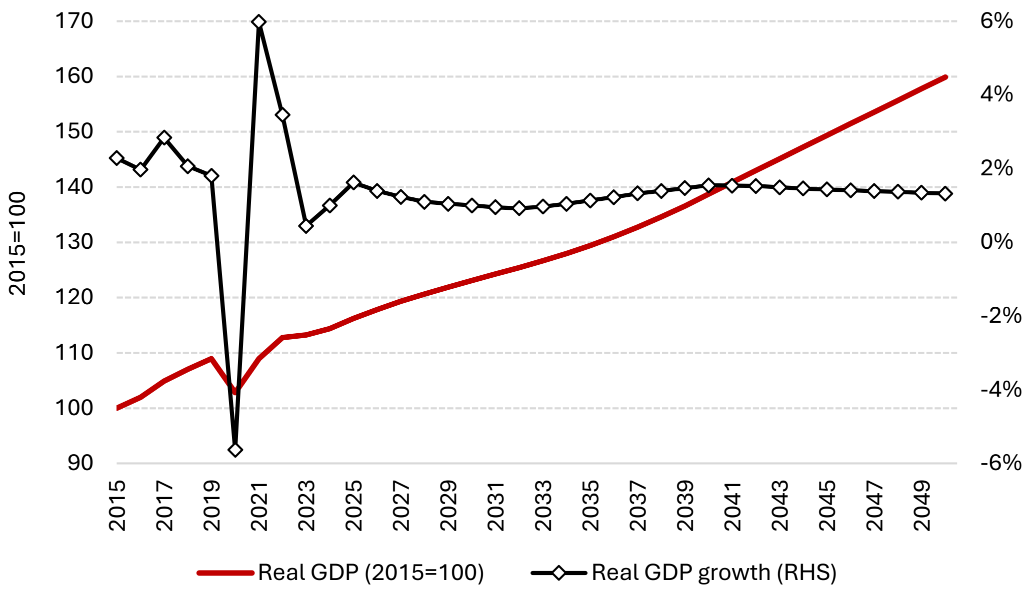
[67] DG ECFIN, European Economic Forecast. Spring 2024.

[68] DG ECFIN, 2024 Ageing Report. Economic and budgetary projections for the EU Member States (2022-2070).

Figure 5: EU GDP (2015 = 100) and GDP growth (%)



Source: DG ECFIN

Alongside socio-economic projections, transport modelling requires projections of international fuel prices. Table 8 shows the oil prices assumptions of the baseline used in this impact assessment.

Table 8: Oil price assumptions

Oil	2015	2020	2030	2040	2050
in $'2023 per boe	62.6	48.0	92.8	105.7	131.6
in €'2023 per boe	57.5	44.0	85.2	97.0	120.7

b. 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 development of the baseline, these assumptions have been updated based on a rigorous literature review carried out by external consultants and reviewed by the JRC. Continuing the approach adopted in the long-term strategy in 2018 and for the Reference Scenario 2020, the Commission consulted on the technology assumption with Member States and stakeholders in 2024. In particular, the technology database of the main model suite (PRIMES, PRIMES-TREMOVE, GAINS, GLOBIOM, and CAPRI) were discussed with Member State during a meeting of the Reference scenario expert group on 5 June 2024. They also benefited from a dedicated consultation workshop with stakeholders, held on 22 and 23 October 2024.

The battery cost trajectory considered is provided in Table 9.

Table 9: Battery cost trajectory

EUR/kWh	2020	2025	2030	2035	2040	2045	2050
	141	97	72	67	63	60	58

3. SUMMARY OF ASSESSMENT METHODOLOGY FOR VEHICLE LABELLING

Qualitative assessment – scoring system

The assessment of the impacts of the **vehicle labelling** options largely relied on a **qualitative** approach, based on data and evidence gathered via desk and field research, including interviews with key stakeholders, in combination with expert judgment. This approach was deemed more appropriate than attempting to quantify the impact[69] of the measures on purchase decisions or the consequential economic, environmental and social effects, as that would require relying on assumptions concerning consumer choices that would not be possible to verify.

Taking into account the range of evidence available, expert judgment was used to score the expected impacts as presented in the table below:

Definition	Score
Major/large positive impact	+2
Minor/small positive impact	+1
No or negligible impact	0
Minor/small negative impact	-1
Major/large negative impact	-2

The assessment of impacts was first undertaken at policy measure level, by assigning a score to each policy measure for impact criteria used to assess the impacts on information provision to consumers and the economic, social and environmental impacts. The scores of the two policy options (each consisting of a combination of policy measures) were calculated according to the following steps:

- Step 1: Grouping of policy measures into ten policy measure groups ("**PM groups**"), which in turn were combined into four **categories**: (i) information channels and methodological aspects; (ii) information elements; (iii) harmonisation; (iv) vehicle scope. For calculating the total score, each of these four categories was assigned an equal weight of 25%.
- Step 2: Assigning weights to each **policy measure group ("PM group")**: within each of the four categories, the 25% weight was distributed equally among the PM groups belonging to that category.
- Step 3: **Adding up** the scores for all policy measures within each category.
- Step 4: Calculating the **weighted average score** for each policy option, i.e. the average of the scores from Step 3, using the weights determined in Step 2.

[69] In general, it is not possible to establish a causal link between legal provisions on providing consumer information and changes in consumer behaviour, since the consumers' decision may be influenced by many other factors than the specific information provided via a label or other channels – such as price and personal preferences. This makes it hard to disentangle the specific effect that the vehicle labels may have on purchasing or leasing choices.

Quantitative assessment of compliance cost for businesses

The adoption of the policy measures under consideration may create certain costs for businesses, in particular dealers. These may include costs to ensure compliance with the new requirements including the one-off costs in certain cases for the introduction of new or updated systems to print the label, and the ongoing costs to apply the new requirements for each vehicle or model sold. In some cases, cost savings may also arise as certain requirements are removed.

The analysis has been based on a combination of logical analysis of how costs might arise, based on assumptions on the affected stakeholders and on the expected split of responsibility for taking further action, compared to the baseline, as well as stakeholder inputs and desk research. To the extent possible, estimates of costs have been made. However, as specific input provided by stakeholders on the impacts of the measures has been limited, in many cases informed assumptions had to be made to allow for an approximate estimate of the costs. Where calculated, costs have been estimated for the period up to 2040 using a discount rate of 3% to project values into the future, based on 2023 prices. Cost estimates from sources prior to 2023 have been adjusted to 2023 using inflation rates. It was assumed that the first year of implementation of the policy options would be 2029.

Removal of the requirement of a poster from showrooms may result in cost savings, although these are probably going to be limited. In the absence of specific input from stakeholders, the associated costs were estimated by multiplying the number of posters removed each year, assumed at one for each of the 146 183 EU vehicle dealers, by the estimated cost of printing a B2-size poster (EUR 17) and the cost of the poster application (EUR 7.5). This leads to an estimated annual cost saving of EUR 3.6 million across all dealers.

Harmonisation: Introducing a common label design with common categorisation is expected to lead to cost savings for manufacturers and dealers. While manufacturers will face small initial investments to integrate their systems with a central EU database and ensure data standardisation, this upfront cost is expected to be offset by the long-term elimination of fragmented national reporting requirements. Dealers, will see savings as they will have the possibility to print labels from the central system. An estimate for total industry savings was made by removing the total expenditure made by manufacturers to update relevant information for the label on national websites, estimated at EUR 7.3 million/year[70].

Measures related to **extending the scope** of the Directive are expected to result in additional costs related to compliance with the new provisions for manufacturers, dealers involved in the sale of new vans and of second-hand cars/vans.

In the case of **extension of the scope to vans**, applicable for both option LAB_1 and LAB_2, there are possible increases in ongoing costs for dealers from displaying the

[70] European Commission: Directorate-General for Climate Action, Brannigan, C., Zabalo, M., Krapp, A., Long, F., Bracci, F., Kilsen, A. & Skinner, I. Support to the review of the car labelling Directive – Report for DG Climate Action European Commission, [not yet published], 2025

information, which was estimated as the sum of costs for printing physical labels (EUR 0.34 per label) and labour costs for placing the labels in the showroom (EUR 2.26 per label). These costs were applied across all new vans sold in the EU from 2029 onwards (projected around 1 570 000 in 2029) and have been estimated at EUR 4.1 million annually. It is assumed that the great majority of dealers selling vans also sell passenger cars, and as a result need to make very limited updates to their systems. Some additional costs may arise for some of the other information channels, but there are also synergies that can be expected with the passenger cars, and such costs have been assumed as marginal.

Extending the scope to cover **second-hand vehicles** will introduce some costs for all dealers that are active in the second-hand vehicles market. LAB_2 addresses all second-hand cars and vans offered for sale or lease by professional retailers, including those first registered before the legislation will enter into force, whereas LAB_1 is limited to those first registered in the EU after the entry into force of the legislation.

- One-off costs have been assumed to be EUR 2 000[71] to cover the need for updates and for new systems to be introduced by dealers that only sell second-hand vehicles and for training of selected staff for these dealers that do not have previous experience with the car label. With an estimated number of 58 000 second hand vehicle dealers[72], the one-off costs would be EUR 116 million.

- Extending the scope to cover all second-hand vehicles (option LAB_2) will necessitate ongoing costs for printing and affixing the labels, which were assumed to be consistent with those linked to the extension of the scope to vans outlined above but only applied across second-hand vehicles sold by dealerships. On the basis that the second-hand vehicles market is 3.8 times larger than that of new vehicles – around 32 million second-hand vehicles were sold in 2023 and close to 38 million are expected in 2029, of which 44% are sold by second-hand dealers rather than in consumer-to-consumer sales[73] – the annual cost for the label for all second-hand cars and vans was estimated to be EUR 43.5 million[74].

This results for option LAB_2 in a net present value (NPV) over the period 2029 to 2040 in EUR 499.4 million, assuming a constant cost of EUR 43.5 million per year over that period.

- Extending the scope to cover only second-hand vehicles put on the market after the entry into force of the revised legislation (option LAB_1), would gradually introduce the abovementioned ongoing cost for printing and affixing the labels. Assuming an

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[71] Cf. footnote 70.

[72] In the absence of specific data on the number of second hand dealers the estimate is based on the number of second hand vehicles sold via dealerships (estimated to be around 17 million) divided by the average number of vehicles sold by each dealership (300) (Data from: https://www.am-online.com/news/dealer-news/2015/11/05/uk-dealerships-ride-high-for-sales-performance-in-europe and https://www.bain.com/insights/the-outlook-for-the-european-used-car-market-brief/).

[73] https://www.bain.com/insights/the-outlook-for-the-european-used-car-market-brief/

[74] This is based on an estimate of 38 million sales, 44% of which sold via dealers and a cost of EUR 2.6/label for printing and affixing each label.

average lifetime of the vehicles of 20 years and that the share of second-hand vehicles registered after the entry into force of the revised legislation in the total number of second-hand vehicles would grow linearly from 2029, results in a share of 11/20 of all the second-hand vehicles sold via dealers in 2040 to be covered under option LAB_1. The NPV of the annual cost for printing and affixing the label for such second-hand cars and vans under LAB_1 was estimated to be EUR 101.9 million.

This results for option LAB_1 in a net present value (NPV) over the period 2029 to 2040 in EUR 205.4 million, assuming a linear increase of annual costs from EUR 0 in 2029 to EUR 23,9 million in 2040, with an average of EUR 12 million over that period.

The additional number of consumers reached under LAB_2 compared to LAB_1 is estimated as 17 million in the first year, based on the following assumptions:

- close to 38 million second-hand vehicles are expected to be sold in 2029 (in 2023 around 32 million);
- 44% of those 38 million (i.e. 17 million) are sold by professional second-hand dealers rather than in consumer-to-consumer sales;
- In the first year (2029), no second vehicles are sold that were first registered in the EU after the entry into force of the legislation. Based on the assumption of average lifetime of 20 years, the difference in consumers reached would be 8,5 million (10/20 * 17 million) in 2039 and would disappear by 2049.

In total, 145 million additional second-hand vehicle buyers would be reached by LAB_2 compared to LAB_1 over the period 2029-2040. In this context, LAB_2 allows to reach a significantly higher number of buyers over the period.

Table 10: Compliance costs (or savings) for businesses (in EUR million) for LAB_1:

Policy measure	One-off cost	Annual costs	NPV (2029-2040)
Remove poster	0	-3.6	-32.6
Harmonisation	0	-7.3	-66.9
Extension of scope to new vans	0	4.1	37.2
Extension of the scope to second hand vehicles registered after the entry into force of the revised legislation	116.4	12[75]	205.4
Total LAB_1	**116.4**	**5**	**143**

[75] NPV calculated from 2029 to 2040, assuming a linear increase from EUR 0 in 2029 to EUR 23.9 million in 2040; annual cost indicated as average over that period.

Note: Values in EUR million. First year of implementation assumed to be 2029. Net Present Value (NPV) based on an annual discount rate of 3%.

Table 11: Compliance costs (or savings) for businesses (in EUR million) for LAB_2:

Policy measure	**One-off cost**	**Annual costs**	**NPV (2029-2040)**
Remove poster	0	-3.6	-32.6
Harmonisation	0	-7.3	-66.9
Extension of scope to new vans	0	4.1	37.2
Extension of the scope to all second-hand vehicles	116.4	43.5	499.4
Total LAB_2	**116.4**	**37**	**437**

Note: Values in EUR million. First year of implementation assumed to be 2029. Net Present Value (NPV) based on an annual discount rate of 3%.

Quantitative assessment of implementation costs for national authorities

Introducing a **common label design with common categorisation** is expected to lead to cost savings for Member States. The development of a European label database would mean that Member States would no longer need to develop, maintain, or operate their own national car labelling databases and associated tools. It was estimated[76] that national authorities spend EUR 2.6 million annually to collect information on labels and a further EUR 900 000 per year on website maintenance. These costs are assumed to be eliminated following the introduction of harmonisation of the label. As a result of the harmonising the label, no changes to enforcement costs are assumed compared to the baseline.

Extending the scope to new vans is expected to result in additional ongoing costs for monitoring and enforcement of the provisions covering new vans. National authorities estimated[77] fixed annual costs at between EUR 1 000 and EUR 10 000 per year. While there may be synergies with the enforcement on cars, it was assumed that some extra resources will be needed. Using the average value within that range, the total annual cost for monitoring was estimated at EUR 0.13 million. Assuming that, in addition, enforcement effort is proportionate to the number of vehicles in scope and the average enforcement cost per vehicle being around EUR 0.15, it was estimated that the additional cost of enforcement will be EUR 0.24 million per year, bringing the total for monitoring and enforcement at EUR 0.37 million per year.

Extending the scope to all second-hand cars, in case of option LAB_2, is also expected to result in ongoing costs associated with the enforcement of the provisions over a larger number of vehicles. National authorities estimated[78] fixed annual costs at EUR 10 000-100 000 per year. Using the average value within that range, the total annual cost for monitoring was estimated at EUR 1.3 million. Assuming that, in addition, enforcement

[76] Cf. footnote 700
[77] Cf. footnote 760
[78] Cf. footnote 7070

effort is proportionate to the number of vehicles in scope and the average enforcement cost per vehicle being around EUR 0.15, it was estimated that the additional cost of enforcement will be EUR 2.6 million per year, bringing the total for monitoring and enforcement at EUR 3.9 million per year. This results for option LAB_2 in a net present value (NPV) over the period 2029 to 2040 of EUR 35.7 million.

Extending the scope to cover only second-hand vehicles put on the market after the entry into force of the revised legislation, in case of option LAB_1, would gradually introduce the abovementioned cost for enforcement effort proportionate to the number of vehicles covered, while the fixed cost per year per Member State is assumed to remain the same. With the same assumption on lifetime and linear growth as for the calculation of costs for businesses, the NPV of the annual cost for enforcement for the second-hand cars and vans covered under LAB_1 was estimated to be EUR 18.2 million.

Table 12: Implementation costs (or savings) for national authorities (in EUR million) for LAB_1:

Policy measure	**One-off cost**	**Annual costs**	**NPV (2029-2040)**
Harmonisation	0	-3.5	-31.6
Extension of scope to new vans	0	0.4	3.4
Extension of the scope to second hand vehicles registered after the entry into force of the revised legislation	0	2[79]	18.2
Total LAB_1	**0**	**-1.1**	**-10**

Note: Values in EUR million. First year of implementation assumed to be 2029. Net Present Value (NPV) based on an annual discount rate of 3%.

Table 13: Implementation costs (or savings) for national authorities (in EUR million) for LAB_2:

Policy measure	**One-off cost**	**Annual costs**	**NPV (2029-2040)**
Harmonisation	0	-3.5	-31.6
Extension of scope to new vans	0	0.4	3.4
Extension of scope to all second-hand vehicles	0	3.9	35.7
Total LAB_2	**0**	**0.7**	**7.5**

[79] NPV calculated from 2029 to 2040, assuming a linear increase from EUR 0 in 2029 to EUR 1,4 million in 2040; annual cost indicated as average over that period.

4. *NOTE: VALUES IN EUR MILLION. FIRST YEAR OF IMPLEMENTATION ASSUMED TO BE 2029. NET PRESENT VALUE (NPV) BASED ON AN ANNUAL DISCOUNT RATE OF 3%.* **ADDITIONAL CONSIDERATIONS**

In case vehicle manufacturers do not meet their CO_2 emission targets, or Member States and transport operators do not fully comply with other legal requirements, or consumers delay the acquisition of new vehicles, the CO_2 emissions from road transport would be higher than projected in the baseline. In this case, other transport modes (where emissions are harder to abate), other instruments or other sectors would need to deliver higher emission reductions to meet the EU climate targets for 2030, 2040 and 2050. The problem identified for the revision of the CO_2 standards are related to the risks that vehicle manufacturers do not comply with future targets and not to an actual compliance failure that has already happened. The perception of such risk is evident in the contributions to the Stakeholder Consultation, especially in the feedback received by the concerned industries. The Dialogues that the President of the Commission held with the automotive value chain, as well as the Industrial Action Plan for the European automotive sector, frame the revision in the context of the need to act without delay, and even in an accelerated manner, to avoid that these risks materialise in the future, since this would have a detrimental impact on industrial competitiveness without providing benefits for climate actions.

The problem related to the technology neutrality is fully reflected in the baseline, since the implementation of the 100% target in 2035 for cars and vans determines that in the new vehicle fleet no other than zero-emission vehicles are deployed as of that date. Due to the renewal of the fleet, soon after 2050 the full stock of cars is made up of zero-emission powertrains, therefore creating a barrier to the use of renewable fuels. Further information on the projected evolution of the system in the baseline based on the Primes projections is available and can be added in the main text of the Impact Assessment or in the Annex.

As explained in the Annex to the Impact Assessment, the models have been calibrated for the baseline to the latest available data (2023 up to 2025, depending on the latest statistics available). For this, the main data inputs to the PRIMES-TREMOVE model, such as for activity and energy consumption, come from the EUROSTAT database and from the Statistical Pocketbook "EU transport in figures". Excise taxes are derived from DG TAXUD excise duty tables. Other data comes from different sources such as the European Alternative Fuels Observatory (EAFO), research projects (e.g. the Study on New Mobility Patterns in European Cities) and reports.

Concerning the new vehicle fleet composition for the baseline, in the context of this exercise, the PRIMES-TREMOVE and the JRC DIONE transport models are updated to take into account historical monitoring data from the years 2005 until 2023 and the 2024 market shares of different powertrain types, based on official monitoring sources under the Regulation itself. In order to reflect the latest data until Autumn 2025, available statistics from EAFO have been used to reflect the deployment of powertrains.

Therefore, the baseline fully reflects the latest available market developments.

The assumptions used for developing baseline scenarios with the PRIMES model, that underpin impact assessments in the energy, transport and climate policy areas, are consulted regularly with Member States and other stakeholders. In this context, the macro-economic projections, the energy price projections and the technology assumptions have been consulted with Member States on 5 June 2024. In addition, bilateral meetings with Member States took place between September 2024 and April 2025 to discuss the national policies to be reflected, based on the updated National Energy and Climate Plans prepared by the MS under the Regulation 2018/1999 on the Governance of the Energy Union and Climate Action and submitted by the Member States to the Commission during 2024-2025.

