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IMPACT ASSESSMENT

Part 2

Accompanying the document

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

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

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10 ANNEX 1: PROCEDURAL INFORMATION

10.1 Organisation and timing:

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

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

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

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

10.2 Consultation of the Regulatory Scrutiny Board (RSB)

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

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

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

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

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

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

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

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

10.3 Evidence, sources and quality

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

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

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

11 ANNEX 2: STAKEHOLDER CONSULTATION

11.1 Introduction

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

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

The Commission sought feedback from stakeholders through the following elements:

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

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

11.2 Public consultation

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

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

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

11.3 Results of the public consultation

11.3.1 Distribution of replies

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

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

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

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

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

Table 19: Distribution of stakeholders by category

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

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

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

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

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

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

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

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

[2] https://www.openpetition.de/petition/online/regenerative-kraftstoffe-efuels-jetzt

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

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

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

The results for each of the elements are as follows.

Objectives of CO_2 emission targets for cars and vans

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

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

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

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

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

[4] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12655-Revision-of-the-CO2-emission-standards-for-cars-and-vans-/public-consultation
[5] i.e. respondents gave this a rating of either a '4' or '5'.
[6] i.e. respondents gave this a rating of either a '1' or '2'.

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

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

Future CO_2 emissions targets for cars and vans – target levels

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

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

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

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

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

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

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

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

Timing of the targets

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

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

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

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

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

<u>Incentivising zero- and low-emission vehicles</u>

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

<u>Contribution of renewable and low-carbon fuels</u>

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

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

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

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

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

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

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

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

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

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

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

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

Allocation of the revenues of the excess emissions premiums

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

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

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

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

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

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

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

Potential impacts of the strengthening of the CO_2 emission standards

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

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

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

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

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

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

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

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

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

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

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

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

Additional comments provided by respondents

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

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

11.4 Summary of the feedback received on the Inception Impact Assessment

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

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

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

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

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

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

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

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

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

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

11.5 Position papers on the revision

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

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

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

11.6 Use of the stakeholder input for the impact assessment

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

12 ANNEX 3: WHO IS AFFECTED AND HOW?

12.1 Practical implications of the initiative

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

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

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

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

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

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

12.2 Summary of costs and benefits

Table 20: Overview of benefits of the preferred options

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

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

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

Table 21: Overview of costs of the preferred options

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

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

13 ANNEX 4: ANALYTICAL METHODS

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

A brief description of each model is provided below.

13.1 Analytical methods

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

13.1.1.1 Introduction

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

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

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

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

13.1.2 Modelling tools for assessments of policies

13.1.2.1 Main modelling suite

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

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

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

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

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

The model suite thus covers:

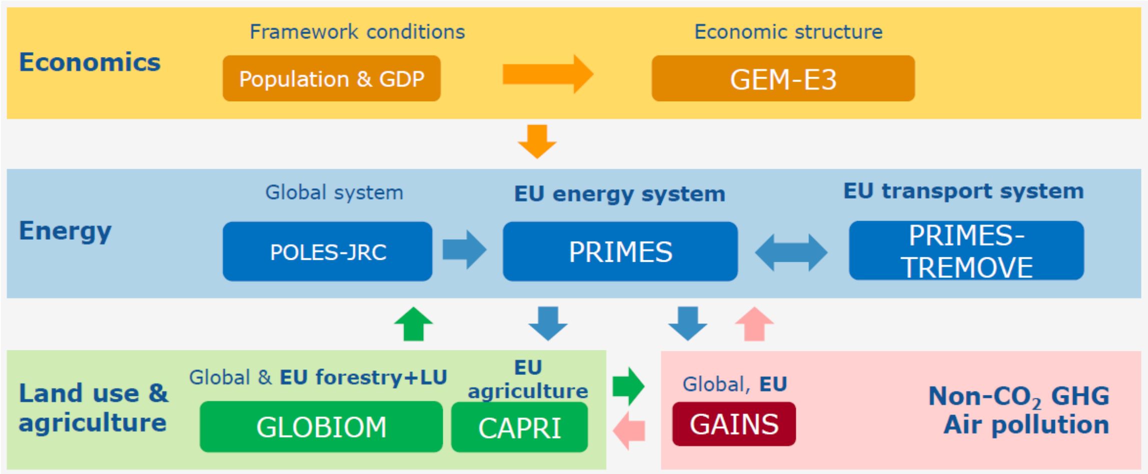
- **The entire energy system** (energy demand, supply, prices and investments to the future) and **all GHG emissions and removals** from the EU economy.
- **Time horizon:** 1990 to 2070 (5-year time steps).
- **Geography:** individually all EU Member States, EU candidate countries and, where relevant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

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

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

Figure 20: Interlinkages between models

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0331
[11] https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf
[12] While cross-border trade is possible, the assumption is that there are no imports from outside EU as the opposite would require global modelling of hydrogen trade.