The technology assumptions, that drive the magnitude of the impacts on costs and benefits, are based on a rigorous literature review carried out by E3-Modelling in collaboration with the JRC and building on studies conducted for the Commission and used in previous Impact Assessments on related topics. Continuing the approach adopted in the long-term strategy in 2018 and for the Reference Scenario 2020, the Commission consulted on the technology assumptions with Member States and stakeholders in 2024. In particular, technology assumptions were discussed with Member States during a meeting on 5 June 2024. They also benefited from a dedicated consultation workshop with stakeholders, held on 22-23 October 2024. It should be noted that the technology assumptions consulted, including costs, refer to those related to vehicles but also power generation, production of fuels such as renewable fuels of non-biological origin (RFNBO) and biomass production pathways and costs. These assumptions, together with the policies included in the baseline (e.g. the Renewable Energy Directive), drive the evolution of electricity and RFNBOs prices over the projection period. They also determine, together with the policies assumed, the magnitude of the impacts on capital and fuel costs in the baseline and in the policy options.

ANNEX 5: COMPETITIVENESS CHECK

1. OVERVIEW OF IMPACTS ON COMPETITIVENESS

As explained in Section **Error! Reference source not found.** of the Impact Assessment, t he Industrial Action Plan for the European automotive sector introduces around 50 flagship actions. The CO_2 standards will not be the only policy tool to support manufacturers competitiveness, profitability and ability to invest, but should be considered as part of a broader policy toolbox. See details on competitiveness in the main text of the Impact Assessment.

The impacts on competitiveness of both option packages were evaluated through the following four dimensions:

- **Cost and price competitiveness**, which accounts for
  i. **ongoing production costs:** recurring expenses of manufacturing vehicles such as labour, energy, intermediate goods, and capital;
  ii. **one-off adaptation or reconversion costs**, including temporary investments to scale production, modify assembly lines, or integrate new powertrain technologies; and
  iii. **administrative costs:** regulatory reporting, documentation, certification, and other compliance-related efforts.

- **International competitiveness** captures effects on EU firms' global positioning, trade, regulatory engagement, cross-border investment, and market share.

- **Capacity to innovate** refers to incentives for R&D, and product and process innovation.

- **SME competitiveness** reflects how the above impacts play out for smaller firms, including their ability to absorb adaptation costs, engage in innovation, and maintain market positioning relative to larger competitors.

An assessment comparing the two main combinations of options (COMBI_1 and COMBI_2) is provided below. A summary of the competitiveness impacts of the preferred combination of options (COMBI_1) is shown in the following table.

Dimensions of Competitiveness	Impact of the initiative (COMBI_1) (++ / + / 0 / - / -- / n.a.)	References to sub-sections of the main report or annexes
Cost and price competitiveness	0	
International competitiveness	0	
Capacity to innovate	0	Section 3.3.4.3

SME competitiveness	+	Section 6.2, Section 6.3, Annex 6

The two combined options differ mainly in the degree and persistence of flexibility. Both ease short-term adjustment pressures but diverge in how clearly they signal the long-term direction of the transition.

Option COMBI_1 introduces moderate flexibilities, which reduce transition pressure without weakening the signal for full electrification. Option COMBI_2 extends these measures, allowing a limited share of ICE and hybrid vehicles to remain in the market, even beyond 2040. This weakens the clarity of the long-term signal and is expected to slow electrification trends more visibly, as the reduced BEV deployment dampens scale effects and learning-by-doing in zero-emission technologies.

Quantitatively, as shown in Section 6.3, both options have very small effects on costs, output, and exports, with COMBI_2 showing somewhat larger negative deviations. The macroeconomic results show that both options have minor effects on GDP and employment, with somewhat larger export reductions for COMBI_2. Biofuel output expands markedly (+8% to +31% in domestic production by 2050 in COMBI_1 and COMBI_2, respectively), while EV and battery production contract (-3% to -12%), resulting in modest GDP losses mainly linked to weaker export performance in high-value manufacturing.

COMBI_1 maintains policy credibility and supports steady investment in zero-emission supply chains. COMBI_2 introduces a less decisive long-term signal, which may discourage some innovation in zero-emission technologies and high-value investment. Both options may contribute to short-term competitiveness through moderate flexibility that may help profitability and investments. COMBI_1 maintains a stronger and clearer innovation signal, while COMBI_2 trades a small amount of signalling strength for slightly more adjustment space – a trade-off that remains minor in quantitative terms.

2. SYNTHETIC ASSESSMENT

The automotive sector is undergoing a global and structural transformation and facing serious competitiveness challenges. The analysis undertaken for the competitiveness check suggests that there is an inherent trade-off between providing flexibilities and ensuring the longer-term strategic position of the sector. Options that delay full electrification, diversify compliance pathways, or allow temporary credits would provide immediate relief both to SMEs and incumbent organisations, easing investment pressure, possibly increasing profitability and supporting employment stability. However, these same measures could risk undermining innovation and further eroding the EU's global leadership position in zero-emission technologies.

The CO_2 standards drive economies of scale which are expected to lower the prices. This is proven already in 2025 with manufacturers starting to produce affordable model in response to the need to comply with CO_2 standards.

Allowing a broader range of vehicle technologies to count towards targets could ease financial and employment pressures for the automotive sector. Ongoing production costs vary by technology; BEVs are currently more expensive to produce due to battery costs, but future reductions are expected to enhance cost competitiveness.

Flexibility in technology choice also affects market dynamics. Manufacturers producing ICEV may gain some competitive advantages, while BEV-specialised manufacturers and suppliers are likely to experience slower growth. Consumer choice is largely preserved, although vehicle availability may differ across OEMs, influencing consumer demand in turn. Negative impacts to the effective functioning of the internal market are not anticipated.

On an international level, EU firms benefit from reduced immediate pressure to scale BEV production, which can enhance operational stability and investment planning, but this is likely to come at the cost of innovation in zero-emission technologies, potentially negatively affecting European leadership relative to global competitors. Flexibility supports investment flows and supply chain resilience, particularly in sustainable renewable-fuel and PHEV/ICEV segments, and reduces risks associated with supply-chain disruptions or rapid market shifts.

The innovation landscape is also influenced by these regulatory choices. Transitional technologies like PHEVs will continue to provide incremental innovation opportunities and sustain R&D incentives in engines, fuels, and related systems, but manufacturers outside the EU will gain competitive advantage in ZEV-related innovation, exacerbated by weakened market signals from the EU automotive sector. These impacts are similarly differentiated for SMEs.

It is also important to stress that: (i) in the options analysed, the flexibilities are capped, so to avoid a negative impact on the economies of scale that are needed, (ii) the assessed flexibilities are optional, and provide for further possibilities for manufacturers to optimise their investments and portfolios depending on their production apparatus, competitive edges and customer bases.

3. COMPETITIVE POSITION OF THE MOST AFFECTED SECTORS

The sectors most affected are OEMs, component suppliers, SMEs, and sustainable renewable fuel producers.

Large automotive OEMs retain a strong position under both options, as eased CO_2 targets and fuel or hybrid flexibilities lower adaptation costs and preserve production stability. Diversified manufacturers stand to benefit most from flexibilities. Component suppliers tied to ICE and fuel systems gain temporary relief as demand for their technologies extends into the 2030s, but their competitiveness declines over time as transition towards electrification in global automotive markets continues. In contrast, BEV-related actors strengthen their long-term competitive position, particularly where clearer market signals for electrification are maintained.

Sustainable renewable fuel producers and related energy-sector actors gain a significant competitive boost through predictable demand for sustainable fuels, with COMBI_2 offering greater short-term growth but less long-term certainty.

SMEs are directly and indirectly affected across several segments of the automotive and fuel value chains. As for larger actors, reduced compliance pressure supports short-term resilience across traditional automotive segments, but BEV-oriented SMEs hold the stronger long-term advantage in innovation and export potential.

The most directly impacted are small-volume vehicle manufacturers and specialist OEMs, many of which already operate under existing exemption or derogation regimes. Changes to CO_2 standards will therefore only marginally affect their regulatory exposure. Downstream, SMEs in vehicle distribution, dealerships, and second-hand sales will also experience indirect impacts through changing product portfolios, supply availability, and consumer demand.) SMEs in supply chains related to internal combustion engines (ICEs), components, and maintenance may face transitional challenges, while those involved in battery systems, charging infrastructure, or renewable fuel production may see emerging opportunities. However, the flexibilities can also somewhat mitigate transition challenges. Tradable credits and exemptions for vehicles running on renewable or sustainable fuels can moderate short-term ZEV demand, allowing SMEs in the automotive and fuel value chains to continue to build operational resilience and develop market opportunities in the medium to longer-term.

ANNEX 6: SME CHECK

OVERVIEW OF IMPACTS ON SMES

Relevance for SMEs
Under the SME filter obligations, the initiative has been screened for its impact on smaller companies. Based on SME filter criteria, this initiative is relevant for SMEs[80]. SMEs play a pivotal role in the automotive sector, with approximately 75% of all original-equipment components for vehicles assembled in the EU delivered by an estimated 2 500 independent suppliers. Alongside larger organisations, SMEs are fundamental drivers of innovation, technological development, and competitiveness in Europe. It is essential that the regulatory framework can ensure an enabling environment to provide certainty, support growth and safeguard against unfair competition.

(1) IDENTIFICATION OF AFFECTED BUSINESSES AND ASSESSMENT OF RELEVANCE
Are SMEs directly affected? In which sectors?
Amongst SMEs, small-volume vehicle manufacturers and niche producers, are directly affected by the initiative. However, many smaller OEMs already apply existing exemptions or derogations, meaning that the changes to the standards will only marginally affect them. The initiative may alleviate compliance burdens by reducing short-term costs and allowing for increased flexibility in production planning and investment. In terms of the provisions for car labelling, SMEs operating within vehicle retail and distribution sectors, including new and second-hand car dealerships, importers and distributors will be directly affected. Small-volume OEMs, in particular, face direct compliance implications, while dealerships and importers will bear the operational aspects of implementing new labelling standards. The simplification of the label avoids administrative burden for all dealers, but extension of the scope to include second-hand vehicles and updated labelling requirements may necessitate additional administrative procedures, marketing materials, and consumer communication. The associated costs are expected to be moderate but will have a bigger impact on SMEs in relative terms.
Estimated number of directly affected SMEs
According to Eurostat (2022) data, the manufacturing of motor vehicles (NACE 29.1) activity is dominated by a small number of large multinational producers. SMEs constitute approximately 95% of enterprises in this segment (2 330 enterprises) but account for less than 10% of total employment.

[80] https://ec.europa.eu/docsroom/documents/63274

In the automotive supplier industry (NACE 29.3), only 17% of the labour force is employed by SMEs[81].
Estimated number of employees in directly affected SMEs
Eurostat (2023) indicates that around 23 300 employees of a total 1 090 000 in the NACE 29.1 segment (manufacturing of motor vehicles) are employed by SMEs. Precise figures for SME employment in downstream activities such as vehicle sales, repair, and related services (NACE G45) are not available.
Are SMEs indirectly affected? *(Yes/No)* **In which sectors? What is the estimated number of indirectly affected SMEs and employees?**
Yes. Suppliers and automotive equipment manufacturers are likely to be indirectly affected through their position in the value chain. Eurostat data (2022) indicates that around 9 500 manufacturers of parts and accessories for motor vehicles (NACE 29.3) are in operation in the EU, of which around 90% are SMEs. If regulatory drivers for electrification are moderated, SMEs involved in renewable-fuel production, distribution, or certification benefit from increased demand for such fuels, with a likely corresponding decrease in growth within BEV-related supply chains. Suppliers of ICEV/PHEV and their components may benefit from a (temporary) extension of market relevance for these technologies.

(2) CONSULTATION OF SME STAKEHOLDERS
How has the input from the SME community been taken into consideration?
Approximately 6% of all respondents to the open public consultation represented SMEs (associations or individual businesses), corresponding to around 40% of all business respondents (see Annex 2). Dialogue with SME representatives has taken place through both structured and informal channels. Commission services have engaged bilaterally with representative organisations representing SMEs active in the automotive sector, including CLEPA (suppliers) and AECDR (car dealers and repairers). These interactions have ensured that SME perspectives have been reflected in the development of policy options.
Are SMEs' views different from those of large businesses? *(Yes/No)*
No. SME responses to the public consultation broadly aligned with those of other industry stakeholders, reflecting general preferences for greater flexibility, introducing multi-annual targets and the inclusion of sustainable renewable fuels. Notably, SMEs called

[81] Employment in the EU's automotive sector | Eurofound (based on Eurostat data)

for a more gradual and cost-sensitive implementation of the standards, particularly regarding the required pace of fleet electrification, reflecting their more limited resources when compared with larger automotive manufacturers.

(3) ASSESSMENT OF IMPACTS ON SMEs[82]
What are the estimated direct costs for SMEs of the preferred policy option*?*
Qualitative assessment
-
Quantitative assessment
Vehicle labelling option LAB_2 brings additional net compliance costs for all businesses – most of which are SMEs – of EUR 437 million (NPV over the period 2029-2040), which translates into around EUR 3 per new vehicle.
What are the estimated direct benefits/cost savings for SMEs of the preferred policy option[83]?
Qualitative assessment
-
Quantitative assessment
Vehicle labelling option LAB_2 brings additional direct cost savings for all businesses – most of which are SMEs – of EUR 100 million (NPV over the period 2029-2040), due to harmonisation and simplification of the requirements, incl. removing the need to produce a poster. This partially alleviates the additional compliance costs, which are mainly due to the extension of the scope to cover also vans and second-hand vehicles, as well as the addition of a number of information elements of high relevance, esp. for BEVs.
What are the indirect impacts of this initiative on SMEs? *(Fill in only if step 1 flags indirect impacts)*
-

(4) MINIMISING NEGATIVE IMPACTS ON SMEs
Are SMEs disproportionately affected compared to large companies? (*Yes/No)*

[82] The costs and benefits data in this annex are consistent with the data in annex 3. The preferred option includes the mitigating measures listed in section 4.
[83] The direct benefits for SMEs can also be cost savings.

Yes.
If yes, are there any specific subgroups of SMEs more exposed than others?
As the market shifts towards zero-emission vehicles, SMEs directly linked to conventional ICEV and their associated supply chain face the highest level of risk due to declining demand for ICE components and systems and aftersales services. The ability to invest in new technologies or diversify product lines is generally lower than that of larger enterprises, which heightens SME vulnerability to regulatory and market changes. SMEs operating in vehicle distribution, retail, and aftersales services also face indirect impacts to revenue models and workforce skills requirements as product portfolios and consumer preferences evolve. These impacts are more gradual but will necessitate adaptation in business practices, training, and infrastructure. Therefore, by providing additional flexibility for target compliance and opening up to technologies involving ICE, this initiative should help to alleviate the direct or indirect effects of the regulatory pressure on SMEs operating within the automotive supply chain. The preferred option regarding vehicle labelling limits the additional compliance costs and administrative burden for car dealerships by harmonising the requirements across the EU and removing certain outdated obligations.
Have mitigating measures been included in the preferred option/proposal? (Yes/No)
The preferred options are largely expected to lead to overall benefits for SMEs, as explained above. For labelling, harmonisation and simplification has been sought, by harmonising the requirements across the EU and removing certain outdated obligations, which brings a reduction in administrative burden for the car dealerships currently covered by the Car Labelling Directive, most of which are SMEs.
CONTRIBUTION TO THE 35% BURDEN REDUCTION TARGET FOR SMES **Are there any administrative cost savings relevant for the 35% burden reduction target for SMEs?**
Vehicle labelling option LAB_2 brings additional direct cost savings for all businesses – most of which are SMEs – of EUR 100 million (NPV over the period 2029-2040), due to harmonisation and simplification of the requirements, incl. removing the need to produce a poster. This partially compensates the additional compliance costs incurred.

Annex 7: Main elements of Regulation (EU) 2019/631 and Directive 1999/94/EC

1. Regulation (EU) 2019/631

CO_2 emission targets

EU fleet-wide targets

The 2025, 2030 and 2035 targets set under Regulation (EU) 2019/631 are defined as a percentage reduction from the EU fleet-wide target in 2021, as shown in Table 14.

The 2025 and 2030 target levels (g CO_2/km) have been published by the Commission in Annex II to Commission Implementing Decision (EU) 2023/1623[84].

Table 14: EU fleet-wide CO_2 targets

	(% reduction from 2021 EU fleet-wide target) (g CO_2/km)		
	2025-2029	**2030-2034**	**2035-**
Passenger Cars	15% (93.6 g CO_2/km)	55% (49.5 g CO_2/km)	100% (0 g CO_2/km)
Vans	15% (153.9 g CO_2/km)	50% (90.6 g CO_2/km)	100% (0 g CO_2/km)

Annual specific emission targets for manufacturers

Each year, except for the years 2025-2027[85], 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[86]. The specific emission targets are determined on the basis of a limit value curve.

From 2025 onwards, a new limit value curve has been defined, which reflects recent trends in the composition of the vehicle fleet – in particular the increased uptake of battery and plug-in hybrid electric vehicles - as it was based on the 2021 monitoring data.

This means that, for cars, manufacturers of heavier vehicles will get a stricter emissions target than manufacturers of lighter vehicles. The opposite is still true for vans. Also, where the curve for vans consists of a combination of two linear parts, each with a different slope.

[84] http://data.europa.eu/eli/dec_impl/2023/1623/oj

[85] Following the amendment of the Regulation through Regulation (EU) 2025/1214, manufacturers' target compliance for the calendar years 2025 to 2027 will be assessed over the three years combined instead of annually.

[86] From 2025 onwards, the test mass of the vehicles is considered for this purpose, while previously this was the mass in running order.

This means that the effect of the mass on the target is more outspoken for manufacturers of the heaviest vehicles.

The curves are set in such a way that, in principle, when all manufacturers comply with their specific emission targets, the EU fleet-wide target is achieved[87].

Compliance assessment and excess emissions premium

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 EUR 95 per gram of CO_2 per kilometre target exceedance for each vehicle in the manufacturer's fleet of new vehicles registered in that year.

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 "bonus-only" crediting system applies between 2025 and 2029. 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 **25% for cars or 17% for vans**.

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%.

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:

Pooling

Pooling offers the possibility for several manufacturers to be considered together as a single manufacturer for the purpose of meeting the CO_2 emission target. This allows mamnufacturers to balance their target exceedance with the target overachievement of other manufacturers. Pooling can be done by manufacturers, which are part of a group of connected undertakings, but also by other manufacturers. Pooling between car and van manufacturers is not possible.

Exemptions and derogations

Car and van manufacturers registering less than 1 000 new vehicles per year are **exempted** from meeting a specific emission target in the following calendar year.

For **"small volume" car and van manufacturers**, i.e. those registering less than 10 000 cars or less than 22 000 vans per year, it is possible to apply for a derogation from their "default" specific emission targets.

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[87] Under the assumption that the average test mass of the fleet is equal to the reference mass (TM_0) used for the limit value curve in that year. That reference mass is adjusted every two years (from 2025 onwards) to take into account the evolution of the average fleet mass over time.

“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

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. These savings are capped up to a maximum of 6 g CO_2/km (from 2025 until 2029) and 4 g CO_2/km (from 2030 until 2034).

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 WLTP emission test procedure yields results which are representative of real-world emissions.

In-service verification of CO_2 emissions

Manufacturers have to ensure correspondence between the CO_2 emissions recorded in the certificates of conformity of their 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.

The procedures for performing these in-service verifications are set out in Commission Delegated Regulation (EU) 2023/2867[88], which contains the guiding principles and criteria, and Commission Implementing Regulation (EU) 2023/2867[89] setting out the actual procedure.

The type-approval authorities have started their verifications in 2024. They shall report their findings to the Commission, in particular where they identify deviations in the CO_2 emissions of vehicles in-service. In that case, the Commission shall take those deviations into account for the purpose of calculating the average specific emissions of a manufacturer.

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

Since 2021, the Commission collecting data from OBFCM on the real-world fuel and energy consumption of passenger cars and vans with the aim of ensure the monitoring how

[88] http://data.europa.eu/eli/reg_del/2023/2867/oj
[89] http://data.europa.eu/eli/reg_impl/2023/2866/oj

the gap between CO_2 emissions recorded at type-approval (WLTP) and real-world emissions evolves.

The detailed procedures for collecting and processing the data are set out in a Commission Implementing Regulation[90]. The first data have been published in 2024, together with a Commission report[91] and Staff Working Document[92] setting out the methodology followed.

The full data set and an overview of the main findings are available on the EEA website[93].