13.1.2.2 Energy: the PRIMES model

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

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

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

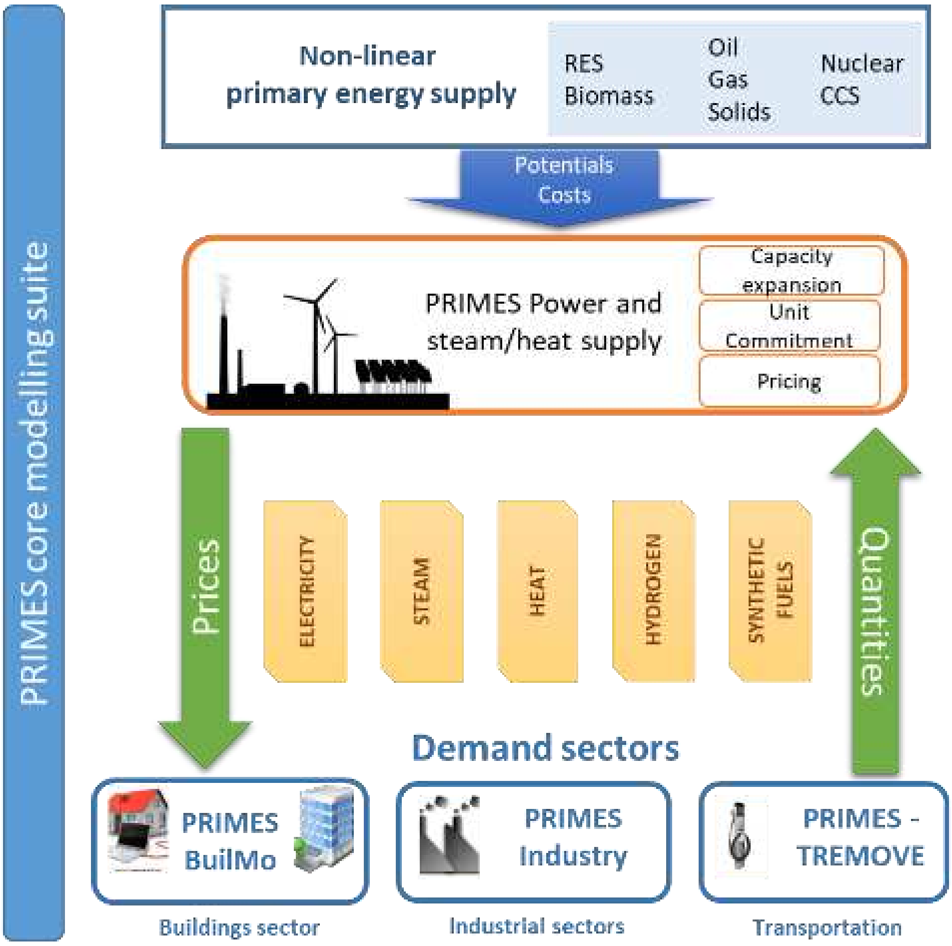
PRIMES offer the possibility of handling market distortions, barriers to rational decisions, behaviours and market coordination issues and it has full accounting of costs (CAPEX and OPEX) and investment on infrastructure needs.

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

PRIMES allows simulating long-term transformations/transitions and includes non-linear formulation of potentials by type (resources, sites, acceptability etc.) and technology learning. **Figure 21** shows a schematic representation of the PRIMES model.

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

Figure 21: Schematic representation of the PRIMES model



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

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

PRIMES is a private model maintained by E3Modelling[14], originally developed in the context of a series of research programmes co-financed by the European Commission.

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

The model has been successfully peer-reviewed, last in 2011[15]; team members regularly participate in international conferences and publish in scientific peer-reviewed journals.

Sources for data inputs

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

- Eurostat and EEA: Energy Balance sheets, Energy prices (complemented by other sources, such IEA), macroeconomic and sectoral activity data (PRIMES sectors correspond to NACE 3-digit classification), population data and projections, physical activity data (complemented by other sources), CHP surveys, CO_2 emission factors (sectoral and reference approaches) and EU ETS registry for allocating emissions between ETS and non ETS
- Technology databases: ODYSSEE-MURE[16], ICARUS, Eco-design, VGB (power technology costs), TECHPOL – supply sector technologies, NEMS model database[17], IPPC BAT Technologies[18]
- Power Plant Inventory: ESAP SA and PLATTS
- RES capacities, potential and availability: JRC ENSPRESO[19], JRC EMHIRES[20], RES ninja[21], ECN, DLR and Observer, IRENA
- Network infrastructure: ENTSOE, GIE, other operators
- Other databases: EU GHG inventories, district heating surveys (e.g. from COGEN), buildings and houses statistics and surveys (various sources, including ENTRANZE project[22], INSPIRE archive, BPIE[23]), JRC-IDEES[24], update to the EU Building stock Observatory[25]

13.1.2.3 Transport: the PRIMES-TREMOVE model

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

The PRIMES-TREMOVE transport model can therefore provide the quantitative analysis for the transport sector in the EU, candidate and neighbouring countries covering activity, equipment, energy and emissions. The model accounts for each country

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[15] SEC(2011)1569 : https://ec.europa.eu/energy/sites/ener/files/documents/sec_2011_1569_2.pdf
[16] https://www.odyssee-mure.eu/
[17] Source: https://www.eia.gov/outlooks/aeo/info_nems_archive.php
[18] Source: https://eippcb.jrc.ec.europa.eu/reference/
[19] Source: https://data.jrc.ec.europa.eu/collection/id-00138
[20] Source: https://data.jrc.ec.europa.eu/dataset/jrc-emhires-wind-generation-time-series
[21] Source: https://www.renewables.ninja/
[22] Source: https://www.entranze.eu/
[23]Source: http://bpie.eu/
[24] Source: https://ec.europa.eu/jrc/en/potencia/jrc-idees
[25] Source: https://ec.europa.eu/energy/en/eubuildings

separately which means that the detailed long-term outlooks are available both for each country and in aggregate forms (e.g. EU level).