2. Directive 1999/94/EC

Directive 1999/94/EC requires Member States to ensure that relevant information is provided to consumers looking to buy or lease a new car. More specifically, it requires:

- A label showing fuel economy and CO_2 emissions on all new cars or displayed nearby at the point of sale;
- A poster or display prominently showing the official fuel consumption and CO_2 emissions data of all new car models displayed or offered for sale or lease at point of sale;
- A yearly guide on fuel economy and CO_2 emissions from new cars, produced in consultation with manufacturers. The guide should be available free of charge at the point of sale and from a designated body within each Member State;
- All promotional literature to contain the official fuel consumption and CO_2 emissions data for the car models to which it refers.

Annexes to the Directive set out minimum requirements that each of these items must meet.

3. The interface between the LDVs CO2 emissions standards Regulation and the Car labelling Directive

The Car labelling Directive is the requirement under the car labelling provisions to supply information to consumers on the CO_2 emissions and fuel consumption of new passenger cars. It is a policy tool to empower informed consumer choices. The Car Labelling Directive and the CO2 emissions emission standard both rely on the same method for determining the CO_2 emissions of passenger cars, i.e. the standardised Worldwide harmonised Light vehicles Test Procedure as set out in type approval legislation. The main synergy between the LDV CO_2 emissions standards Regulation and the Car labelling Directive consists of the objective to increase the demand for fuel-efficient and low-emitting vehicles, in particular ZEVs. Whereas manufacturers have indicated that a (perceived) lack of demand for ZEVs is hampering them in achieving compliance with the CO_2 emissions standards, the Car labelling Directive aims to ensure that information

[90] 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 (http://data.europa.eu/eli/reg_impl/2021/392/oj)
[91] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52024DC0122
[92] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52024SC0059
[93] https://climate-energy.eea.europa.eu/topics/transport/real-world-emissions/data

relating to the fuel economy and CO_2 emissions of new passenger cars offered for sale or lease in the EU is made available to consumers in order to enable them to make informed decisions and encourage sustainable choices (for example clear information on battery autonomy could reduce perceived anxiety and misconceptions from consumers on BEV). Indirectly, such information may contribute to shifting demand towards more fuel efficient and less CO_2 emitting cars and thus help manufacturers comply with their CO_2 emission targets set by Regulation (EU) 2019/631.

The evaluation of the Car labelling Directive found that it could be further aligned with the objective of increasing the uptake of zero-emission vehicles, by extending its information requirements to cover the key parameters of zero-emission cars. This is particularly relevant as the group of consumers buying zero-emission cars is expected to increase significantly over time as a result of the requirements in the CO_2 emissions standards and as the EU moves towards achieving its 2050 climate neutrality objective.

Therefore, both the CO_2 emission standards and vehicle labels should be designed to work together to incentivise the market uptake of zero-emission vehicles, acting both on the supply side (CO_2 emission standards) by shifting investments by car industry towards those powertrains, and on the demand side (car label) by trying to incentivise sustainable choices by consumers and nudge them towards zero-emission vehicles by providing clear information on vehicle CO_2 performance and turning them into active contributors to the transition.

ANNEX 8: OPTIONS DESCRIPTION AND ASSESSMENT– COMPLEMENTARY INFORMATION

1. FUELS – DESCRIPTION OF OPTIONS

Mechanisms

Under the option CCM, the specific emissions targets of all manufacturers would be increased through a carbon correcting mechanism that reflects the market deployment of the eligible fuels. The amount of eligible fuels used by cars (vans) in a year, multiplied by the CO_2 intensity of such fuels, gives the CO_2 emissions saved. This is then divided by the lifetime mileage of a car (van) and by the number of new cars (vans).

This will rely on the monitoring of the amount of eligible fuels put on the market. For the CCM to be effective, vehicle manufacturers have to know at the beginning of the year how much credits they can expect to prepare their compliance strategy. This means that the credits for year N will have to rely on consolidated fuels data. By then, such data will only be available for year N-2. Thus, manufacturers do not benefit immediately from a potential fast ramp-up of the deployment of the eligible fuels, which could an obstacle to fast deployment of such fuels. Besides, potential fluctuations in the placement of eligible fuels on the market may render CO_2 target compliance more difficult for vehicle manufacturers as they would have to deal with fluctuating targets over the years. Under certain circonstances, this may even jeopardise their ability to reach their targets.

Under the option VEEF, vehicle manufacturers would have to put on the EU market vehicles than can only run on the eligible fuel(s), while fuel distributors would have to install and operate dedicated pumps for those fuels. For fuel suppliers and distributors, developing and marketing those fuels can be a competitive advantage as it may attract both private and corporate (e.g. fuel card holders) customers to their networks. However, fuel suppliers and distributors would need to invest and convert a certain amount of fuel pumps upfront as drivers will not buy such vehicles if they are not convinced they will be able to refuel conveniently.

2. OVC-HEV OPTIONS

OVC-HEV options: description and rationale

Option 0 (baseline) provides certainty to investors and industries, in particular in the whole electric vehicle ecosystem by sticking to the current direction of travel, indicating that only tailpipe zero-emission vehicles can be put on the market as of 2035. Options OVC-HEV_1 and OVC-HEV_2 leave room for PHEV/EREV and will therefore stimulate limited investments in combustion engines in the longer term, possibly supporting the competitiveness of some European manufacturers in other markets.

While option OVC-HEV_1 would help ensure that PHEV/EREV put on the market will have a sufficient electric range to cover most trips (in particular daily commutes), a too low minimum electric range would render the safeguard meaningless as PHEV/EREV are already evolving towards such longer ranges. In addition, only covering a low minimum range would assume very frequent recharging, while increased ranges allow the use of the vehicle in electric mode also with less frequent charging (likely the case for those citizens who do not own a private charging point).

Option OVC-HEV_2 would offer greater confidence that PHEV/EREV are used as intended, meaning primarily in pure electric mode. Ensuring that these vehicles have access to fast charging (as in California) is a minimum safeguard to guarantee they can be conveniently and frequently recharged for any kind of usage. Making sure that under usual conditions of use (e.g. highway, cold temperatures, strong accelerations) these vehicles keep running in electric mode will improve the share of pure electric drive and reduce CO_2 emissions and the need to refuel altogether. Finally, this could be used as a global landmark for developing advanced PHEV/EREV, which would further stimulate development in the technology and eventually support even more the competitiveness of European manufacturers.

Limiting real-world CO_2 emissions of OVC-HEV

In view of limiting the potential detrimental environmental impact of allowing OVC-HEV (that are not zero-emission vehicles) to be accounted as emitting 0 gCO_2/km as of 2035, is it key to ensure that those OVC-HEV are actual close-to-zero-emitting vehicles.

Since 2022, the Commission is collecting real-world fuel consumption data from new LDVs put on the EU roads since 2021, including from OVC-HEV. The data show that real-world CO_2 emissions from OVC-HEV are on average 3,5 times higher than their type-approval average CO_2 emissions[94]. This is notably due to the fact that drivers do not recharge their vehicles as frequently as anticipated.

It is important to note that, on top of introducing further requirements for OVC-HEV, key automotive markets (incl. EU, US and China) have decided to tighten the testing regime for OVC-HEV, lowering the so-called Utility Factors to reduce the gap between lab and real-world emissions. The EU has done so in two steps, with a first tightening that already took place in 2025, while a next one is foreseen for 2027. In the public consultation, the automotive industry (ACEA, VDA, CLEPA) requested to freeze the utility factors to their 2025 levels. They argue that the 2027 changes are based on vehicles already put on the market, whereas the technology is evolving rapidly and improvements in real-world emissions should be visible shortly – with 2027 utility factors, several industrial actors argue that OVC-HEV would stop being developed and new models would not come to the market as they would help to reach CO_2 targets. In view of ensuring that real-world performances of OVC-HEV improve and to ensure a greater alignment with utility factors, some vehicle manufacturers and suppliers have suggested to introduce additional technical requirements on vehicles such as an inducement system that could reduce the performances of a vehicle if it is not frequently recharged.

Other countries and regions seeing a future in OVC-HEV have set up additional rules to ensure that OVC-HEV are driven in electric mode as much as possible and are actual low-emitting vehicles. For example, Canada has set a minimum range (80 km) for OVC-HEV

[94] https://climate-energy.eea.europa.eu/topics/transport/real-world-emissions/data

to be able to be registered on its market as of 2035, and California has set, on top of a minimum range (113 km), additional criteria to ensure OVC-HEV can be fast-charged, and can drive in pure electric mode even under extreme driving conditions. China also announced tightening rules for OVC-HEV as from 2026. This would mean that only models with more than 100 km of pure electric range and a high energy efficiency would be able to benefit from tax incentives.

Under both options, OVC-HEV_1 and OVC-HEV_2, the OVC-HEV eligible for being accounted as emitting 0 g CO_2/km as of 2035 would need to have a large minimum electric range. The average electric range of OVC-HEV put on the EU market in 2024 was 78,4 km, which is 10 km more than in 2023. While most vehicles were having a range of not more than 50 km a few years ago there are now models with 140 km and even 200 km electric range on offer. The ongoing decrease in battery prices is also supporting this trend. This indicates that setting a minimum range of around 150 km for 2035 would follow the currently ongoing evolution.

Under OVC-HEV_2, next to the minimum range requirement, eligible OVC-HEV would be required to have additional characteristics to maximise their use in electric mode, in particular:

(i) Electric range larger than non-electric range;

(ii) ICE not operating when the battery is not depleted;

(iii) Fast DC charging[95] - maximum power output of at least 50 kW.

These additional conditions would ensure that the eligible vehicles are designed in such a way that their potential to drive electrically is significant, which will considerably decrease the gap between real-world and laboratory CO_2 emissions. Conditions (i) and (iii) would incentivise the driver to recharge more frequently due to a possibility to fast charge and the inconvenience of driving solely on the combustion engine with a limited range. Condition (ii) would ensure that OVC-HEV drive in pure electric mode when the battery is charged and customers would expect to drive electrically. The analysis of real-world data has shown that, even in charge depleting mode, the combustion engine is frequently activated[96].

OVC-HEV options: impacts on vehicle cost

In 2024, the average electric range of OVC-HEVs put on the EU market was about 80 km, and the average range keeps increasing year after year. In 2035, the battery of an OVC-HEV with a 150 km range would cost about 240 EUR more than today's battery of an average OVC-HEV.

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[95] Regulation - 2023/1804 - EN - EUR-Lex

[96] Smoke screen: the growing PHEV emissions scandal | T&E

For vans, the uptake of OVC-HEV is very limited .There is currently only one OVC-HEV model sold in the EU, and this has an electric range of around 120 km. For this case, an increase in range to 150 km in 2035 would not result in additional cost.

Under option OVC-HEV_2, the additional technical conditions set out above would come with the following costs:

(i) is achieved by limiting the capacity of the fuel tank, which results in no additional costs.

(ii) is achieved through software adaptations to the vehicles, which result in no additional costs. To fulfill this requirement, the electric motor will need to be powerful enough to cover all driving situations in pure electric mode, which is a prerequisite to ensuring that those vehicles are driven primarily electrically under real-world condition of usage and therefore should be considered to be part of the baseline.

As regards (iii), the maximum charging power is limited by the battery capacity. With the current technologies, the maximum charging power is 2-3 times the battery capacity. However, new battery chemistries have the potential to achieve a higher ratio. Currently, an OVC-HEV with a 25 kWh battery (equivalent with an electric range of around 150 km) would have a maximum charging power between 50 and 75 kW. Setting a fast charging power threshold of 50 kW would ensure that vehicles are fitted with fast DC charging whithout putting additional constraints on the battery capacity. The extra cost of DC charging is estimated at EUR 200 per vehicle which is below 1% of the cost of an OVC-HEV.

3. DETAILED ASSESSMENT OF TOTAL COSTS OF OWNERSHIP FOR NEW LIGHT-DUTY VEHICLES

The below describes the costs car users face for the purchase and operation of a light-duty vehicle. Three different perspectives are offered, namely those of a first vehicle owner, buying a new vehicle in 2030 and using it for five years until they sell it in 2035, a second owner buying the 5-year-old vehicle in 2035 and using it for another 5 years, and a third owner holding the vehicle for another 5 years from 2040 to 2045. Costs taken into account are the following:

- the capital cost of the vehicle, i.e., the loss in vehicle value occurring throughout the respective use phases;
- the expenses for fuel and energy, which depend on vehicle efficiency, annual activities, and fuel and energy prices taken from the baseline scenario; and
- the operation, maintenance and insurance costs.

All cost types are discounted to calculate the net present value of the expenses. They are summed over the specific years of vehicle ownership of the respective user perspective to calculate the total costs of ownership (TCO) the vehicle owner faces.

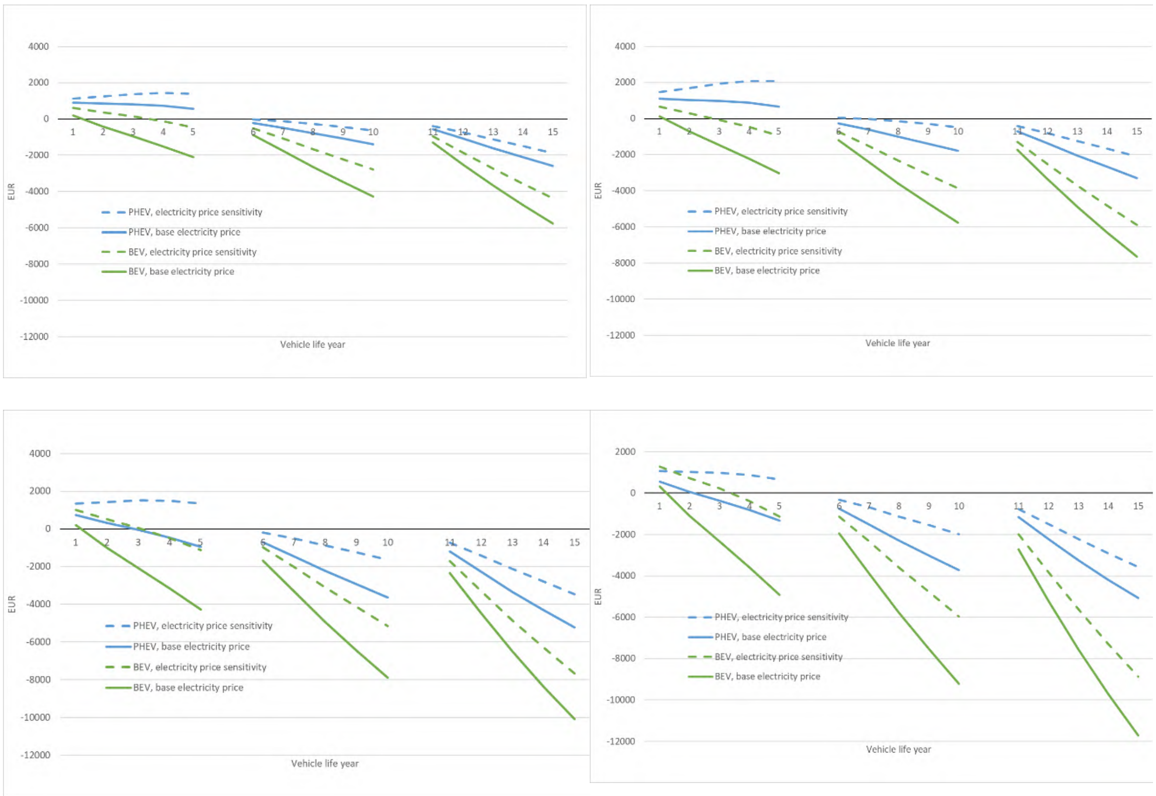
Cumulative TCO comparison for user perspectives and powertrains

Figure 6 shows the cumulative TCO for a 2030 new car of different segments. Results are presented for Plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV), whose costs are compared to those of a conventional internal combustion engine vehicle (ICE). The three groups of graphs refer to the use period of the first, second and third owner, consecutively.

As can be seen (top-left and top right, respectively), over five years of usage, the first owner of a small/lower-medium PHEV car (solid blue line) faces total costs which are higher than that of an equivalent ICE car (represented by the x-axis). The first owner of a small and lower medium BEV (green line) faces the lowest costs. It can also be seen that PHEV become cheaper than ICEV for the second user, and even more so for the third. This is due to lower fuel and energy expenditures for the PHEV. BEV is always the cheapest option.

For upper-medium and large car owners (bottom-left and bottom-right, respectively), PHEV vehicles are slightly less costly than ICEV already for the first user, and increasingly so for the second and third user. BEV are significantly cheaper for all users.

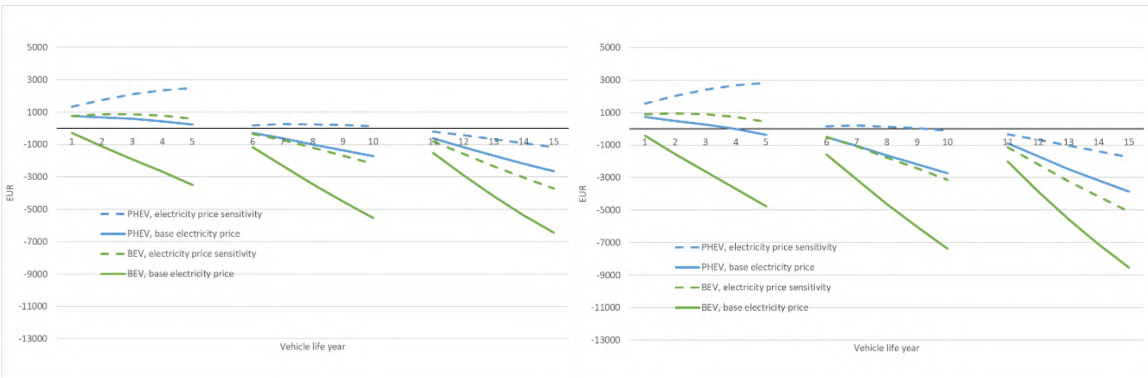
Figure 6: Cars 2030 Cumulative TCO difference vs. ICEV, over vehicle age, for first/second/third user (EUR)

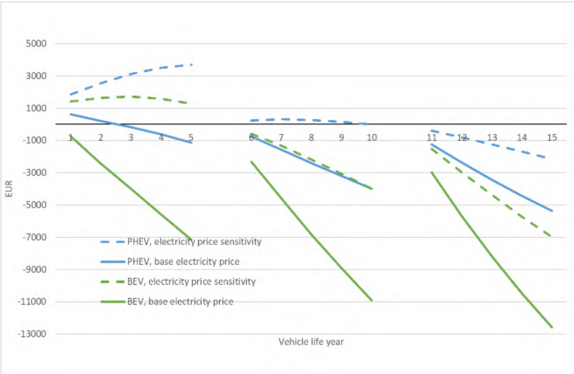


From top left to bottom right: Small/lower Medium/upper medium/large car. Blue: PHEV, Green: BEV; solid lines: base electricity price, dashed: doubled electricity price (sensitivity – see below more details on the sensitivity analysis)

Also for small, medium and large vans (Figure 7) BEV are the cheapest option from a TCO perspective. PHEV are roughly cost competitive with an ICEV for a first owner (with some savings projected for large vans), and increasingly cheaper for a second and third owner. Across all sizes, BEV are the cheapest option, by far, for all users and all sizes of vans.