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

The PRIMES-TREMOVE has been developed and is maintained by E3Modelling, based on, but extending features of, the open source TREMOVE model developed by the TREMOVE[26] modelling community. Part of the model (e.g. the utility nested tree) was built following the TREMOVE model.[27] Other parts, like the component on fuel consumption and emissions, follow the COPERT model.

Data inputs

The main data sources for inputs to the PRIMES-TREMOVE model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[28]. Excise taxes are derived from DG TAXUD excise duty tables. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports.

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

13.1.2.4 Maritime transport: PRIMES-maritime model

The maritime transport model is a specific sub-module of the PRIMES and PRIMES-TREMOVE models aiming to enhance the representation of the maritime sector within the energy-economy-environment modelling nexus. The model, which can run in stand-

[26] Source: https://www.tmleuven.be/en/navigation/TREMOVE
[27] Several model enhancements were made compared to the standard TREMOVE model, as for example: for the number of vintages (allowing representation of the choice of second-hand cars); for the technology categories which include vehicle types using electricity from the grid and fuel cells. The model also incorporates additional fuel types, such as biofuels (when they differ from standard fossil fuel technologies), LPG, LNG, hydrogen and e-fuels. In addition, representation of infrastructure for refuelling and recharging are among the model refinements, influencing fuel choices. A major model enhancement concerns the inclusion of heterogeneity in the distance of stylised trips; the model considers that the trip distances follow a distribution function with different distances and frequencies. The inclusion of heterogeneity was found to be of significant influence in the choice of vehicle-fuels especially for vehicles-fuels with range limitations.
[28] Source: https://ec.europa.eu/transport/facts-fundings/statistics_en

alone and/or linked mode with PRIMES and PRIMES-TREMOVE, produces long-term energy and emission projections, until 2070, separately for each EU Member-State.

The coverage of the model includes the European intra-EU maritime sector as well as the extra-EU maritime shipping. The model covers both freight and passenger international maritime. PRIMES-maritime focuses only on the EU Member State, therefore trade activity between non-EU countries is outside the scope of the model. The model considers the transactions (bilateral trade by product type) of the EU-Member States with non-EU countries and aggregates these countries in regions. Several types and sizes of vessels are considered.

PRIMES-maritime features a modular approach based on the demand and the supply modules. The demand module projects maritime activity for each EU Member State by type of cargo and by corresponding partner. Econometric functions correlate demand for maritime transport services with economic indicators considered as demand drivers, including GDP, trade of energy commodities (oil, coal, LNG), trade of non-energy commodities, international fuel prices, etc. The supply module simulates a representative operator controlling the EU fleet, who offers the requested maritime transport services. The operator of the fleet decides the allocation of the vessels activity to the various markets (representing the different EU MS) where different regulatory regimes may apply (e.g. environmental zones). The fleet of vessels disaggregated into several categories is specific to cargo types. PRIMES maritime utilises a stock-flow relationship to simulate the evolution of the fleet of vessels throughout the projection period and the purchasing of new vessels.

PRIMES-maritime solves a virtual market equilibrium problem, where demand and supply interact dynamically in each consecutive time period, influenced by a variety of exogenous policy variables, notably fuel standards, pricing signals (e.g. ETS), environmental and efficiency/operational regulations and others. The PRIMES maritime model projects energy consumption by fuel type and purpose as well as CO_2, methane and N_2O and other pollutant emissions. The model includes projections of costs, such as capital, fuel, operation costs, projections of investment expenditures in new vessels and negative externalities from air pollution.

The model serves to quantify policy scenarios supporting the transition towards carbon neutrality. It considers the handling of a variety of fuels such as fossil fuels, biofuels (bioheavy[29], biodiesel, bio-LNG), synthetic fuels (synthetic diesel, fuel oil and gas, e-ammonia and e-methanol) produced from renewable electricity, hydrogen produced from renewable electricity (for direct use and for use in fuel cell vessels) and electricity for electric vessels. Well-to-Wake emissions are calculated thanks to the linkage with the PRIMES energy systems model which derives ways of producing such fuels. The model also allows to explore synergies with Onshore Power Supply systems. Environmental regulation, fuel blending mandates, GHG emission reduction targets, pricing signals and policies increasing the availability of fuel supply and supporting the alternative fuel infrastructure are identified as drivers, along fuel costs, for the penetration of new fuels.

[29] Bioheavy refers to bio heavy fuel oil.

As the model is dynamic and handles vessel vintages, capital turnover is explicit in the model influencing the pace of fuel and vessel substitution.

Data inputs

The main data sources for inputs to the PRIMES-maritime model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[30]. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports. PRIMES-maritime being part of the overall PRIMES model is it calibrated to the EUROSTAT energy balances and transport activity; hence the associated CO_2 emissions are assumed to derive from the combustion of these fuel quantities. The model has been adapted to reflect allocation of CO_2 emissions into intra-EU, extra-EU and berth, in line with data from the MRV database.[31] For air pollutants, the model draws on the EEA database.