Figure 7: Vans 2030 Cumulative TCO difference vs. ICEV, over vehicle age, for first/second/third user (EUR)



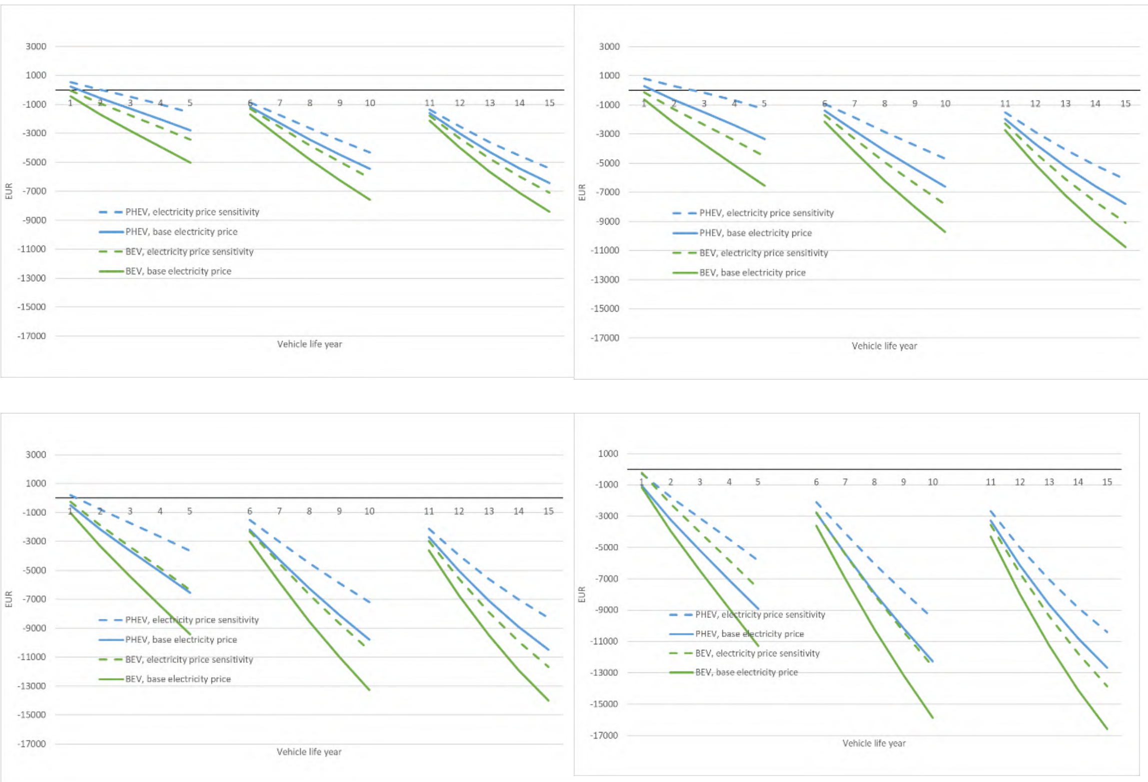


From top left to bottom right: Small/Medium/Large Van. Blue: PHEV, Green: BEV; solid lines: base electricity price, dashed: doubled electricity price (sensitivity)

2035 powertrain cost comparisons

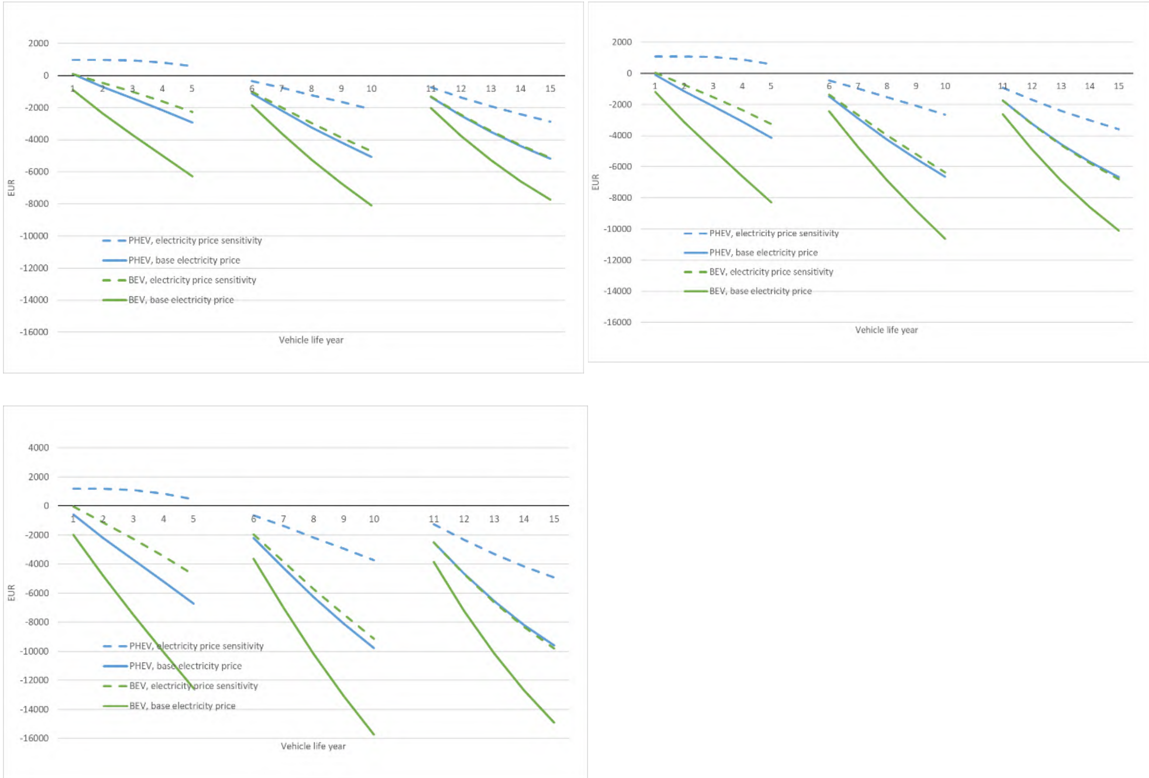
The TCO comparison shows that BEV and PHEV become less costly on a TCO basis in comparison to the 2030 results, for a vehicle bought in 2035. Therefore, enduser TCO savings per vehicle compared to ICE are higher than shown above. For all three user perspectives, BEV and PHEV cars of all segments as well as most van segments are cheaper than ICE, even if electricity prices double.

Figure 8: Cars 2035 Cumulative TCO difference vs. ICE, over vehicle age, for first/second/third user (EUR)



From top left to bottom right: Small/lower Medium/upper medium/large car. Blue: PHEV, Green: BEV; solid lines: base electricity price, dashed: doubled electricity price (sensitivity)

Figure 9: Vans 2035 Cumulative TCO difference vs. ICE, over vehicle age, for first/second/third user (EUR), TL_90



From top left to bottom right: Small/Medium/Large Van. Blue: PHEV, Green: BEV; solid lines: base electricity price, dashed: doubled electricity price (sensitivity)

Impact of dedicated SRF vehicles on TCO

For scenarios where vehicles running exclusively on eligible sustainable renewable fuels are considered, the TCO of 2035 gasoline combustion engine vehicles change. As regards vehicle capital costs, they face an, albeit small, additional cost for technology allowing that only eligible fuels can be used by them, and fuel prices can be expected to be higher.

3.1. IMPACT OF ELECTRICITY PRICE ON TCO

This sensitivity is useful due to the general uncertainty of the future development of electricity prices, as well as to reflect the wide spread of charging costs for different charging options, such as household charging, public slow and public fast charging. The impact of doubling the electricity price can also be seen in the figures presented above (dotted line).

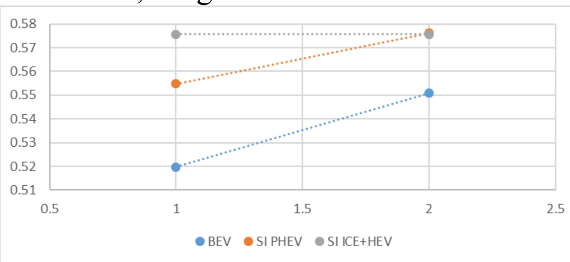
The sensitivity shows that, even if electricity prices are double compared to what projected by the model, BEV cars and vans costs remain lower than those for same-segment conventional vehicles, for all segments and user perspectives, whereas for smaller segments PHEV first users may face extra costs.

More in detail, as before, different user perspective and car segment combinations are shown. For the first end user, for both large and upper medium cars, the energy cost savings brought about by a BEV translate into savings of a few cents per kilometer compared to ICEV. Even at electricity prices that are more than twice the baseline, they remain less costly than ICEV over the 5-year use period. PHEV, on the other hand, are less costly than ICEV at baseline electricity prices, but can become more costly if electricity prices rise significantly.

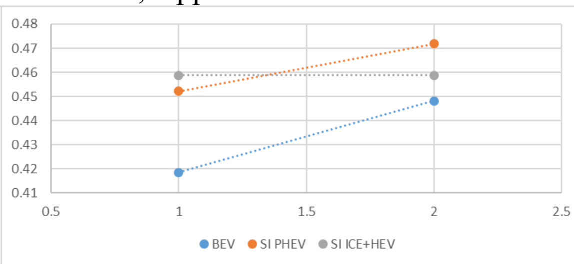
For the second and third user, the BEV advantage becomes more prominent, due to the lower upfront cost burden, as they buy vehicles which already are depreciated strongly compared to the first user, and lose less value. BEV are therefore the lower cost option over an extremely large range of electricity prices. Also PHEV are more beneficial than ICE, in terms of user costs, in the case of the third end user, even at doubled electricity costs. For the second user, PHEV are the lower-cost option than ICE at baseline electricity prices, but not if they rise strongly.

Figure 10: TCO per kilometre driven [EUR/km] for 2030 new passenger cars, depending on the electricity price which ranges from baseline electricity price ("1" on the x-axis) to twice the baseline price ("2"), for different user perspectives and car segments

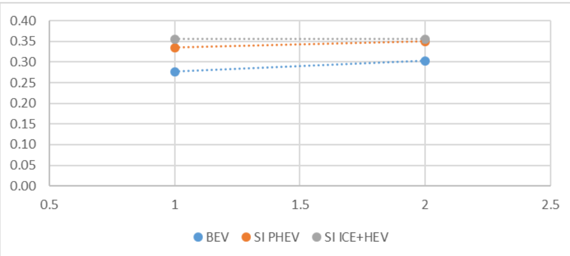
End user 1, Large Car



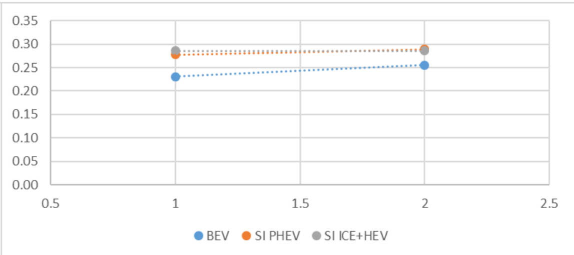
End user 1, Upper Medium Car



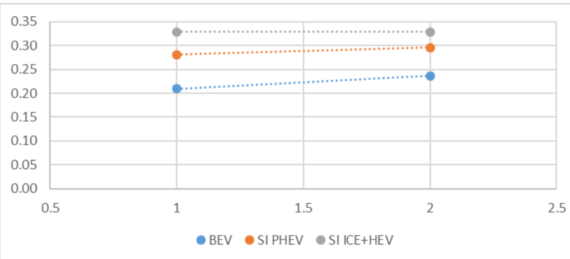
End user 2, Lower Medium Car



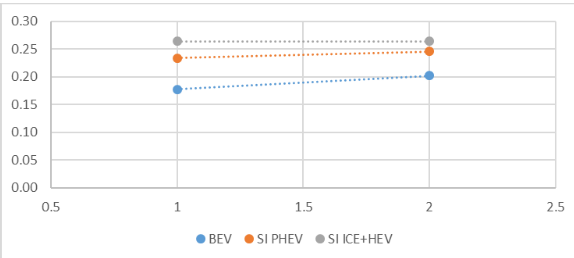
End user 2, Small Car



End user 3, Lower Medium Car



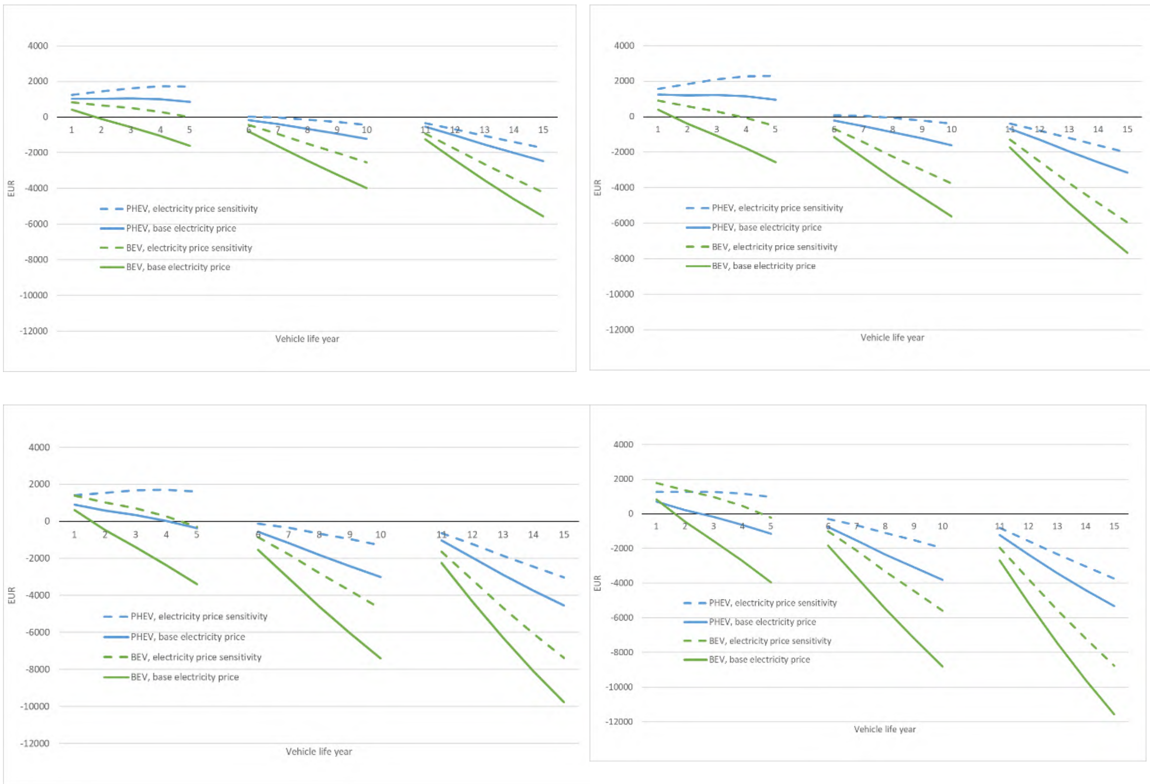
End user 3, Small Car



3.2. 2030 POWERTRAIN COST COMPARISONS (BATTERY COST SENSITIVITY)

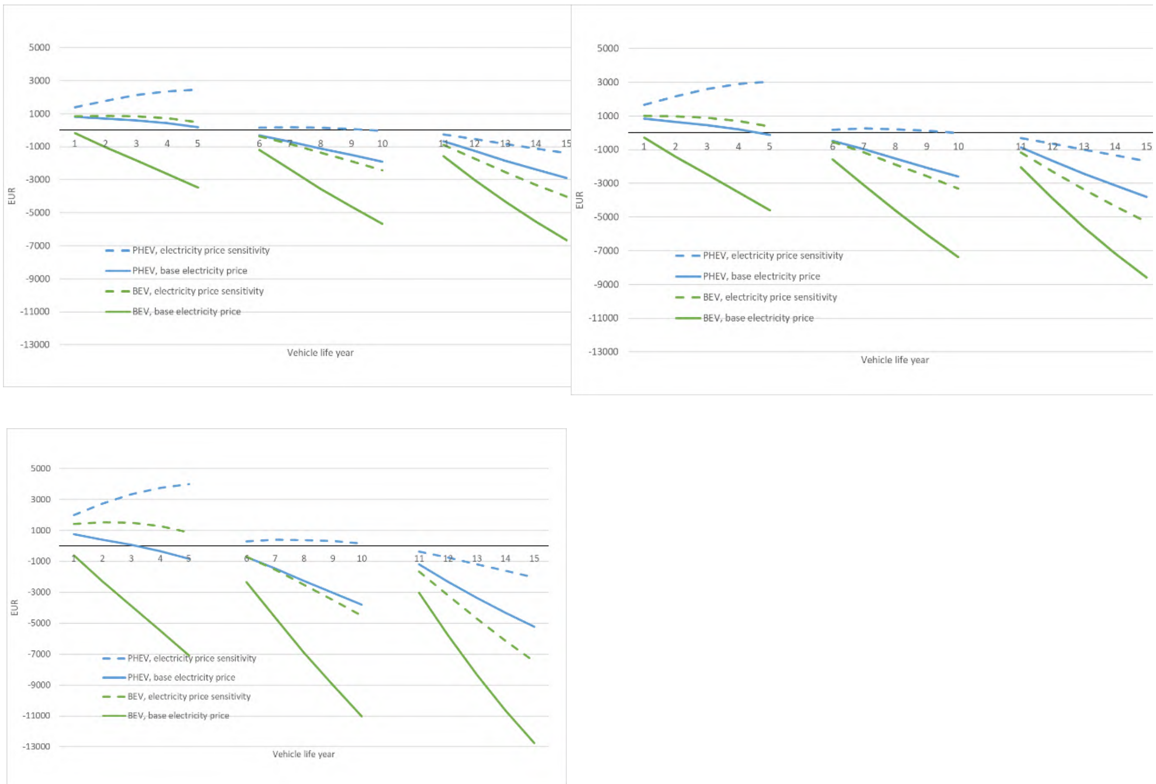
A sensitivity calculation has been carried out, on top of the baseline scenario, to explore the impacts of battery prices remaining 20% higher than expected. The battery sensitivity impacts the capital costs of BEV and PHEV, and thus their TCO. Below figures shows that, in comparison to conventional vehicles, TCO for BEV cars and vans over the 5-year use period remain lower than that for same-segment conventional vehicles, for all segments and user perspectives. For PHEV, first users face slightly higher TCO for small and lower medium cars and for small vans, whereas all other users and segments still show a positive balance compared to conventional vehicles.

Figure 11: Cars 2030 Cumulative TCO difference vs. ICE, over vehicle age, for first/second/third user (EUR), Battery Cost Sensitivity



From top left to bottom right: Small/lower Medium/upper medium/large car. Blue: PHEV, Green: BEV; solid lines: base electricity price, dashed: doubled electricity price (sensitivity)

Figure 12: Vans 2030 Cumulative TCO difference vs. ICE, over vehicle age, for first/second/third user (EUR), Battery Cost Sensitivity



From top left to bottom right: Small/Medium/Large Van. Blue: PHEV, Green: BEV; solid lines: base electricity price, dashed: doubled electricity price (sensitivity)

4. ADDITIONAL SCENARIO RESULTS

The tables below complement the information provided in Chapter 6.

4.1. FLEET COMPOSITION

Table 15: share of new cars and vans, by powertrain, in different scenarios (ICEV includes non-chargeable hybrids)

	Share of new cars by powertrain					Share of new vans by powertrain				
	2030	2035	2040	2045	2050	2030	2035	2040	2045	2050
Baseline										
ICEV	37%	0%	0%	0%	0%	49%	0%	0%	0%	0%
PHEV	3%	0%	0%	0%	0%	2%	0%	0%	0%	0%
ZEV	60%	100%	100%	100%	100%	50%	100%	100%	100%	100%
TL_Vans										
ICEV	37%	0%	0%	0%	0%	58%	0%	0%	0%	0%
PHEV	3%	0%	0%	0%	0%	1%	0%	0%	0%	0%
ZEV	60%	100%	100%	100%	100%	41%	100%	100%	100%	100%
TL_100_2040										
ICEV	37%	9%	0%	0%	0%	49%	8%	0%	0%	0%
PHEV	3%	2%	0%	0%	0%	2%	8%	0%	0%	0%
ZEV	60%	89%	100%	100%	100%	50%	84%	100%	100%	100%
TL_90										
ICEV	37%	9%	8%	8%	9%	58%	8%	5%	4%	4%
PHEV	3%	2%	2%	2%	3%	1%	8%	14%	14%	13%
ZEV	60%	89%	90%	89%	88%	41%	84%	81%	82%	83%
OVC-HEV										
ICEV	37%	0%	0%	0%	0%	49%	0%	0%	0%	0%
PHEV	3%	4%	5%	4%	4%	2%	14%	14%	14%	14%
ZEV	60%	96%	95%	96%	96%	50%	86%	86%	86%	86%
CCM-RFNBO										
ICEV	37%	1%	8%	7%	8%	49%	1%	3%	2%	2%
PHEV	3%	1%	2%	2%	2%	2%	2%	9%	9%	8%
ZEV	60%	98%	90%	90%	90%	50%	98%	88%	89%	90%
CCM-SRF										
ICEV	37%	12%	13%	12%	10%	49%	6%	5%	4%	3%
PHEV	3%	2%	3%	2%	3%	2%	7%	14%	13%	10%
ZEV	60%	86%	84%	86%	87%	50%	86%	81%	84%	87%
VEEF-SRF										
ICEV	37%	4%	1%	1%	1%	49%	13%	9%	6%	6%
PHEV	3%	0%	0%	0%	0%	2%	0%	0%	0%	0%
ZEV	60%	96%	99%	99%	99%	50%	87%	91%	94%	94%

	Share of new cars by powertrain					Share of new vans by powertrain				
	2030	2035	2040	2045	2050	2030	2035	2040	2045	2050
VEEF-RFNBO										
ICEV	37%	1%	1%	1%	1%	49%	10%	7%	5%	5%
PHEV	3%	0%	0%	0%	0%	2%	0%	0%	0%	0%
ZEV	60%	99%	99%	99%	99%	50%	90%	93%	95%	95%
Small ZEV										
ICEV	41%	0%	0%	0%	0%	49%	0%	0%	0%	0%
PHEV	3%	0%	0%	0%	0%	2%	0%	0%	0%	0%
ZEV	56%	100%	100%	100%	100%	50%	100%	100%	100%	100%
COMBI_1										
ICEV	39%	3%	1%	1%	1%	58%	7%	3%	3%	3%
PHEV	3%	4%	4%	3%	4%	1%	8%	8%	8%	7%
ZEV	58%	93%	94%	96%	95%	41%	85%	89%	90%	90%
COMBI_2										
ICEV	41%	13%	11%	10%	11%	58%	19%	15%	13%	13%
PHEV	3%	3%	5%	3%	4%	1%	7%	8%	8%	7%
ZEV	56%	83%	84%	87%	85%	41%	73%	77%	79%	80%

4.2. ECONOMIC IMPACTS

a. ADJUSTMENTS COSTS

The table below shows the NPV of the total LDV costs in different scenarios (absolute values and % difference to the baseline).