In the context of this exercise, the PRIMES-maritime model is calibrated to 2005, 2010 and 2015 historical data.

13.1.2.5 Non-CO_2 GHG emissions and air pollution: GAINS

The GAINS (Greenhouse gas and Air Pollution Information and Simulation) model is an integrated assessment model of air pollutant and greenhouse gas emissions and their interactions. GAINS brings together data on economic development, the structure, control potential and costs of emission sources and the formation and dispersion of pollutants in the atmosphere.

In addition to the projection and mitigation of non-CO_2 greenhouse gas emissions at detailed sub-sectorial level, GAINS assesses air pollution impacts on human health from fine particulate matter and ground-level ozone, vegetation damage caused by ground-level ozone, the acidification of terrestrial and aquatic ecosystems and excess nitrogen deposition of soils.

Model uses include the projection of non-CO_2 GHG emissions and air pollutant emissions for the EU Reference scenario and policy scenarios, calibrated to UNFCCC emission data as historical data source. This allows for an assessment, per Member State, of the (technical) options and emission potential for non-CO_2 emissions. Health and environmental co-benefits of climate and energy policies such as energy efficiency can also be assessed.

The GAINS model is accessible for expert users through a model interface[32] and has been developed and is maintained by the International Institute of Applied Systems Analysis[33]. The underlying algorithms are described in publicly available literature. GAINS and its predecessor RAINS have been peer reviewed multiple times, in 2004, 2009 and 2011.

Sources for data inputs

[30] Source: https://ec.europa.eu/transport/facts-fundings/statistics_en
[31] https://mrv.emsa.europa.eu/#public/eumrv
[32] Source: http://gains.iiasa.ac.at/models/
[33] Source: http://www.iiasa.ac.at/

The GAINS model assesses emissions to air for given externally produced activity data scenarios. For Europe, GAINS uses macroeconomic and energy sector scenarios from the PRIMES model, for agricultural sector activity data GAINS adopts historical data from EUROSTAT and aligns these with future projections from the CAPRI model. Projections for waste generation, organic content of wastewater and consumption of F-gases are projected in GAINS in consistency with macroeconomic and population scenarios from PRIMES. For global scenarios, GAINS uses macroeconomic and energy sector projections from IEA World Energy Outlook scenarios and agricultural sector projections from FAO. All other input data to GAINS, i.e., sector- and technology- specific emission factors and cost parameters, are taken from literature and referenced in the documentation.

13.1.2.6 Forestry and land-use: GLOBIOM-G4M

The Global Biosphere Management Model (GLOBIOM) is a global recursive dynamic partial equilibrium model integrating the agricultural, bioenergy and forestry sectors with the aim to provide policy analysis on global issues concerning land use competition between the major land-based production sectors. Agricultural and forestry production as well as bioenergy production are modelled in a detailed way accounting for about 20 globally most important crops, a range of livestock production activities, forestry commodities as well as different energy transformation pathways.

GLOBIOM covers 50 world regions / countries, including the EU27 Member States.

Model uses include the projection of emissions from land use, land use change and forestry (LULUCF) for EU Reference scenario and policy scenarios. For the forestry sector, emissions and removals are projected by the Global Forestry Model (G4M), a geographically explicit agent-based model that assesses afforestation, deforestation and forest management decisions. GLOBIOM-G4M is also used in the LULUCF impact assessment to assess the options (afforestation, deforestation, forest management, and cropland and grassland management) and costs of enhancing the LULUCF sink for each Member State.

The GLOBIOM-G4M has been developed and is maintained by the International Institute of Applied Systems Analysis[34].

Sources for data inputs

The main market data sources for GLOBIOM-EU are EUROSTAT and FAOSTAT, which provide data at the national level and which are spatially allocated using data from the SPAM model[35]. Crop management systems are parameterised based on simulations from the biophysical process-based crop model EPIC. The livestock production system parameterization relies on the dataset by Herrero et al[36]. Further datasets are incorporated, coming from the scientific literature and other research projects.

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[34] Source : http://www.iiasa.ac.at/

[35] See You, L., Wood, S. (2006). An Entropy Approach to Spatial Disaggregation of Agricultural Production, Agricultural Systems 90, 329–47 and http://mapspam.info/.

[36] Herrero, M., Havlík, P., et al. (2013). Biomass Use, Production, Feed Efficiencies, and Greenhouse Gas Emissions from Global Livestock Systems, Proceedings of the National Academy of Sciences 110, 20888–93.

GLOBIOM is calibrated to FAOSTAT data for the year 2000 (average 1998 - 2002) and runs recursively dynamic in 10-year time-steps. In the context of this exercise, baseline trends of agricultural commodities are aligned with FAOSTAT data for 2010/2020 and broadly with AGLINK-COSIMO trends for main agricultural commodities in the EU until 2030.

The main data sources for G4M are CORINE, Forest Europe (MCPFE, 2015)[37], countries' submissions to UNFCCC and KP, FAO Forest Resource Assessments, and national forest inventory reports. Afforestation and deforestation trends in G4M are calibrated to historical data for the period 2000-2013.