	Total costs (NPV, in EUR billion 2023) (excl. disutility)	Total costs (% difference vs baseline)
Baseline		
LDVs	24 867	
Cars	21 386	
Vans	3 481	
TL_Vans		
LDVs	24 883	0.06%
Cars	21 387	0.00%
Vans	3 496	0.43%
TL_100_2040		
LDVs	24 877	0.04%
Cars	21 392	0.03%
Vans	3 486	0.12%
TL_90		
LDVs	24 920	0.21%
Cars	21 414	0.13%
Vans	3 506	0.71%
OVC-HEV		

	Total costs (NPV, in EUR billion 2023) (excl. disutility)	Total costs (% difference vs baseline)
LDVs	24 863	-0.02%
Cars	21 371	-0.07%
Vans	3 493	0.32%
OVC-HEV 20%		
LDVs	24 820	-0.19%
Cars	21 331	-0.26%
Vans	3 489	0.21%
CCM-RFNBO		
LDVs	24 886	0.08%
Cars	21 404	0.09%
Vans	3 482	0.03%
CCM-SRF		
LDVs	24 918	0.20%
Cars	21 433	0.22%
Vans	3 485	0.09%
VEEF-SRF		
LDVs	24 864	-0.01%
Cars	21 369	-0.08%
Vans	3 495	0.39%
VEEF-RFNBO		
LDVs	24 871	0.02%
Cars	21 376	-0.05%
Vans	3 495	0.40%
VEEF-SRF-20%		
LDVs	24 902	0.14%
Cars	21 397	0.05%
Vans	3 505	0.66%
VEEF-RFNBO-20%		
LDVs	24 921	0.22%
Cars	21 410	0.11%
Vans	3 511	0.84%
Small ZEV		
LDVs	24 868	0.01%
Cars	21 387	0.01%
Vans	3 481	0.00%
COMBI_1		
LDVs	24 871	0.02%
Cars	21 369	-0.08%
Vans	3 502	0.59%
COMBI_2		
LDVs	24 940	0.29%
Cars	21 418	0.15%
Vans	3 521	1.15%

The monetised cost of air pollutants and CO_2 is presented in Section 4.3 of this Annex.

The table below shows the reduction of the NPV of their costs that manufactures are projected to see in the different scenarios.

	Manufacturers costs (NPV in EUR billion 2023)	**Difference vs baseline (NPV in EUR billion 2023)**	**(% difference vs baseline)**
Baseline	8 643		
TL_Vans	8 645	1	0.02%
TL_100_2040	8 618	-25	-0.29%
TL_90	8 604	-40	-0.46%
OVC-HEV	8 654	11	0.12%
OVC-HEV 20%	8 664	21	0.24%
CCM-RFNBO	8 621	-23	-0.26%
CCM-SRF	8 587	-57	-0.65%
VEEF-SRF	8 623	-20	-0.23%
VEEF-RFNBO	8 628	-16	-0.18%
VEEF-SRF-20%	8 428	-215	-2.49%
VEEF-RFNBO-20%	8 365	-278	-3.22%
Small ZEV	8 638	-5	-0.06%
COMBI_1	8 637	-7	-0.08%
COMBI_2	8 600	-43	-0.50%

The table below shows the NPV of LDV total costs (broken down by capital costs and operating costs) and environmental externalities. All costs reported as NPV, in billion EUR (2023)

	Capital costs	Operating costs, including energy costs	CO_2 costs	Air pollution costs
Baseline	8 643	16 224	368	94
TL_Vans	1	15	2	1
TL_100_2040	-25	35	8	2
TL_90	-40	92	15	4
OVC-HEV	11	-14	2	1
OVC-HEV 20%	21	-68	6	1
CCM-RFNBO	-23	42	5	4
CCM-SRF	-57	108	17	1
VEEF-SRF	-20	17	-3	1
VEEF-RFNBO	-16	20	-2	1
VEEF-SRF-20%	-215	250	-4	7
VEEF-RFNBO-20%	-278	332	-3	8
Small ZEV	-5	6	2	0
COMBI_1	-7	10	1	2
COMBI_2	-43	116	15	6

Starting from the costs just presented, the table below shows the benefits (negative costs in the table above) and costs , and their ratio.

	NPV Benefits (EUR billion)	NPV Costs (EUR billion)	benefit/cost ratio
TL_Vans	0	19	0.00
TL_100_2040	25	45	0.55
TL_90	40	111	0.36
OVC-HEV	14	13	1.09
CCM-RFNBO	23	51	0.44
CCM-SRF	57	126	0.45
VEEF-SRF	23	18	1.29
VEEF-RFNBO	18	20	0.87
Small ZEV	5	9	0.55
COMBI_1	7	13	0.50
COMBI_2	43	136	0.32

b. NET ECONOMIC COSTS FOR NEW VEHICLES FROM DIFFERENT PERSPECTIVES (SOCIETAL, FIRST USE, SECOND USE)

CO_2 emission targets

Reducing the target level ambition, compared to the baseline, as done in the scenarios TL_100_40 and TL_90, as well as in TL_VANS for vans, has a negative TCO impact from a user as well as societal perspective. These extra costs are driven by lower vehicle efficiency and remaining conventional vehicles in the fleet, which have higher fuel costs over the use period that are not compensated by the moderate savings in vehicle capital costs. The second user is more affected than the first, as they have less margin for savings on capital costs as they pay a lower share of initial vehicle value and are likely to face higher fuel costs for conventional vehicles according to the forecasted ICEV trajectories.

Table 16 shows the TCO differences for each perspective and target scenario, compared to the baseline. The first user of a passenger car will pay, on average, less than EUR 100 more in 2035 in both options, but EUR 450 in addition in 2040 if the target level is kept at 90%. For the second user, there is a roughly EUR 400 higher 5-year TCO in 2035 and more than EUR 600 in 2040 for TL_90. Societal costs are more than EUR 800 in 2035 and EUR 1300 in 2040, over the 20 years of vehicle lifetime, taking into account also the additional external costs for higher carbon emissions.

Table 16: Cars TCO changes in TL options versus baseline (EUR)

	TL_100_2040	**TL_100_2040**	**TL_100_2040**	**TL_90**	**TL_90**	**TL_90**
	End user1	End user2	Societal	End user1	End user2	Societal
2035	66	430	839	83	443	869
2040				460	640	1 306

For vans, an additional option was explored to reduce the ambition of the 2030 targets (TL_vans) by 10 percentage points to 40%. This would increase TCO for a new vehicle of 2030 by EUR 600 for the first user, EUR 900 for the second user, and EUR 2 000 from a societal perspective.

In TL_90, for vans, the lowering of the 2035 target is accompanied by a lower target for 2030, as in TL_vans. Therefore the 2030 TCO are the same as just presented lowered to 90%. For a 2035 van instead the model project a TCO increase of around EUR 1 100 for the first user, EUR 1 400 for the second user, and EUR 2 900 at societal level, whereas for a 2040 van the impacts are larger, as shown in Table 17.

As in the scenario TL_100_2040 the 2030 target is unchanged and the reduction of the 100% target is limited in time, the impact in terms of TCO are identical to what described for the TL_90 scenario for a van bought in 2035, and virtually zero for a 2030 and a 2040 van. Similar as for cars, these extra costs are driven by lower targets allowing for less efficient and less electrified new fleets, and capital cost savings are overcompensated for by higher fuel expenses, which are more dominant for vans than for cars, given their higher activity.

Table 17: Vans TCO changes in TL options versus baseline (EUR)

	TL_vans			TL_100_2040			TL_90		
	End user1	End user2	Societal	End user1	End user2	Societal	End user1	End user2	Societal
2030	606	917	2031	0	0	0	606	917	2031
2035	0	0	0	1129	1377	2858	1130	1378	2860
2040	0	0	0	0	0	0	1722	1675	3526

Role of sustainable renewable fuels

Sustainable fuel options can have a wide range of impacts on TCO. For cars, the investigated option of giving emission credits for renewable fuels of non-biological (CCM_RFNBO) show no impact for a 2035 car, given the limited credit available in that year. However this causes extra costs in 2040. In comparison, credits for a mix of advanced biofuels and renewable fuels of non-biological origin (CCM-SRF) is more expensive in terms of additional TCO (see Table 18). The extra costs are due to the fact that the credits, lowering the tailpipe standard, drive a fleet with more conventional and less efficient vehicles, which in turn raises fuel costs.

Table 18: Cars TCO changes in CCM options versus baseline (EUR)

Cars	CCM-RFNBO			CCM-SRF		
	End user1	End user2	Societal	End user1	End user2	Societal
2035	-0	-0	-0	201	626	1257
2040	476	503	1071	618	827	1678

As regards the options of introducing vehicles that can run exclusively on eligible sustainable renewable fuels, these come at very limited TCO costs compared to the baseline as the VEEF share remains very low. However, when users would take up these vehicles to a level of 10 or 20% of the new fleet, additional costs in the order of magnitude between 1000 and 2000 EUR occur for end-users 1 and 2, and between 3000 and almost 5000 EUR from a societal perspective (higher in the case of RFNBO only and lower for a fuel mix), see Table 19.

This is again explained by the less efficient fleet, in comparison to the baseline, as VEEF allow for substantial numbers of conventional vehicles in particular in the mandate versions, and the fact that this fleet consumes more and more costly fuel, in particular in the case of RFNBO. Technology for ensuring that these vehicles can run exclusively on the eligible fuels also adds to their cost, albeit very little.

Table 19: Cars TCO changes in VEEF options versus baseline (EUR)

Cars	VEEF-RFNBO			20% VEEF-RFNBO			VEEF-SRF			20%-VEEF-SRF		
	Eu1	Eu2	Soc.	Eu1	Eu2	Soc	Eu1	Eu2	Soc	Eu1	Eu2	Soc
2035	0	47	101	1778	1988	4811	0	41	20	1171	1645	3663
2040	0	39	67	1597	1793	4092	0	32	37	1273	1546	3363

As regards vans, emission credits for renewable fuels of non-biological (RFNBO CRD) cost the end users almost 200 EUR in addition in 2035, and around 500 EUR in 2040, very similar for first and second user, but with more than twice these costs a societal level. As for cars, the credit for a mix of advanced biofuels and renewable fuels of non-biological origin (CCM-SRF) is more expensive in terms of additional TCO, around 1000 EUR for users and 2000 from a societal perspective (see table xxx below), for the same reasons as above.

Table 20: Vans TCO changes in CCM options versus baseline (EUR)

Vans	**CCM-RFNBO**			**CCM-SRF**		
	End user1	End user2	Societal	End user1	End user2	Societal
2035	170	194	414	764	943	1938
2040	548	499	1016	952	938	1890

For vans, both VEEF options cause higher costs than credits (see below table), as once more reduced efficiency requirements at vehicle level translate into higher fuel costs.

Table 21: Vans TCO changes in VEEF options versus baseline (EUR)

Vans	**VEEF-RFNBO**			**20% VEEF-RFNBO**			**VEEF-SRF**			**20%-VEEF-SRF**		
	Eu1	Eu2	Soc.	Eu1	Eu2	Soc.	Eu1	Eu2	Soc.	Eu1	Eu2	Soc.
2035	668	927	1832	1353	1840	3689	855	1196	2354	1337	1847	3665
2040	708	758	1482	2158	2288	4545	921	987	1929	2139	2276	4503

Role of OVC-HEV

For cars, also this option comes at additional TCO, which however is modest given the uptake of these vehicles (OVC-HEV). If, however, these vehicles make up 20% of the new fleet, additional TCO is in the order of magnitude of just below EUR 1 000 for both end users (a bit lower for the second user compared to the first), and almost EUR 2 000 from the societal perspective. Additional costs arise from the fact that OVC-HEV have higher capital costs as well as higher fuel costs than BEV.

Table 22: Cars TCO changes in OVC-HEV options versus baseline (EUR)

Cars	**OVC-HEV**			**20%OVC-HEV**		
	End user1	End user2	Societal	End user1	End user2	Societal
2035	154	159	364	866	786	1852
2040	212	194	438	1004	844	1957

For vans, as for cars, both OVC-HEV options cause additional costs to users and society, which increase with a higher share of these vehicles, given both higher capital and higher fuel costs compared to the baseline.

Table 23: Vans TCO changes in OVC-HEV options versus baseline (EUR)

Vans	**OVC-HEV**			**20%OVC-HEV**		
	End user1	End user2	Societal	End user1	End user2	Societal
2035	724	737	1637	1100	1111	2485
2040	895	824	1796	1299	1189	2621

Super-credits for small ZEV

For this option, small zero emission vehicles are counted as more than one vehicle between 2030 and 2034. This results in additional fuel costs of a less efficient new fleet which ultimately leads to a small additional TCO, as seen in the table below. After 2035 this option has no impacts.

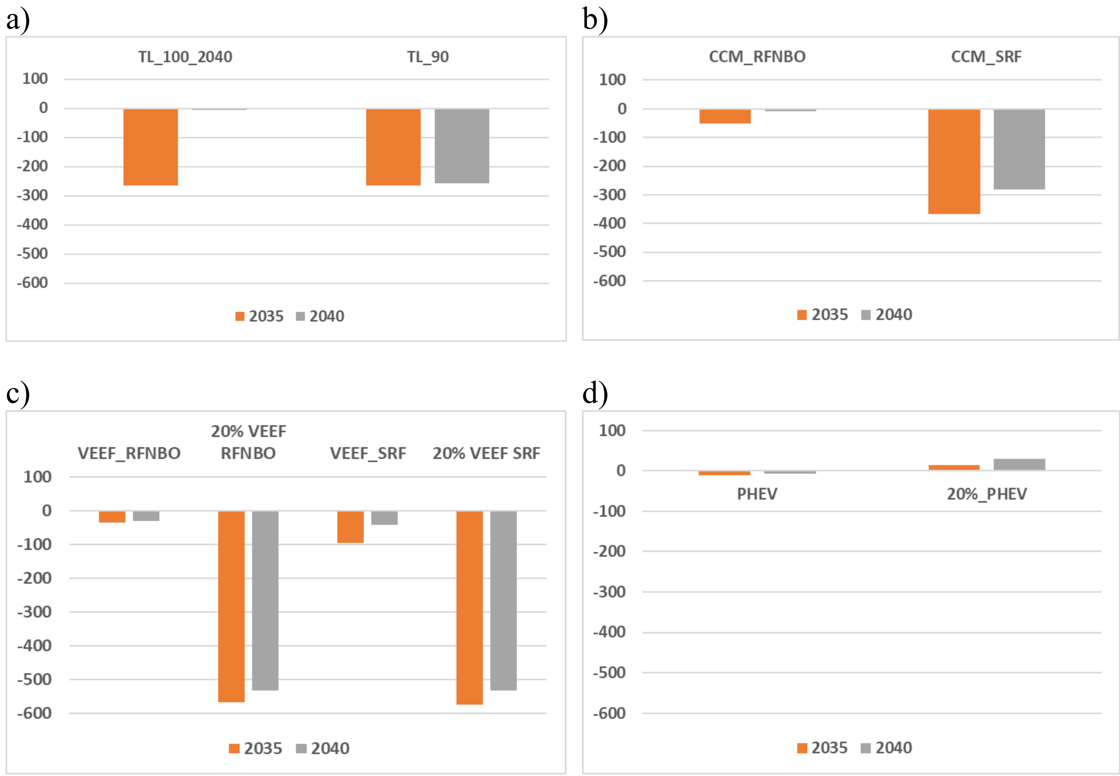
Table 24: Cars TCO changes in small ZEV option versus baseline (EUR)

SMALL ZEV			
	End user1	End user2	Societal
2030	123	238	566

c. COSTS FOR AUTOMOTIVE MANUFACTURERS

Similarly to the manufacturer costs reductions presented for the combinations of options in the impact assessment, manufacturers face lower production costs for vehicles in almost all scenarios. Figure 13 shows cost changes for cars. In case of the scenarios where target level stringency for cars is reduced (panel a), manufacturers face costs that are around EUR 250/car lower in the years where the target is relaxed, as they need to employ less costly technology to comply. In the case of credits for RFNBO (panel b left), manufacturer costs are only very slightly lowered, but more strongly so in case of SRF credits (EUR -250 to -350/car). For the scenarios where vehicles using exclusively eligible sustainable renewable fuels (SRF, panel c), manufacturer costs can be up to EUR 600/car less than in the baseline, as the effort to decarbonize is shifted from the vehicles, which face relaxed targets, to the fuels. Finally, when PHEV are accounted for as zero emission (panel d), a low penetration (with corresponding little impact on regulation stringency) has a very minor manufacturer cost impact. In contrast, the high PHEV penetration shown in panel c, right, leads to a low additional manufacturing costs of EUR 15 and 30/car in 2035 and 2040, as PHEV are more costly than other powertrain options.

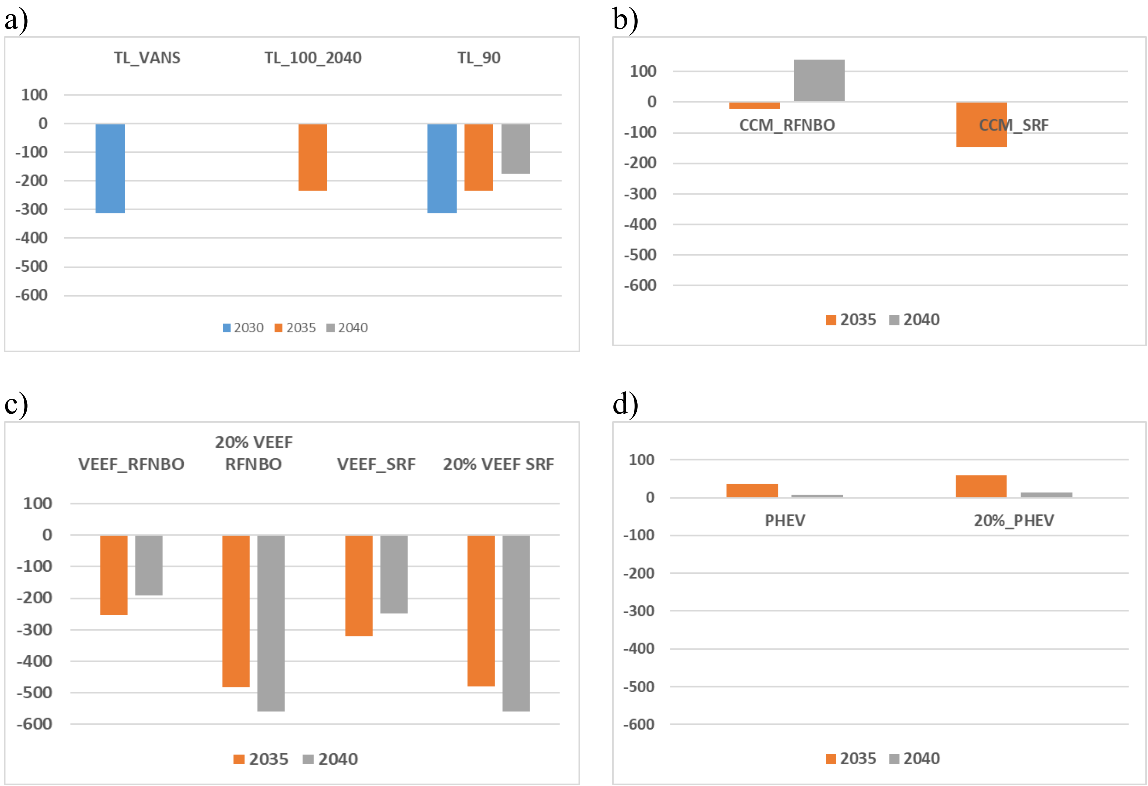
Figure 13: Average cost differences to baseline for automotive manufacturers, for cars (in EUR/vehicle), for a) target level variations, b) sustainable renewable fuel options, c) elegible fuel vehicles, and d) PHEV scenarios



For vans, trends are very similar to what was shown above for cars. Less ambitious target levels lead to manufacturer cost savings of few hundred euros per van, see

Figure 14 panel a, and highest reductions of manufacturer costs of up to more than EUR 500/van are achieved for the SRF dedicated vehicles scenarios (panel c). Sustainable renewable fuel options, in the absence of dedicated vehicles (panel b) have mixed impacts. In this case, in 2040, manufacturers costs are an additional EUR 100 per van in the RFNBO scheme. Also for the PHEV scenarios (panel d), in the case of vans additional manufacturing costs occur compared to the baseline, due to the costs of PHEV powertrains, but these remain modest at a maximum of below EUR 60/van.

Figure 14: Average cost differences to baseline for automotive manufacturers, for vans (in EUR/vehicle), for a) target level variations, b) sustainable renewable fuel options, c) elegible fuel vehicles, and d) PHEV scenarios



4.3. ENERGY SYSTEM AND ENVIRONMENTAL IMPACTS

The following results come from the PRIMES-TREMOVE model.

The table below shows the impact of different options on the LDV energy demand, both in relative (%) and absolute (ktoe) terms.

	Difference vs baseline (%)					Difference vs baseline (ktoe)				
TL_Vans	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0.1%	0.6%	0.6%	0.5%	0.2%	120	762	506	288	97
Electricity	0%	-1%	0%	0%	0%	-34	-157	-106	-65	-25
Fossil fuels	0%	1%	1%	1%	0%	130	769	398	136	6
Biofuels	0%	1%	1%	1%	1%	24	143	123	118	54
RFNBO	0%	1%	1%	1%	1%	0	19	100	105	64
Hydrogen	0%	-2%	0%	0%	0%	-0	-12	-8	-5	-2
TL_100_2040	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	1%	4.3%	4.6%	3.7%	0	805	3 782	2 904	1 812
Electricity	0%	-2%	-6%	-4%	-2%	0	-262	-1 255	-998	-634
Fossil fuels	0%	1%	8%	12%	14%	0	872	3 343	1 658	278

Biofuels	0%	1%	10%	14%	18%	0	208	1 253	1 417	1 140
RFNBO	0%	1%	8%	12%	16%	0	16	745	1 090	1 201
Hydrogen	0%	-5%	-12%	-6%	-3%	0	-29	-304	-262	-174
TL_90	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	1%	6%	12%	13%	120	1 558	5 040	7 262	6 268
Electricity	0%	-3%	-8%	-10%	-8%	-34	-416	-1 617	-2 495	-2 166
Fossil fuels	0%	2%	10%	31%	51%	130	1 630	4 413	4 211	978
Biofuels	0%	2%	13%	35%	62%	24	350	1 629	3 529	4 002
RFNBO	0%	2%	11%	31%	55%	0	34	995	2 759	4 217
Hydrogen	0%	-7%	-15%	-17%	-13%	-0	-40	-380	-742	-761
OVC-HEV	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	0%	1%	1%	1%	0	254	564	722	573
Electricity	0%	0%	-1%	-1%	-1%	0	-26	-231	-334	-235
Fossil fuels	0%	0%	1%	4%	7%	0	216	640	589	129
Biofuels	0%	0%	2%	4%	7%	0	52	194	432	473
RFNBO	0%	1%	2%	5%	8%	0	8	155	409	580
Hydrogen	0%	1%	-7%	-9%	-6%	0	5	-193	-373	-375
OVC-HEV 20%	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	0%	2%	4%	6%	2	413	1 544	2 415	2 761
Electricity	0%	-1%	-3%	-4%	-4%	-1	-111	-702	-1 042	-966
Fossil fuels	0%	0%	4%	14%	32%	3	417	1 830	1 920	619
Biofuels	0%	1%	4%	12%	31%	0	98	504	1 244	2 022
RFNBO	0%	1%	4%	14%	33%	0	11	414	1 238	2 513
Hydrogen	0%	0%	-19%	-22%	-24%	-0	-2	-502	-945	-1 426
CCM-RFNBO	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	0%	1%	7%	8%	0	97	1 251	4 124	4 134
Electricity	0%	0%	-2%	-6%	-5%	0	-39	-414	-1 411	-1 391
Fossil fuels	0%	0%	3%	18%	34%	0	118	1 120	2 420	653
Biofuels	0%	0%	3%	20%	40%	0	21	413	2 004	2 630
RFNBO	0%	0%	3%	17%	36%	0	2	249	1 562	2 757
Hydrogen	0%	-1%	-4%	-11%	-9%	0	-5	-117	-450	-516
CCM-SRF	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	1%	7%	15%	16%	0	1 007	5 872	9 339	7 988
Electricity	0%	-2%	-9%	-13%	-10%	0	-320	-1 915	-3 198	-2 733
Fossil fuels	0%	1%	12%	39%	65%	0	1 078	5 132	5 379	1 260
Biofuels	0%	1%	15%	45%	77%	0	260	1 946	4 504	5 030
RFNBO	0%	1%	12%	39%	69%	0	19	1 142	3 503	5 280
Hydrogen	0%	-5%	-17%	-20%	-14%	0	-31	-433	-850	-850
VEEF-SRF	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	0%	1%	3%	3%	0	133	1 270	1 703	1 488

Electricity	0%	-1%	-2%	-2%	-2%	0	-128	-460	-581	-476
Fossil fuels	0%	-1%	-2%	-2%	-2%	0	-1 083	-744	-307	-42
Biofuels	0%	6%	10%	14%	15%	0	1 150	1 277	1 361	948
RFNBO	0%	14%	14%	16%	16%	0	210	1 304	1 399	1 213
Hydrogen	0%	-3%	-4%	-4%	-3%	0	-17	-107	-168	-155
VEEF-RFNBO	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	0%	1%	2%	2%	0	-92	737	1 053	965
Electricity	0%	0%	-1%	-2%	-1%	0	-53	-296	-399	-337
Fossil fuels	0%	-1%	-1%	-1%	-1%	0	-678	-460	-195	-28
Biofuels	0%	0%	-1%	-1%	-1%	0	-83	-95	-111	-84
RFNBO	0%	50%	18%	21%	20%	0	736	1 667	1 884	1 533
Hydrogen	0%	-2%	-3%	-3%	-2%	0	-14	-80	-127	-119
VEEF-SRF-20%	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	1%	12%	28%	44%	2	1 087	10 666	17 573	21 491
Electricity	0%	-3%	-15%	-21%	-24%	-1	-403	-3 190	-5 358	-6 362
Fossil fuels	0%	-1%	-2%	-3%	-4%	3	-1 073	-965	-435	-68
Biofuels	0%	11%	59%	119%	199%	0	2 148	7 516	11 870	12 922
RFNBO	0%	30%	84%	140%	218%	0	446	7 864	12 558	16 590
Hydrogen	0%	-5%	-21%	-25%	-26%	-0	-31	-559	-1 062	-1 591
VEEF-RFNBO-20%	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	1%	12%	27%	42%	2	1 291	10 523	16 965	20 569
Electricity	0%	-4%	-16%	-22%	-25%	-1	-493	-3 370	-5 640	-6 696
Fossil fuels	0%	-1%	-2%	-3%	-3%	3	-815	-816	-383	-63
Biofuels	0%	-1%	-2%	-2%	-3%	0	-106	-204	-250	-202
RFNBO	0%	185%	166%	272%	383%	0	2 741	15 495	24 352	29 198
Hydrogen	0%	-6%	-22%	-26%	-28%	-0	-36	-583	-1 114	-1 667
Small ZEV	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0.2%	0.5%	0.4%	0.3%	0.2%	262	593	394	210	122
Electricity	-1%	-1%	-1%	0%	0%	-71	-174	-121	-68	-37
Fossil fuels	0%	1%	1%	1%	1%	271	622	333	117	17
Biofuels	0%	1%	1%	1%	1%	63	138	110	91	68
RFNBO	0%	1%	1%	1%	1%	0	13	78	75	76
Hydrogen	-2%	-1%	0%	0%	0%	-2	-6	-6	-4	-2
COMBI_1	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**
Energy demand LDVs	0%	1%	2%	3%	4%	273	1 044	1 759	1 992	2 158
Electricity	-1%	-2%	-3%	-3%	-2%	-73	-309	-598	-688	-645
Fossil fuels	0.23%	0.006%	1%	2%	6%	286	6	242	300	109
Biofuels	0%	6%	9%	14%	22%	62	1 172	1 183	1 362	1 430
RFNBO	0%	14%	12%	15%	23%	0	201	1 135	1 367	1 788
Hydrogen	-1%	-4%	-8%	-8%	-9%	-2	-26	-204	-350	-524
COMBI_2	**2030**	**2035**	**2040**	**2045**	**2050**	**2030**	**2035**	**2040**	**2045**	**2050**

Energy demand LDVs	0%	2%	7%	14%	21%	384	2 102	6 568	8 938	10 418
Electricity	-1%	-5%	-10%	-12%	-13%	-105	-642	-2 178	-3 120	-3 518
Fossil fuels	0%	1%	10%	31%	72%	404	1 157	4 382	4 242	1 381
Biofuels	0%	7%	22%	48%	103%	88	1 422	2 824	4 802	6 720
RFNBO	0%	15%	22%	44%	94%	0	215	2 031	3 895	7 123
Hydrogen	-2%	-8%	-19%	-21%	-21%	-3	-51	-492	-882	-1 289

The table below shows the cumulative (2030 to 2050) CO_2 emissions of the light-duty vehicles, and the difference in relative (%) and absolute (Mt CO_2) terms to the baseline. It also shows the impact in terms of external costs of CO_2[97]

	Cumulative emissions LDVs			**External cost CO_2**	
	2030-50 (Mt CO_2)	**Diff. vs baseline (%)**	**Diff. vs baseline (Mt CO_2)**	**2030-50 (bn EUR)**	**Diff. vs baseline (bn EUR)**
Baseline	3 396			368	
TL_Vans	3 418	**0.6%**	21	370	2
TL_100_2040	3 488	**2.7%**	92	376	8
TL_90	3 563	**4.9%**	167	383	15
OVC-HEV	3 420	**0.7%**	23	370	2
OVC-HEV 20%	3 464	**2.0%**	67	374	6
CCM-RFNBO	3 458	**1.8%**	62	373	5
CCM-SRF	3 585	**5.5%**	188	384	17
VEEF-SRF	3 365	**-0.9%**	-32	365	-3
VEEF-RFNBO	3 377	**-0.6%**	-20	366	-2
VEEF-SRF-20%	3 360	**-1.1%**	-37	364	-4
VEEF-RFNBO-20%	3 366	**-0.9%**	-30	365	-3
Small ZEV	3 415	**1%**	19	370	2
COMBI_1	3 410	**0.4%**	13	369	1
COMBI_2	3 565	**5.0%**	168	383	15

The table below shows the external costs of air pollution (2030 to 2050), in million euros (baseline) in selected year, their NPV (in billion euro) and as % difference compared to the Baseline[98].

[97] Monetised using the value presented in the 2019 Handbook on the external costs of transport https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

[98] See footnote 97

LDVs Air Pollution External Costs					
	2030	**2040**	**2050**	**NPV (bn EUR)**	**NPV - diff. vs baseline (%)**
Baseline	13 007	4 137	655	93.7	
TL_Vans	0%	1%	1%	94.2	1%
TL_100_2040	0%	5%	15%	95.4	2%
TL_90	0%	7%	55%	97.3	4%
OVC-HEV	0%	1%	2%	94.2	1%
OVC-HEV 20%	0%	1%	5%	94.4	1%
CCM-SRF	0%	8%	72%	97.8	4%
CCM-RFNBO	0%	2%	36%	95.2	2%
VEEF-SRF	0%	2%	12%	94.5	1%
VEEF-RFNBO	0%	2%	11%	94.4	1%
VEEF-SRF-20%	0%	14%	169%	101.1	8%
VEEF-RFNBO-20%	0%	15%	182%	101.9	9%
Small ZEV	0%	1%	1%	94.1	0%
COMBI_1	0%	3%	14%	95.3	2%
COMBI_2	0%	11%	97%	99.2	6%

4.4. MACRO-ECONOMIC IMPACTS OF THE COMBINATIONS OF OPTIONS

This section evaluates the macroeconomic and sectoral implications of the two combinations of options (COMBI_1 and COMBI2) that result in a shift from electric mobility (EVs) to internal combustion engine (ICEV) vehicles mostly powered by sustainable renewable fuels.

Key findings:

- GDP declines modestly in both scenarios, mainly due to lower exports.
- Investments increase, driven by capital-intensive sustainable renewable fuels production.
- Household expenditures on vehicles fall while expenditures on operation increase.
- Exports of batteries and non-ferrous metals decline, while domestic ICEV production offsets EV losses.
- Sustainable renewable fuels emerge as the strongest growth sector, while power supply and battery production contract.

Direct Impacts

At the household level, the reduction in activity leads to a reduction in the number of new vehicles which drives a decline in expenditures on vehicle purchases. On the other hand, operating costs increase, reflecting higher expenses associated with running ICEV vehicles on sustainable renewable fuels (SRF) compared to electricity. In the land transport sector[99], however, the cost of purchasing vehicles rises, though the increase is smaller than the savings observed at the household level.

Overall, the direct impacts can be positive. Substituting EVs with ICEVs increases the use of domestically produced vehicles and other inputs, while the switch to SRF reduces reliance on technology imports. At the same time, SRF value generation outweighs the losses from lower electricity demand.

Macro-economic Impacts

Despite these positive direct effects, GDP falls marginally under both policy scenarios. The primary driver is a reduction in exports, as higher production costs reduce competitiveness in international markets.

Labour costs are a key driver of rising production costs. As the consumer price index increases—primarily due to higher vehicle operating costs—nominal wages rise, feeding into higher unit costs across the economy.

Capital costs also rise, as the demand for SRF production capacity is capital intensive and outpaces the available supply of capital. The model assumes no idle capital, so even as other sectors release resources, the surge in demand for SRF pushes up the cost of capital. This dynamic increases investment but also places stress on the capital market. Over time, however, the larger capital stock can provide minor long-term benefits.

To serve the higher demand for capital, investment increases in both policy scenarios. This is due to the capital-intensive nature of SRF production, which requires significant upfront spending. Renewable power supply is also capital-intensive, but the demand for SRF outweighs the declining demand for electricity.

	% change from baseline			
	2040		2050	
Macro-economic Aggregates	**COMBI_1**	**COMBI_2**	**COMBI_1**	**COMBI_2**
Gross Domestic Product	-0.02%	-0.04%	-0.04%	-0.12%
Investment	0.02%	0.05%	0.02%	0.12%
Public Consumption	0.00%	0.00%	0.00%	0.00%
Private Consumption	0.00%	-0.04%	-0.01%	-0.04%
Exports	-0.24%	-0.46%	-0.27%	-0.76%
Imports	-0.16%	-0.38%	-0.11%	-0.20%

Trade and Competitiveness

[99] Land transport includes road transport other than private passenger transport, including rail transport, pipelines, and other related auxiliary transport services

Exports decline most sharply in batteries and non-ferrous metals. Battery exports fall because global prices rise as learning-by-doing effects weaken with the reduced EU demand, while non-ferrous metals suffer from reduced demand as battery production slows.

In absolute terms, the largest export losses occur in high-exporting sectors such as other equipment goods, market service, computer and electronic products, and transport equipment. These declines are driven by higher unit costs of production, which stem from rising labour and capital costs, as well as higher costs in land transport.

Imports also fall, reflecting lower overall demand and the substitution of imported EVs and batteries with domestically produced ICEVs.

	% change from baseline			
	2040		**2050**	
Exports	**COMBI_1**	**COMBI_2**	**COMBI_1**	**COMBI_2**
Agriculture	-0.24%	-0.45%	-0.31%	-0.87%
Oil	-0.01%	-0.17%	-0.02%	0.03%
Power Supply	-0.19%	-0.37%	-0.17%	-0.45%
SRF	-0.11%	-0.21%	-0.14%	-0.38%
Ferrous metals	-0.39%	-0.74%	-0.47%	-1.31%
Non-ferrous metals	-0.76%	-1.59%	-0.78%	-2.07%
Transport equipment (excluding EV)[100]	-0.27%	-0.51%	-0.31%	-0.90%
Other Equipment Goods	-0.33%	-0.64%	-0.38%	-1.07%
Consumer Goods Industries	-0.29%	-0.54%	-0.32%	-0.89%
Construction	-0.27%	-0.51%	-0.33%	-0.97%
Batteries	-1.43%	-3.09%	-1.29%	-3.35%
EV Transport Equipment[101]	-0.22%	-0.45%	-0.27%	-0.74%
Land transport	0.04%	0.11%	0.01%	-0.04%
Market Services	-0.20%	-0.37%	-0.22%	-0.62%
Non Market Services	-0.22%	-0.43%	-0.27%	-0.77%

Employment Impacts

Total employment has marginal impacts, with minor increases in the short-term and small reductions in the longer-term relative to the reference scenario. Sectoral employment generally follows the trends in domestic production. Employment in the overall transport equipment sector records a net positive effect due to the higher domestic content of ICEV

[100] ICE vehicle vale chain including suppliers
[101] EV vehicle value chain including suppliers

transport equipment, while SRF also experience employment gains driven by their increased adoption. The sharpest employment declines are observed in EV equipment, reflecting the substitution towards ICEV vehicles, as well as in batteries and non-ferrous metals, due to reduced demand from the EV transport equipment sector.

	% change from baseline			
	2040		**2050**	
Sectoral employment	**COMBI_1**	**COMBI_2**	**COMBI_1**	**COMBI_2**
Agriculture	-0.03%	-0.04%	-0.04%	-0.02%
Oil	-0.02%	1.18%	0.07%	1.01%
Power Supply	-0.40%	-1.27%	-0.45%	-2.82%
Sustainable renewable fuels	5.08%	9.79%	7.67%	28.99%
Hydrogen	-0.52%	-1.13%	-0.32%	-1.53%
Ferrous metals	-0.06%	-0.05%	-0.20%	-0.69%
Non-ferrous metals	-1.73%	-3.99%	-1.76%	-4.97%
Transport equipment (excluding EV)	1.95%	4.56%	1.54%	3.67%
Other Equipment Goods	-0.15%	-0.26%	-0.26%	-0.80%
Consumer Goods Industries	-0.11%	-0.20%	-0.17%	-0.52%
Construction	-0.01%	-0.02%	-0.06%	-0.19%
Batteries	-3.67%	-9.17%	-3.28%	-9.86%
EV Transport Equipment	-5.07%	-12.36%	-4.94%	-13.62%
Land transport	0.01%	0.01%	-0.08%	-0.30%
Market Services	-0.02%	-0.04%	-0.10%	-0.33%
Non Market Services	-0.01%	-0.03%	-0.04%	-0.14%
Total	0.00%	0.00%	-0.05%	-0.18%

Sectoral Impacts

Domestic production of conventional vehicles offsets the decline in EV production, as ICEV vehicles have a lower import share. Similarly, domestic production of biofuels offsets the decline in power supply, as the shift to less efficient modes implies higher production volumes. Yet, the indirect effects result in an overall lower production levels compared to the reference case. This is both due to lower production of non-ferrous metals, reflecting reduced domestic and international demand for batteries, and due to the higher labour and capital costs that result in lower production levels for all the remaining manufacturing industries and service sectors.

Among all sectors, land transport experiences the largest increase in unit costs in 2040, due to the switch from electricity to SRF. By 2050, the battery sector faces the steepest cost increases, as the shrinking global market raises production costs through reduced economies of scale.