13.1.2.7 Agriculture: CAPRI

CAPRI is a global multi-country agricultural sector model, supporting decision making related to the Common Agricultural Policy and environmental policy and therefore with far greater detail for Europe than for other world regions. It is maintained and developed in a network of public and private agencies including the European Commission (JRC), Universities (Bonn University, Swedish University of Agricultural Sciences, Universidad Politécnica de Madrid), research agencies (Thünen Institute), and private agencies (EuroCARE), in charge for use in this modelling cluster). The model takes inputs from GEM-E3, PRIMES and PRIMES Biomass model, provides outputs to GAINS, and exchanges information with GLOBIOM on livestock, crops, and forestry as well as LULUCF effects.

The CAPRI model provides the agricultural outlook for the Reference Scenario, in particular on livestock and fertilisers use, further it provides the impacts on the agricultural sector from changed biofuel demand. It takes into account recent data and builds on the 2020 EU Agricultural Outlook[38]. Depending on the need it may also be used to run climate mitigation scenarios, diet shift scenarios or CAP scenarios.

Cross checks are undertaken ex-ante and ex-post to ensure consistency with GLOBIOM on overlapping variables, in particular for the crop sector.

Sources for data inputs

The main data source for CAPRI is EUROSTAT. This concerns data on production, market balances, land use, animal herds, prices, and sectoral income. EUROSTAT data are complemented with sources for specific topics (like CAP payments or biofuel production). For Western Balkan regions a database matching with the EUROSTAT inputs for CAPRI has been compiled based on national data. For non-European regions the key data source is FAOSTAT, which also serves as a fall back option in case of missing EUROSTAT data. The database compilation is a modelling exercise on its own because usually several sources are available for the same or related items and their reconciliation involves the optimisation to reproduce the hard data as good as possible while maintaining all technical constraints like adding up conditions.

[37] MCPFE (2015). Forest Europe, 2015: State of Europe's Forests 2015. Madrid, Ministerial Conference on the Protection of Forests in Europe: 314.

[38] EU Agricultural Outlook for markets, income and environment 2020-2030, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/agricultural-outlook-2020-report_en.pdf

In the context of this exercise, the CAPRI model uses historical data series at least up to 2017, and the first simulation years (2010 and 2015) are calibrated on historical data.

13.1.3 Assumptions on technology, economics and energy prices

In order to reflect the fundamental socio-economic, technological and policy developments, the Commission prepares periodically an EU Reference Scenario on energy, transport and GHG emissions. The scenarios assessment used for the "Fit for 55" policy package builds on the latest "EU Reference Scenario 2020" (REF2020)[39].

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

13.1.3.1 Economic assumptions

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

Population projections from Eurostat[40] are used to estimate the evolution of the European population, which is expected to change little in total number in the coming decades. The GDP growth projections are from the Ageing Report 2021[41] by the Directorate General for Economic and Financial Affairs, which are based on the same population growth assumptions.

Table 22: Projected population and GDP growth per MS

	Population			GDP growth	
	2020	2025	2030	2020-'25	2026-'30
EU27	447.7	449.3	449.1	0.9%	1.1%
Austria	8.90	9.03	9.15	0.9%	1.2%
Belgium	11.51	11.66	11.76	0.8%	0.8%
Bulgaria	6.95	6.69	6.45	0.7%	1.3%
Croatia	4.06	3.94	3.83	0.2%	0.6%
Cyprus	0.89	0.93	0.96	0.7%	1.7%
Czechia	10.69	10.79	10.76	1.6%	2.0%
Denmark	5.81	5.88	5.96	2.0%	1.7%
Estonia	1.33	1.32	1.31	2.2%	2.6%

[39] See related publication.
[40] EUROPOP2019 population projections https://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data
[41] The 2021 Ageing Report : Underlying assumptions and projection methodologies https://ec.europa.eu/info/publications/2021-ageing-report-underlying-assumptions-and-projection-methodologies_en

Finland	5.53	5.54	5.52	0.6%	1.2%
France	67.20	68.04	68.75	0.7%	1.0%
Germany	83.14	83.48	83.45	0.8%	0.7%
Greece	10.70	10.51	10.30	0.7%	0.6%
Hungary	9.77	9.70	9.62	1.8%	2.6%
Ireland	4.97	5.27	5.50	2.0%	1.7%
Italy	60.29	60.09	59.94	0.3%	0.3%
Latvia	1.91	1.82	1.71	1.4%	1.9%
Lithuania	2.79	2.71	2.58	1.7%	1.5%
Luxembourg	0.63	0.66	0.69	1.7%	2.0%
Malta	0.51	0.56	0.59	2.7%	4.1%
Netherlands	17.40	17.75	17.97	0.7%	0.7%
Poland	37.94	37.57	37.02	2.1%	2.4%
Portugal	10.29	10.22	10.09	0.8%	0.8%
Romania	19.28	18.51	17.81	2.7%	3.0%
Slovakia	5.46	5.47	5.44	1.1%	1.7%
Slovenia	2.10	2.11	2.11	2.1%	2.4%
Spain	47.32	48.31	48.75	0.9%	1.6%
Sweden	10.32	10.75	11.10	1.4%	2.2%

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

13.1.3.2 International energy prices assumptions

Alongside socio-economic projections, EU energy modelling requires projections of international fuel prices. The 2020 values are estimated from information available by mid-2020. The projections of the POLES-JRC model – elaborated by the Joint Research Centre and derived from the Global Energy and Climate Outlook (GECO[42]) – are used to obtain long-term estimates of the international fuel prices.

[42] https://ec.europa.eu/jrc/en/geco

The COVID crisis has had a major impact on international fuel prices[43]. The lost demand cause an oversupply leading to decreasing prices. The effect on prices compared to pre-COVID estimates is expected to be still felt up to 2030. Actual development will depend on the recovery of global oil demand as well as supply side policies[44].

Table 23 shows the international fuel prices assumptions of the REF2020 and of the different scenarios and variants used in the "Fit for 55" policy package impact assessments.

Table 23: International fuel prices assumptions

in $'15 per boe	2000	'05	'10	'15	'20	'25	'30	'35	'40	'45	'50
Oil	38.4	65.4	86.7	52.3	39.8	59.9	80.1	90.4	97.4	105.6	117.9
Gas (NCV)	26.5	35.8	45.8	43.7	20.1	30.5	40.9	44.9	52.6	57.0	57.8
Coal	11.2	16.9	23.2	13.1	9.5	13.6	17.6	19.1	20.3	21.3	22.3
in €'15 per boe	2000	2005	'10	'15	'20	'25	'30	'35	'40	'45	'50
Oil	34.6	58.9	78.2	47.2	35.8	54.0	72.2	81.5	87.8	95.2	106.3
Gas (NCV)	23.4	31.7	40.6	38.7	17.8	27.0	36.2	39.7	46.6	50.5	51.2
Coal	9.9	15.0	20.6	11.6	8.4	12.0	15.6	16.9	18.0	18.9	19.7

Source: Derived from JRC, POLES-JRC model, Global Energy and Climate Outlook (GECO)

13.1.3.3 Technology assumptions

Modelling scenarios on the evolution of the energy system is highly dependent on the assumptions on the development of technologies - both in terms of performance and costs. For the purpose of the impact assessments related to the "Climate Target Plan" and the "Fit for 55" policy package, these assumptions have been updated based on a rigorous literature review carried out by external consultants in collaboration with the JRC[45].

Continuing the approach adopted in the long-term strategy in 2018, the Commission consulted on the technology assumption with stakeholders in 2019. In particular, the technology database of the main model suite (PRIMES, PRIMES-TREMOVE, GAINS, GLOBIOM, and CAPRI) benefited from a dedicated consultation workshop held on 11th November 2019. EU Member States representatives also had the opportunity to comment on the costs elements during a workshop held on 25th November 2019. The updated technology assumptions are published together with the EU Reference Scenario 2020.

[43] IEA, Global Energy Review 2020, June 2020
[44] IEA, Oil Market Report, June 2020 and US EIA, July 2020.
[45] JRC118275

13.1.4 The existing 2030 framework: the EU Reference Scenario 2020

13.1.4.1 The EU Reference Scenario 2020 as the common baseline

The EU Reference Scenario 2020 (REF2020) provides projections for energy demand and supply, as well as greenhouse gas emissions in all sectors of the European economy under the current EU and national policy framework. It embeds in particular the EU legislation in place to reach the 2030 climate target of at least 40% compared to 1990, as well as national contributions to reaching the EU 2030 energy targets on Energy efficiency and Renewables under the Governance of the Energy Union. It thus gives a detailed picture of where the EU economy and energy system in particular would stand in terms of GHG emission if the policy framework were not updated to enable reaching the revised 2030 climate target to at least -55% compared to 1990 proposed under the Climate Target Plan[46].

The Reference Scenario serves as the common baseline shared by all the initiatives of the "Fit for 55" policy package to assess options in their impact assessments:

- updating the Effort Sharing Regulation,
- updating the Emission Trading System,
- revision of the Renewables Energy Directive,
- revision of the Energy Efficiency Directive,
- revision of the Regulation setting CO_2 emission performance standards for cars and light commercial vehicles,
- review of the LULUCF EU rules.

13.1.4.2 Difference with the CTP "BSL" scenario

The REF2020 embeds some differences compared to the baseline used for the CTP impact assessment. While the technology assumptions (consulted in a workshop held on 11th November 2019) were not changed, the time between CTP publication and the publication of the "Fit for 55" package allowed updating some other important assumptions:

- GDP projections, population projections and fossil fuel prices were updated, in particular to take into account the impact of the COVID crisis through an alignment with the 2021 Ageing Report[47] and an update of international fossil fuel prices notably on the short run.
- While the CTP baseline aimed at reaching the current EU 2030 energy targets (on energy efficiency and renewable energy), the Reference Scenario 2020, used as the baseline for the "Fit for 55" package, further improved the representation of the National Energy Climate Plans (NECP). In particular it aims at reaching the national contributions to the EU energy targets, and not at respecting these EU targets themselves.

13.1.4.3 Reference scenario process

[46] COM/2020/562 final

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

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

It benefitted from a stakeholders consultation (on technologies) and is aligned with other outlooks from Commission services, notably DG ECFIN's Ageing Report 2021 (see section 0), as well as, to the extent possible, the 2020 edition of the EU Agricultural Outlook 2020-2030 published by DG AGRI in December 2020[48].

13.1.4.4 Policies in the Reference scenario

The REF2020 also takes into account the still-unfolding effects of the COVID-19 pandemic, to the extent possible at the time of the analysis. According to the GDP assumptions of the Ageing Report 2021, the pandemic is followed by an economic recovery resulting in moderately lower economic output in 2030 than pre-COVID estimates.