	% change from baseline			
	2040		2050	
Sectoral Production	**COMBI_1**	**COMBI_2**	**COMBI_1**	**COMBI_2**
Agriculture	-0.03%	-0.04%	-0.03%	-0.01%
Oil	0.05%	1.34%	0.23%	1.41%
Power Supply	-0.46%	-1.43%	-0.58%	-3.23%
Sustainable renewable fuels	5.41%	10.46%	8.33%	30.96%
Hydrogen	-0.57%	-1.22%	-0.35%	-1.49%
Ferrous metals	-0.05%	-0.02%	-0.16%	-0.57%
Non-ferrous metals	-1.69%	-3.86%	-1.68%	-4.63%
Transport equipment (excluding EV)	1.95%	4.53%	1.56%	3.73%
Other Equipment Goods	-0.13%	-0.23%	-0.22%	-0.67%
Consumer Goods Industries	-0.09%	-0.17%	-0.13%	-0.39%
Construction	0.00%	0.02%	-0.01%	0.01%
Batteries	-3.71%	-8.91%	-3.29%	-9.12%
EV Transport Equipment	-5.22%	-12.31%	-4.77%	-12.53%
Land transport	0.00%	0.02%	-0.04%	-0.17%
Market Services	-0.01%	-0.01%	-0.05%	-0.20%
Non Market Services	-0.01%	-0.01%	-0.02%	-0.08%

Conclusion

The shift from EVs to ICEV vehicles powered by sustainable renewable fuels creates a mixed economic picture:

- Households face lower costs, and the economy as a whole faces modest GDP losses.
- Investments rise due to the capital-intensive nature of sustainable renewable fuels sustainable renewable fuels production, though this also raises capital costs.
- Exports decline, particularly in batteries and non-ferrous metals, while domestic ICEV production provides partial compensation.
- Sustainable renewable fuels emerge as a growth engine, but EV-related industries and power supply contract.

The results are robust across sensitivity analyses on the capital intensity of sustainable renewable fuels production.

4.5. Modelling of biofuels in PRIMES

In PRIMES, biofuels availability depends on domestic feedstock potential for energy purposes and on imported feedstock or biofuels from outside the EU. The modelling incorporates explicit, time-dependent cost-supply curves, specific to each EU Member State, for approximately 20 different feedstock types. Feedstock is used to produce demand-driven food-based, Part A (advanced) and Part B liquid biofuels and other types of bioenergy (e.g., solid biomass, biomethane). The cost-supply curves exhibit decreasing returns to scale as marginal production costs increase. Over time, feedstock costs decrease incrementally, driven by more efficient agricultural management practices and yield increases. Total available land for food and lignocellulosic crops for energy acts as an optimisation constraint, ultimately determining the domestic supply potential for these crops. The upper limit, different by Member State, reaches around 40 Mha for the EU, assuming extension to marginal and degraded lands. Extra-EU imports of bioenergy commodities and feedstock are subject to their own cost-supply structures. In both cases, we see higher prices with increasing produced or imported quantities.

The cost-supply curves were constructed by linking with PRIMES the inputs from other dedicated model outputs on forestry, waste and crop production, with the most recent updates made during 2024-2025 (Table 25).

Table 25: Overview of sources of the cost-supply curves

Feedstock	Source
Food and feed crops	Bottom-up cost estimates based on detailed cost components. Supply potential based on CAPRI[a]
Forestry feedstock (harvestable stemwood, primary forestry residues, secondary forestry residues)	IIASA – GLOBIOM / G4M
Annual and perennial energy crops	IIASA – GLOBIOM / G4M
Agricultural residues	EUROCARE – CAPRI[102]
Waste feedstock categories (manure, MSW, industrial solid waste, wastewater)	IIASA – GAINS[103]
Other waste feedstock (e.g., used cooking oil, black liquor)	Linked with endogenous drivers in PRIMES

The demand for bioenergy and the distribution of different biofuels and bioenergy across the various end-use sectors is projected with PRIMES and depend on bottom-up interactions among EU regulations, sectoral and system-wide targets, EU-wide and Member State policies (e.g. RES targets, blending mandates), technical constraints (e.g.

[102] Research and innovation perspective of the mid-and long-term potential for advanced biofuels in Europe - Publications Office of the EU

[103] As developed in EUCLIMIT VI, based on the method described in https://adgeo.copernicus.org/articles/45/105/2018/

blend walls of internal combustion engines), and economic criteria such as fuel prices and technological alternatives.

On the supply-side, the model computes energy and resource balances endogenously for the production of bioenergy and calculates various prices (e.g., advanced biofuels, solid biomass for electricity and heat, biomethane). This is performed by solving a minimization problem for long-term bioenergy supply costs subject to equilibrium constraints for each bioenergy commodity and MS. The outputs reflect the cost-supply of the various feedstocks and the cost functions of technology suppliers (including capital, fixed operational and other non-feedstock variable cost).

For different biofuel prices the model re-optimises fuel consumption in the transport sector, potentially shifting demand to other fuels and energy carriers and end-use technologies based on cost-effectiveness and policy constraints. An increase in demand for biomass, due to an increase in bioenergy demand, would entail exploiting costlier parts of the feedstock supply curves.

The non-linearity of the cost-supply curves is an inherent feature of the optimization and resource allocation problem in PRIMES, reflecting the increasing difficulty of deployment (e.g., administrative, logistical, and practical constraints) as feedstock expansion and utilisation progress. However, this non-linearity of all feedstocks does not necessarily translate directly into biofuel pricing, which is influenced by various elements (e.g. feedstock type, fossil fuel price elasticity). This is reflected in the price of a bioenergy commodity, not necessarily the one driving the demand increase, as the model solves the minimization problem for the entire biomass supply system over time. Small changes in bioenergy demand, typically do not impact bioenergy prices enough to influence the competitiveness of bioenergy commodities relative to other fuels and technologies. Notable differences in bioenergy demand or for a specific bioenergy commodity would be needed for bioenergy prices to be distinctly different. In events of significant bioenergy demand increase the model identifies the cost-optimal production pathway, prioritising more economically viable alternatives within the available supply options as it dynamically adjusts the fuel mix in response to updated price signals.

Higher ends of the bioenergy supply curve represent theoretical upper limits to factor in land use considerations, including the sustainability dimension, rather than operational supply expectations.

The upper limit for the overall bioenergy use in the entire EU energy system in the scenarios has been capped at 210 Mtoe in 2040, increasing to 235 Mtoe in 2050. This is aligned with the total potential of the JRC's ENSPRESO biomass database[104,105], and is roughly 60% higher than the current overall bioenergy production level. This is

[104] The JRC ENSPRESO Biomass database provides different potentials for biomass for energy purposes combining assumptions on land use, productivity and activities: https://data.jrc.ec.europa.eu/collection/id-00138

[105] The cap on bioenergy availability considered here is in-between the "low scenario" and the "medium scenario" of the JRC ENSPRESO Biomass database.

complemented by a specific cap on the use of forestry products and residues[106] as feedstocks for bioenergy purposes. Finally, the modelling assumes a limitation of the contribution of bioenergy net imports to 15 Mtoe of biomass feedstock or biofuels imports. These caps aim at limiting the uptake of bioenergy in the energy system in view of the sustainability considerations. The total bioenergy demand in the Baseline scenario respects the assumed production cap and the import availability. Assuming typical conversion efficiencies, converting all the primary biomass (produced and imported) to advanced biofuels within the upper limit as described above, would yield approximately 145 Mtoe in 2040 and 162 Mtoe in 2050. However, bioenergy is consumed in various sectors, including in power and heat production (where it can generate carbon removals if associated with CCS), industry, buildings, aviation and navigation, beside road transport.

For comparison the liquid fuel demand in road transport was 241 Mtoe in 2023 (Eurostat). In the same year, total transport biofuel demand was 4.3 Mtoe Part A, 3.3 Mtoe Part B and 10.5 Mtoe of food- and feed-based, most of which consumed in road transport (SHARES, 2025).

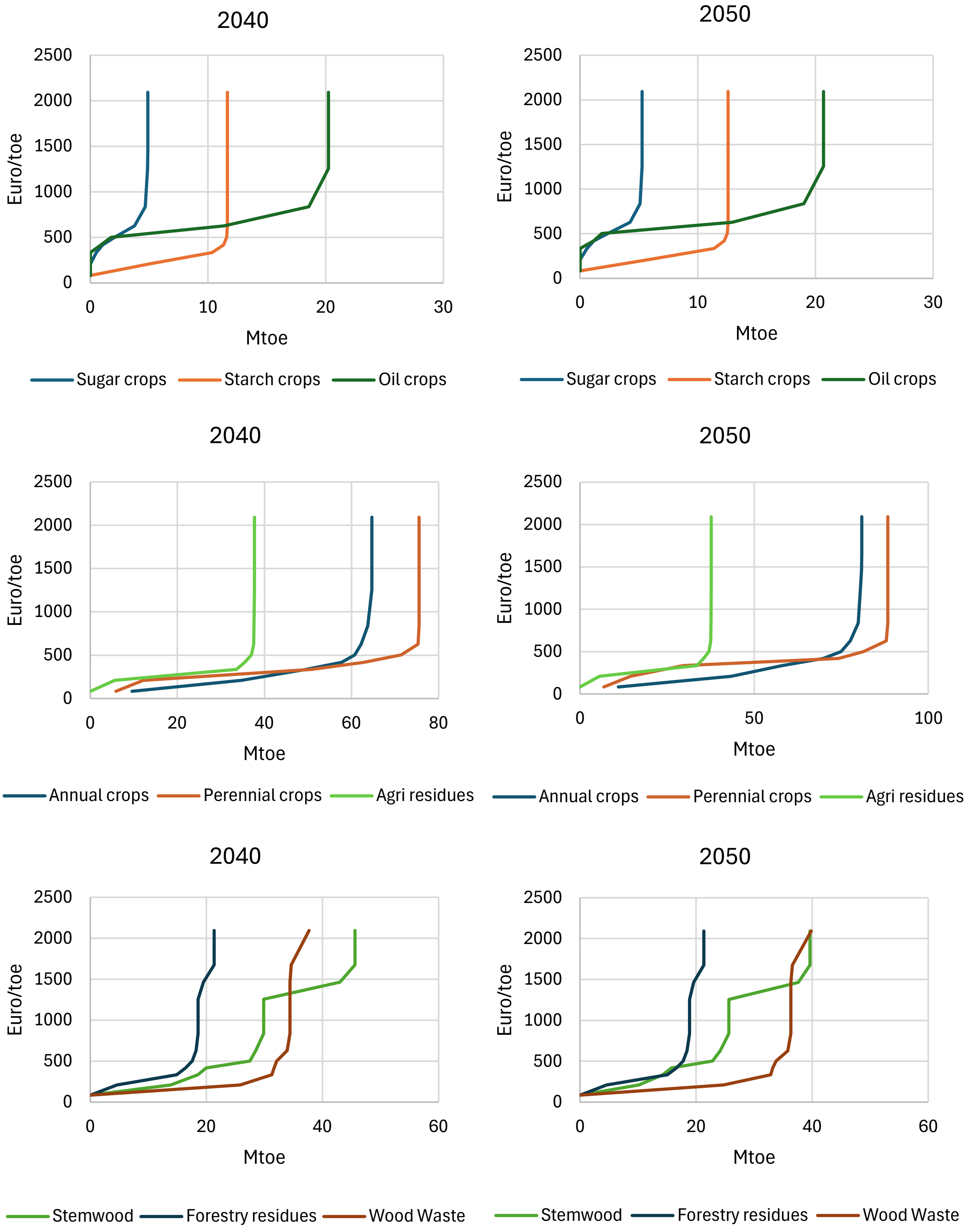
The quantities of advanced biofuels consumed in road transport in the Baseline scenario projection is 19 Mtoe in 2040 and 15 Mtoe in 2050. This translates into primary biomass needs for road transport of 30 Mtoe in 2040 and 24 Mtoe in 2050. This amount represents 14% and 12% of total domestic sustainable primary biomass potential in 2040 and 2050, respectively. In the Baseline scenario, cultivated land for bioenergy is projected at 16 Mha in 2040 and 13 Mha in 2050. Arable land used to produce road transport advanced biofuels is around 4 Mha representing around 25% - 31% of cultivated land for bioenergy.

Excluding the demand from all sectors (including road transport), as projected in the Baseline, the remaining available sustainable potential for additional advanced biofuels in road transport for the policy scenarios is about 2 Mtoe in 2040 (fully relying on imports, as the cap for domestic primary biomass production is reached) and about 30 Mtoe of primary biomass in 2050 (equivalent to 2 Mtoe of advanced biofuels imports in 2040, and 21 Mtoe in 2050 of advanced biofuels domestically produced and imported).

If the aviation and the maritime sector are also included, then the advanced biofuels supply increases to around 54 Mtoe in 2040 and 2050, and the resulting primary biomass needs reach around 80 Mtoe. Domestic supply of Part B biofuels is fully utilized, reaching 2.6 Mtoe in 2030, 3.2 Mtoe in 2040 and 3.6 Mtoe in 2050, limited by the amount of collectable used cooking oil within the EU (domestic feedstock ranges between 3-5 Mtoe in the period 2030-2050). Road transport is responsible for 85%, 65%, 35% of Part B biofuels in 2030, 2040, and 2050, respectively. With imports the supply may increase considerably, yet in the model this is limited to maximum historical net import levels.

[106] Forestry-based feedstocks are key for sustainability and LULUCF dimensions. The cap on such type of feedstock is set at 50 Mtoe, which is 35% lower than in the "low scenario" of the JRC ENSPRESO database.

Figure 15: Cost-supply curves of feedstocks for liquid biofuels production in PRIMES for the EU27 in 2040 and 2050



Note: PRIMES incorporates cost-supply curves at the MS level. The curves represent the EU27 aggregate.

4.6. MODELLING OF RFNBO IN PRIMES

Similarly to biofuels demand, hydrogen and e-fuels demand projections depend on the interplay of various factors, including regulatory restrictions, targets, technical constraints, pricing, and the existence of technological alternatives. example, e-fuels are in direct competition with biofuels since they are interchangeable in terms of use in ICEVs, so their share is to some extent the result of the interplay of their pricing, feedstock availability etc.

In the supply side, hydrogen and synthetic fuels production capability for each country is determined based on RES capacity expansion potential, taking into account current projections of RES electricity for other end uses and satisfying constraints on additionality. The model then computes each country's hydrogen and e-fuels production capacities, quantities, and prices, solving a minimization problem incorporating technical (e.g. electricity, CO_2 and H_2 feedstock needs) and cost assumptions of various technologies, the endogenously calculated cost of electricity for each country, availability and costs of CO_2 sources for synthetic fuel production, and hydrogen trading infrastructure availability, capacity and cost. Table 26 includes all carriers and respective technologies used in the model, as well as a list of the main sources used in our technoeconomic assumptions.

Table 26: Overview of carriers, associated production technologies, and technoeconomic assumptions sources

Carriers	Technologies	Sources
Hydrogen	Alkaline Electrolysers PEM Electrolysers SOEC Electrolysers SMR SMR with CCS Methane Pyrolysis Biomass Gasification Ammonia Cracking	— DEA (2024), Technology Data for Generation of Electricity and District Heating, Energy Storage, Renewable Fuels, Carbon Capture and Storage. Danish Energy Agency — DNV (2020), Study on the Import of Liquid Renewable Energy: Technology Cost Assessment — IEA (2024), Global Hydrogen Review — CONCAWE (2024), E-fuels — Platts (2023), Platts Methodology and Specifications Guide: Global Hydrogen & Ammonia — IEA (2020), CCUS in Clean Energy Transitions — DNV(2025), Energy Transition Outlook: CCS to 2050
Synthetic Methane	Methanation (Sabatier)	
e-Methanol	Methanol Synthesis	
e-Ammonia	Haber-Bosch Synthesis	
e-Gasoline	Fischer-Tropsch Synthesis Methanol-to-Gasoline	
e-Diesel	Fischer-Tropsch Synthesis Methanol-to-Diesel	
e-Kerosene	Fischer-Tropsch Synthesis Methanol-to-Kerosene	

The model assumes a technology mix of Fischer-Tropsch and Methanol-to-X pathways, of which Methanol-to-X is the dominant one. Methanol-to-X has lower H_2 and CO_2 feedstock needs than Fischer-Tropsch although it has higher fixed costs.

Hydrogen and synthetic fuels production is assumed to comply with the RFNBO definition provided in the RED and to be climate neutral. The installed capacity of electrolysers is approximatively 30 GW in 2030, 250 GW in 2040 and 500 GW in 2050.

PRIMES determines the technology mix used for hydrogen and synthetic fuels production for each country based on the capital and operational costs of each technology and the fuel price (electricity in most cases) in conjunction with fuel consumption for each technology or P2X pathway. The costs and conversion efficiencies associated with each production technology are as follows:

Table 27: Investment Costs of Hydrogen and E-Fuels

Conversion technologies	Investment cost per unit of capacity (EUR/kW-output)			
	2020	2030	2040	Ultimate
Electrolysis PEM centralised - Large scale (per 1 kW H2 LHV)	2195	1155	825	590
Electrolysis PEM de-centralised (per 1 kW H2 LHV)	3130	1775	1175	645
Electrolysis - Alkaline centralised - Large scale (per 1 kW H2 LHV)	1600	850	720	555
Electrolysis Alkaline de-centralised (per 1 kW H2 LHV)	2700	1217	920	670
Electrolysis SOEC centralised - electric driven heat (per 1 kW H2 LHV)	2500	1670	920	695
Electrolysis SOEC de-centralised - external heat input (per 1 kW H2 LHV)	5525	2905	1895	1220
Methanation (per 1 kW CH4 LHV)	1200	880	525	500
Methanol synthesis (per 1 kW CH3OH LHV)	1685	1419	1246	830
Methanol-to-Olefins, Methanol-to-Kerosene and Methanol-to-Gasoline (per 1 kW final fuel	2113	1788	1563	1089
Fischer Tropsch (per 1 kW FT LHV - considered same as diesel)	2040	1628	1232	880
Haber-Bosch ammonia synthesis (per 1 kW NH3 LHV)	1915	1815	1650	1510

Table 28: Heat/Electricity input requirements (input/output)

Conversion technologies	Fuel consumption (input over output ratio)							
	2020 Heat	2020 Electricity	2030 Heat	2030 Electricity	2040 Heat	2040 Electricity	Ultimate Heat	Ultimate Electricity
Electrolysis PEM centralised - Large scale (per 1 kW H2 LHV)	0.00	1.64	0.00	1.42	0.00	1.38	0.00	1.38
Electrolysis PEM de-centralised (per 1 kW H2 LHV)	0.00	1.73	0.00	1.50	0.00	1.48	0.00	1.41
Electrolysis - Alkaline centralised - Large scale (per 1 kW H2 LHV)	0.00	1.54	0.00	1.50	0.00	1.43	0.00	1.39
Electrolysis Alkaline de-centralised (per 1 kW H2 LHV)	0.00	1.65	0.00	1.50	0.00	1.43	0.00	1.42
Electrolysis SOEC centralised - electric driven heat (per 1 kW H2 LHV)	0.00	1.71	0.00	1.50	0.00	1.42	0.00	1.30
Electrolysis SOEC de-centralised - external heat input (per 1 kW H2 LHV)	0.35	1.38	0.33	1.24	0.31	1.06	0.30	1.00
Methanation (per 1 kW CH4 LHV)	-0.173	0.022	-0.173	0.022	-0.173	0.022	-0.173	0.022
Methanol synthesis (per 1 kW CH3OH LHV)	-0.072	0.045	-0.072	0.045	-0.072	0.045	-0.072	0.045
Methanol-to-Olefins, Methanol-to-Kerosene and Methanol-to-Gasoline (per 1 kW final fuel	-0.030	0.068	-0.030	0.068	-0.030	0.068	-0.030	0.068
Fischer Tropsch (per 1 kW FT LHV - considered same as diesel)	-0.200	0.044	-0.200	0.044	-0.200	0.044	-0.200	0.044
Haber-Bosch ammonia synthesis (per 1 kW NH3 LHV)	-0.116	0.132	-0.116	0.132	-0.116	0.132	-0.116	0.132

Table 29: Feedstock H2/CO_2 requirements for e-fuels

Conversion technologies	Feedstock input requirements (input over output ratio)	
	H_2 (1MWh H_2/ 1MWh output)	CO_2 (t CO_2/ 1MWh output)
Methanation (per 1 kW CH4 LHV)	1.250	0.200
Methanol synthesis (per 1 kW CH3OH LHV)	1.185	0.279
Methanol-to-Olefins, Methanol-to-Kerosene and Methanol-to-Gasoline (per 1 kW final fuel	1.304	0.279
Fischer Tropsch (per 1 kW FT LHV - considered same as diesel)	1.465	0.409
Haber-Bosch ammonia synthesis (per 1 kW NH3 LHV)	1.154	

The prices of electricity are derived from the PRIMES Power and steam generation and supply model. Electricity (and steam/heat) fuel prices are determined by category of customer (sectors and sub-sectors of demand). The aim is to allocate variable, fixed, and capital costs as well as grid and other costs to each category of customers as would be the case in a well-functioning market in which suppliers would conclude efficient and stable bilateral contracts with each customer category, based for example on the specific load profile of the customer. Accordingly, the price of electricity used by electrolysers depends on end use demand and differ by sector. Demand of hydrogen blended in the natural gas pipeline network by all sectors, as well as hydrogen production aimed at exporting, which would require larger scale electrolysers with higher utilization rates due to technical constraints related to the hydrogen injection to the grid, is assumed to use grid electricity prices. This corresponds to the centralized electrolyser category of the technical datasheets, as it has larger capacities and lower specific technology costs. For most end use demand sectors a RES PPA pricing scheme is assumed. PPAs are priced based on the LCOE of the RES plus grid tariffs plus a risk premium. Transport costs depend on the carrier form used in each demand sector and the location of the electrolyser. The utilization rate of such facilities is similar to the one for RES. The electrolyser technology used corresponds to the decentralized category of our technical datasheets, as it has smaller capacities and higher technology costs. Those sectors fall into one of the following categories: a) Sectors that the nature of their main activity, allows them to shift easily to synthetic fuel production, such as Chemicals, Petrochemicals and Refineries. b) sectors that their process needs, combined with their already established infrastructure, would facilitate an on-site production of hydrogen. Finally, in limited cases where logistics allow, hydrogen is produced using electricity by RES which is installed on-site (e.g. industrial complex, hydrogen valley etc). In such cases the electricity is priced at the lowest possible cost, close to the levelized cost of RES.