The scenario is based on existing policies adopted at national and EU level at the beginning of 2020. In particular, at EU level, the REF2020 takes into account the legislation adopted in the Clean Energy for All European Package[49]. At national level, the scenario takes into account the policies and specific targets, in particular in relation with renewable energy and energy efficiency, described in the final National Energy and Climate Plans (NECPs) submitted by Member States at the end of 2019/beginning of 2020.

The REF2020 models the policies already adopted, but not the target of net-zero emissions by 2050. As a result, there are no additional policies introduced driving decarbonisation after 2030. However, climate and energy policies are not rolled back after 2030 and several of the measures in place today continue to deliver emissions reduction in the long term. This is the case, for example, for products standards and building codes and the ETS Directive (progressive reduction of ETS allowances is set to continue after 2030).

Details on policies and measures represented in the REF2020 can be found in the dedicated "EU Reference Scenario 2020" publication.

13.1.4.5 Reference Scenario 2020 key outputs

For 2030, the REF2020 scenario mirrors the main targets and projections submitted by Member States in their final NECPs. In particular, aggregated at the EU level, the REF2020 projects a 33.2% share of renewable energy in Gross Final Energy Consumption. Final energy consumption is 823 Mtoe, which is 29.6% below the 2007 PRIMES Baseline.

In the REF2020, GHG emissions from the EU in 2030 (including all domestic emissions & intra EU aviation and maritime) are 43.8% below the 1990 level. A carbon price of 30 EUR/tCO_2eq. in 2030 drives emissions reduction in the ETS sector. **Table 24** shows a

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

[49] COM(2016) 860 final.

summary of the projections for 2030. A detailed description of the REF2020 can be found in a separate report published by the Commission[50].

Table 24: REF2020 summary energy and climate indicators

EU 2030	REF2020
GHG reductions (incl. Domestic emissions & intra EU aviation and maritime) vs 1990	-43.8%
RES share	33.2%
PEC energy savings	-32.7%
FEC energy savings	-29.6%
Environmental impacts	
GHG emissions reduction in current ETS sectors vs 2005	-48.2%
GHG emissions reduction in current non-ETS sectors vs 2005	-30.7%
Energy system impacts	
GIC (Mtoe)	1224.2
- Solid fossil fuels	9.3%
- Oil	31.9%
- Natural gas	22%
- Nuclear	11%
- Renewables	25.8%
Final Energy Demand (Mtoe)	822.6
RES share in heating & cooling	32.8%
RES share in electricity	58.5%
RES share in transport	21.2%
Economic and social impacts	
System costs (excl. auction payment) (average 2021-30) as % of GDP	10.9%
Investment expenditures (incl. transport) average annual (2021-30) vs (2011-20) (bn€)	285
EU ETS carbon price (€/ton, 2030)	30
Energy- expenditures (excl. transport) of households as % of total consumption	7.0%

Source: PRIMES model

The system costs (excluding ETS carbon-related payments) reaches close to 11% of the EU's GDP on average over 2021-2030. This cost[51] is calculated ex-post with a private

[50] EU Reference Scenario 2020 publication

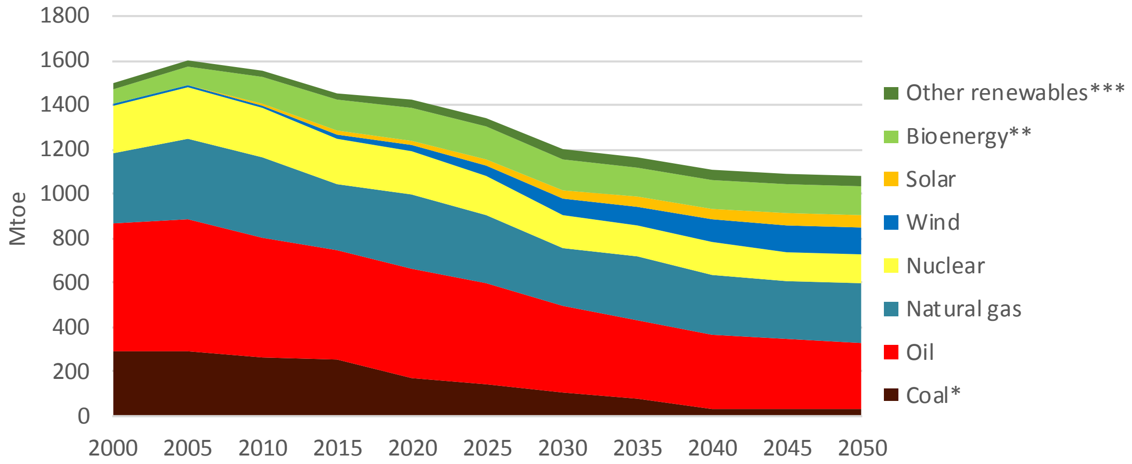
[51] Energy system costs for the entire energy system include capital costs (for energy installations such as power plants and energy infrastructure, energy using equipment, appliances and energy related costs of transport), energy purchase costs (fuels + electricity + steam) and direct efficiency investment costs, the latter being also expenditures of capital nature. For transport, only the additional capital costs for energy purposes (additional capital costs for improving energy efficiency or for using alternative fuels, including alternative fuels infrastructure) are covered, but not other costs including the significant transport related infrastructure costs e.g. related to railways and roads. Direct efficiency investment costs include additional costs for house insulation, double/triple glazing, control systems, energy management and for efficiency enhancing changes in production processes not accounted for under energy capital and fuel/electricity purchase costs. Energy system costs are calculated ex-post after the model is solved.

sector perspective applying a flat 10% discount rate[52] over the simulation period up to 2050 to compute investment-related annualized expenditures.