CO_2 feedstock for e-fuels in PRIMES is either derived from biogas upgrade, bioethanol and biofuels production processes, or by DAC. The possibility of using industrial capture is present in the model, but not allowed in these scenarios due to the Delegated Act (EU) 2023/1184. As such, CO_2 feedstock is determined by the associated costs and availability of each of the previously mentioned CO_2 streams and DAC is used when the cheaper biogenic CO_2 potential is depleted. CO_2 intercountry trading is not yet implemented in the modelling.

Hydrogen trading between countries is realised by pipelines. The infrastructure modelled currently follows TYNDP's assumptions[107] on available pipelines and possible expansions, which are themselves based on the European Hydrogen Backbone suggested pipeline network. The drivers for hydrogen imports are, consequentially, the pricing for its production, the cost of its transportation, and the technical constraints associated with pipeline infrastructure. For e-fuels trading inside and outside the EU, the assumption is that the main producers and exporters of their fossil fuel equivalents will remain largely the same. Those that have refinery assets, will be able to capitalize on the accumulated experience, storage, favourable land use near ports and manpower expertise and maintain their production capacity by shifting to clean fuels. It will be extremely difficult for new actors to be able to produce those fuels and build all the infrastructure needed in a competitive manner. Based on the above, and the fact that no region will have an inherent competitive advantage on e-fuel costs, we expect that the current trade flows of distillation products will also be to a significant extent maintained in the future. After the determination of production and trading quantities, the final price of each fuel is the result

[107] Ten-Year Network Development Plan: https://tyndp.entsoe.eu/

of the interplay of each country's production cost, the production and transportation costs of the imported quantities, and costs associated with storage, compression/liquefaction etc.

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[108] Ten-Year Network Development Plan: https://tyndp.entsoe.eu/

4.7. IMPACT OF MULTIANNUAL COMPLIANCE

Options and Mechanism

We consider the following two options for estimating the impact of the multiannual compliance:

- **Option 0:** status-quo, no multiannual compliance in 2030 and beyond.
- **Option 1 [MAC]:** There is multiannual compliance for the years 2030 – 2032. In this period, the OEMs have to comply in average with the CO_2 emission standards.

Impact Estimation

The estimation of the GHG emission impact of the two policy options is based on the following key assumptions:

The introduction of multiannual compliance alters the composition of newly registered passenger cars between 2030 and 2032. While the total number of newly registered cars per vehicle size class remains constant, a shift between drivetrains is assumed — from ZEVs towards ICEVs and PHEVs, and vice versa.

- In the first year (2030), the number of newly registered ZEVs is assumed to decrease compared to the option without multiannual compliance, as fewer ZEVs are needed to meet the CO_2 target.
- For the second year of the compliance period, no change in the composition of newly registered vehicles is assumed compared to the 2030 data from PRIMES-TREMOVE model.
- In the final year (2032), an increase in newly registered ZEVs is assumed to compensate for non-compliance in 2030.
- Changes in newly registered ZEVs per size class follow the existing yearly distribution of ZEVs by size.

No change in specific energy consumption is assumed within each drivetrain and vehicle size class.

The number of vehicles shifted between ZEVs to ICEVs and PHEVs (2030) and vice versa (2032) is derived using the increase in average WLTP CO_2 emissions (in g CO_2/km) for the first year of the multiannual compliance period as the input variable. This approach can be used to estimate the impact of non-compliance in the first year of multi-year compliance period.

Methodological approach and assumptions

The estimation applies a post-processing approach to the PRIMES-TREMOVE model results. Specifically, the analysis determines the impact on tank-to-wheel GHG emissions, on the final energy demand by energy carrier, and on the associated energy costs for passenger cars and vans newly registered between 2030 and 2032, over their lifetime until 2050, as described below.

- The number of newly registered vehicles in each drivetrain and vehicle size class is multiplied by the average mileage, vehicle age, specific energy consumption and respective GHG emission factor. This calculation is then repeated for each subsequent year of vehicle use until 2050 for the cohort of vehicles newly registered between 2030 and 2032.

- The input data on the number of new registrations, specific energy consumption, average annual mileage by vehicle age and emission factors are derived from PRIMES model outputs.

- For option 1 the adjusted composition of new registrations, as defined by the above assumptions, is taken into account.

- The resulting change in the above-mentioned categories (GHG emissions, final energy demand, and energy costs) due to the introduction of multiannual compliance is calculated as the difference between the total values of option 1 and option 0.

- The annual mileage is assumed to be the same for all drivetrains within a given vehicle size class (assumption from PRIMES).

- Vehicle energy consumption per kilometre and per drivetrain, as calculated by the PRIMES model, is constant (values for 2030 in PRIMES)

- The fuel emission factors and energy costs for end users from the PRIMES model are linearly interpolated between the values provided for modelled years (2030, 2035, 2040, 2045, 2050).

For the counterfactual scenario of option 0 (no multiannual compliance), there is no modelled data for the years 2031 and 2032. Therefore, an assumption must be made on the emission trend for the years 2031 and 2032. For past target values steps in 2015 and 2021, the following emission trends for passenger cars are visible in the monitoring data in the period after the target levels increased:

- 2015: 119.5 g CO_2/km; 2016: 118.1 g CO_2/km (-1.2% compared to 2015); 2017: 118.5 g CO_2/km (-0.8% compared to 2015)

- 2021: 114.1 g CO_2/km; 2022: 108.1 g CO_2/km (-5.3% compared to 2021); 2023: 106.4 g CO_2/km (-7.7% compared to 2021)

The data on past developments between years in which new targets were set clearly shows that the average CO_2 emissions of new vehicles only decreased slightly after the year in which the new target was set. For the counterfactual scenario without the multiannual compliance option, we therefore assume for our impact estimation that the average CO_2 emissions of new vehicles

- in 2031 will be 1.25 g CO_2/km lower than in 2030, and

- in 2032 2.5 g CO_2/km lower than in 2030.

This assumption is set for passenger cars and for vans.

Current data for 2025 shows that OEMs are likely to fall well short of the new 2025 target and will have to compensate for this deficit in 2026 and 2027. For the period from January to August 2025, the gap between actual and target emissions of passenger cars is 9% or 8 g CO_2/km[109].

For the analyses, we therefore assume for passenger cars and vans that there will be a 9% deficit in 2030, which OEMs will compensate for in 2032. For 2031, it is assumed that manufacturers will meet the 2030 target value precisely.

Results

Option 1 results in additional emissions compared to the scenario in which the target values must be met from 2030 onwards. Overall, GHG emissions from newly registered passenger cars and vans in the years 2030–2032 increase by 2.9%. The majority of the additional GHG emissions will occur in the period up to 2039, as the mileage of new vehicles from the 2030 – 2032 cohort decreases and the share of renewable fuel use increases over time.

Passenger cars cause a total of 9.6 Mt CO_2e in additional emissions; for vans, the additional emissions are 2.7 Mt CO_2e.

The higher GHG emissions are due to higher fossil fuel energy demand. For passenger cars, multiannual compliance increases the final energy demand by 3.1 million toe over the period up to 2050. This corresponds to a final energy increase of 1.7% for newly registered passenger cars in the years 2030–2032. Users of newly registered vans from 2030 - 2032 consume 0.9 million toe more final energy, which corresponds to a final energy increase of 1.9% of the new vehicle cohort from the years 2030 – 2032 for the time period until 2050.

The higher energy consumption also results in higher costs for the use of new vehicles in the years 2030–2032. Overall, the additional costs for refuelling and charging amount to EUR 7.8 billion (passenger cars) and EUR 1.8 billion (vans).

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[109] https://theicct.org/wp-content/uploads/2025/09/ID-484-%E2%80%93-EU-monitor-September-market-spotlight-A4-70167-v2.pdf

5. SOCIAL IMPACTS

The main element considered as regards social impacts is whether and to what extent the policy packages under assessment affect different population groups differentiated according to their income. Therefore, building on an economic analysis of total costs of ownership for first and second users, this analysis looks at the impacts of the different packages 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[110]). 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.

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. The 'subjective TCO' refers to the total cost of ownership adjusted to reflect income-group-specific parameters. The analysis covers all powertrain types across all scenarios, though some powertrains are not available at all/have zero market uptake in certain scenarios (e.g. only ZEVs are allowed from 2035 in the baseline scenario).

Affordability

Table 30 summarises the results on affordability for the baseline and the two packages 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 income group Q5, for income group Q4 as second user, and for the income groups Q2, Q3, and Q4 as third user. Therefore, these categories are not included in the table.

Across all scenarios, affordability patterns differ markedly between first, second, and third users and, within each user group, are shaped mainly by vehicle size and (albeit to a lesser extent) by powertrain type, rather than by year or scenario:

- *First users:* Q1 and Q2 cannot afford any vehicle segment (S, LM, UM, L). Q3 can afford small (S) vehicles, while lower-medium (LM) is affordable only for conventional and hybrid powertrains; upper-medium (UM) and large (L) vehicles are unaffordable across all powertrains. Q4 can afford S, LM, and most UM

[110] *Mean and median economic resources of households by income, consumption and wealth quantiles - experimental statistics*, available at this link. A population-weighted EU27 average was calculated based on available Member State data.

vehicles (only FCEV versions are unaffordable in 2030), while L vehicles remain unaffordable. Q5 can afford all segments.

- *Second users:* Q1 again faces unaffordability across all size classes. Q2 finds most UM (except SI + Hybrid) and L vehicles unaffordable (apart from a minor change in Package 2, discussed below). Q3 can afford all segments except L (FCEV), which becomes affordable by 2040, and Q4 shows no affordability constraints.

- *Third users:* Q1 faces unaffordability for UM (CI PHEV, BEV, FCEV) and L in 2030, but by 2035 both UM CI PHEV and UM BEV become affordable, leaving only UM (FCEV) and L unaffordable. Higher-income groups (Q2–Q4) show no affordability limitations for third-hand purchases.

Across all user types, **differences by powertrain** are limited. Electrified powertrains (PHEV, BEV, FCEV) tend to be less affordable than conventional or hybrid ones. Overall, affordability remains largely stable over time, with only minor shifts, confirming that income and vehicle size dominate affordability outcomes rather than scenario-specific effects.

Over time, only a few isolated changes occur. For first users, upper-medium FCEVs become affordable for Q4 households by 2035; for second users, large FCEVs become affordable for Q3 households by 2040; and for third users, some upper-medium electrified options (CI PHEV and BEV) become affordable for Q1 households by 2035, while UM FCEVs and large vehicles remain unaffordable.

Table 30: Overview of unaffordable car types (powertrains) and segments per income group under the baseline and the two combined options in 2030, 2035 and 2040

<table>
<tr><th></th><th colspan="3">Q1</th><th colspan="3">Q2</th><th colspan="3">Q3</th><th colspan="3">Q4</th></tr>
<tr><th></th><th>2030</th><th>2035</th><th>2040</th><th>2030</th><th>2035</th><th>2040</th><th>2030</th><th>2035</th><th>2040</th><th>2030</th><th>2035</th><th>2040</th></tr>
<tr><td colspan="13">First user</td></tr>
<tr><td>Baseline</td><td colspan="6" rowspan="3">S, LM, UM, L</td><td colspan="3" rowspan="3">LM (PHEV, BEV, FCEV), UM, L</td><td rowspan="3">UM (FCEV), L</td><td colspan="2" rowspan="3">L</td></tr>
<tr><td>COMBI_1</td></tr>
<tr><td>COMBI_2</td></tr>
<tr><td colspan="13">Second user</td></tr>
<tr><td>Baseline</td><td colspan="3" rowspan="3">S, LM, UM, L</td><td colspan="3">UM (CI+Hybrid, PHEV, BEV, FCEV), L</td><td colspan="2" rowspan="3">L (FCEV)</td><td colspan="4" rowspan="3"></td></tr>
<tr><td>COMBI_1</td><td></td><td colspan="2">UM, L</td></tr>
<tr><td>COMBI_2</td><td colspan="3"></td></tr>
<tr><td colspan="13">Third user</td></tr>
<tr><td>Baseline</td><td rowspan="3">UM (CI PHEV, BEV, FCEV), L</td><td colspan="2" rowspan="3">UM (FCEV), L</td><td colspan="9" rowspan="3"></td></tr>
<tr><td>COMBI_1</td></tr>
<tr><td>COMBI_2</td></tr>
</table>

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.

The only **scenario-related difference** appears in COMBI_1, while under COMBI_2 there are no changes in affordability compared with the baseline. Under COMBI_1, the situation changes only for Q2 households purchasing UM vehicles as second users (most likely due to the additional costs of dedicated renewable fuel vehicles). In this case, also SI + Hybrid vehicles become unaffordable, which means that all UM vehicles are unaffordable for Q2 second users under this option.

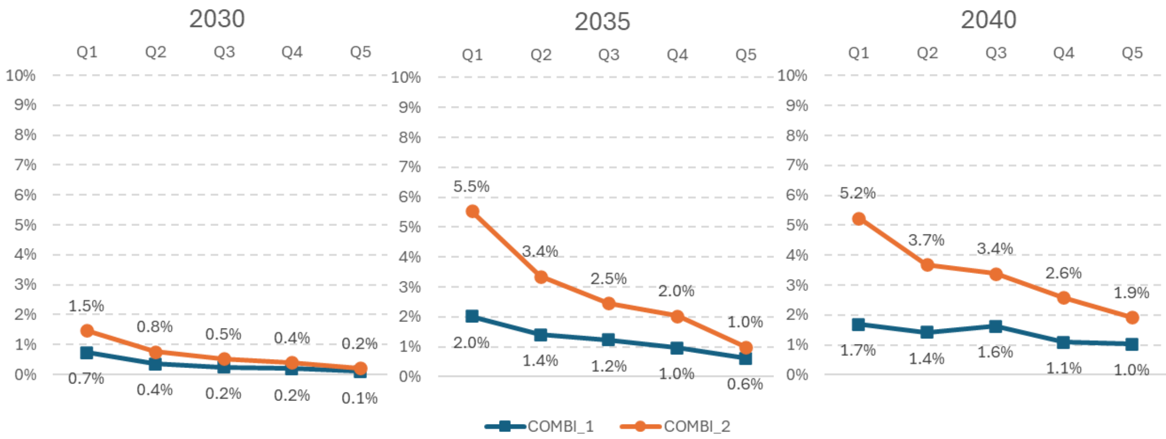
Subjective TCO

An assessment has also been made on how each of the two packages affects the subjective TCO for affordable options, as compared to the baseline.

Figure 16 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 two packages, as compared to the baseline. Across both packages, all income groups are projected to face increases in subjective TCO relative to their annual income. The cost increases are higher under the more ambitious package and decline with income: lower-income households experience larger increases relative to income, while higher-income groups are less affected. Between 2030 and 2035, cost increases become more pronounced across all income groups and for both packages. By 2040, they generally stabilise, with some income groups and packages showing slight increases and others slight decreases compared to 2035.

This result is driven by two main factors: (i) both packages lead to a slightly higher share of ICEVs, HEVs and PHEVs in the vehicle mix compared to the baseline. Since these powertrains have higher TCO compared to BEVs (particularly in periods after 2030 as the projected price of fuel increases more versus electricity), this results in overall increases in average ownership costs across all income groups; (ii) even if differences in technology costs and fuel savings are the same across income groups in absolute terms, they represent a higher share of income for lower-income households, which amplifies the relative cost increases observed for them across scenarios.

Figure 16: Average subjective TCO changes (% of annual income) for income groups across the two combined options for a car newly purchased in 2030, 2035 and 2040



Note: Positive values represent cost increases. 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.

The social impact analysis focuses on income groups defined at the 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 16. 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 16.

6. Literature regarding availability and costs of sustainable biological feedstocks

In literature, there is a wide range of estimation for what concerns the potential availability of sustainable biological feedstocks and their costs.

A 2024 ICCT study[111] found that the availability of RED advanced biofuel compliant biomass in the EU would be short of meeting even fuel demand for the aviation sector after 2035. On the other hand, an Imperial College Report shows higher availability, and argues that the potential availability of advanced and waste-based biofuels (through EU domestic production) in 2050 can reach 137 Mtoe with some progress in biomass collection and yield improvement. Similarly, a 2024 RTD study[112] found out that there is feedstock potential in Europe for the production of second-generation bioethanol, however, feedstock potential is not enough to cover the biodiesel demand and it would need to be imported from outside Europe. A 2025 IEA report on sustainable fuels[113] argues that a fourfold increase in the global use of sustainable fuels by 2035 is ambitious yet achievable. A SPGCI Study, commissioned by Concawe[114], argues that complementing electrification with an increased use of low carbon fuels could save a significant number of refineries, which otherwise would be shut down: the demand for low carbon fuels creates an opportunity for traditional refineries to be reconverted. However, from the energy system perspective, this comes with a cost. Electricity demand is higher in a scenario in which transport electrification is relaxed, due to the energy intensity of hydrogen and e-fuels production. The study also shows that, excluding carbon price, the cost of producing low carbon fuels will be higher than that of fossil fuels. On RFNBO, the IEA report on the Role of E-fuels in Decarbonising Transport[115], and the International PowerToX Hub[116] point out to the technical challenges of ramping up electrolyser manufacturing needed to scale up the production of such fuels. The International PowerToX Hub also states that e-fuels are expensive and less energy efficient and will likely only be available in very limited quantities over the next few decades. They should be prioritised for segments of the transport sector that lack alternatives, mainly aviation and maritime transport. On RFNBO prices, a report commissioned by Concawe[117] argues that the cost for electricity has the highest share of the overall costs of fuel supply (up to around 70%), that RFNBO supply costs range between EUR 1.7 and 4.6 per litre of diesel equivalent in the short term and between EUR 1.4 and 2.8 per litre of diesel equivalent in the long term, and that Europe is cost competitive with the MENA region. On a similar note, the eFuel Alliance, in its cost outlook[118], shows that Spain due to its low electricity costs is cost competitive with Colombia, Namibia and Australia, and projects costs (without taxes and profit margin) around EUR 2 per litre of diesel equivalent for different types of RFNBO already for 2030.

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[111] https://theicct.org/wp-content/uploads/2024/08/ID-185-%E2%80%93-Biomass-SAF_brief_final2.pdf
[112] Development of outlook for the necessary means to build industrial capacity for drop-in advanced biofuels
[113] Delivering Sustainable Fuels, https://www.iea.org/reports/delivering-sustainable-fuels
[114] https://www.concawe.eu/publication/study-on-the-potential-evolution-of-refining-and-liquid-fuels-production-in-europe/
[115] The Role of E-fuels in Decarbonising Transport – Analysis - IEA
[116] Discussion paper: E-fuels – Separating the substance from the hype - PtX Hub
[117] https://www.concawe.eu/wp-content/uploads/Rpt_24-4-1.pdf
[118] https://www.efuel-alliance.eu/efuels/costs-outlook

To be noted that, in 2023, hydrogen production costs through electrolysis with a direct connection to a renewable energy source had an average estimated cost of 6.61 €/kg[119].

[119] The European hydrogen market landscape_November 2024.pdf