By 2050, final energy consumption is projected at around 790 Mtoe and approximately 74% of the European electricity is generated by renewable energy sources. GHG emissions in the EU are projected to be about 60% lower than in 1990: the REF2020 thus falls short of the European goal of climate neutrality by 2050.

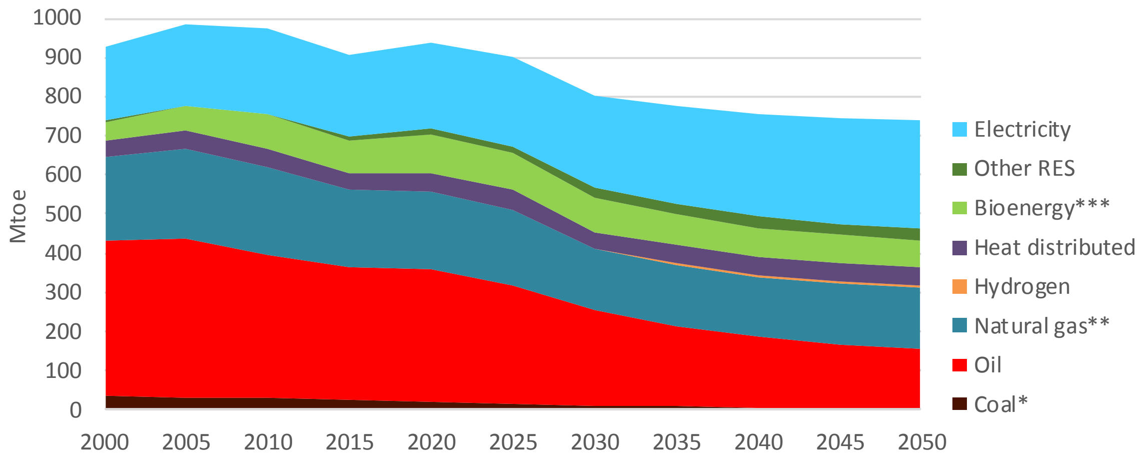
Focusing on the energy system, REF2020 shows that in 2030 fuel mix would still be dominated by fossil fuels. While the renewables grow and fossil fuels decline by 2050, the substitution is not sufficient for carbon neutrality. It also has to be noted that there is no deployment of e-fuels that are crucial for achievement of carbon neutrality as analysed in the Long Term Strategy[53] and in the CTP.

Figure 22: Fuel mix evolution of the Reference Scenario 2020



Source: Eurostat, PRIMES model

Figure 23: Share of energy carriers in final energy consumption in the Reference Scenario 2020



[52] See the EU Reference Scenario 2020 publication for a further discussion on the roles and levels of discount rates in the modelling, which also represent risk and opportunity costs associated with investments.

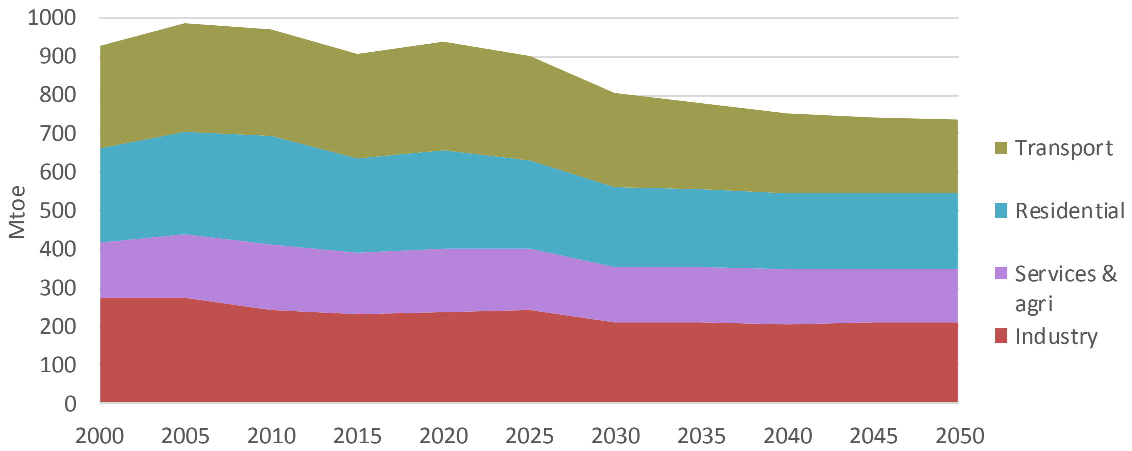
[53] COM(2018) 773

*Note: * includes peat and oil shale; ** includes manufactured gases, *** includes waste*

Source: Eurostat, PRIMES model

Coal use in power generation decrease by 62% by 2030 and almost completely disappear by 2050. Also demand for oil sees a significant decrease of 54% over the entire period – the most important in absolute terms. Electricity generation grows by 24% by 2050.

Figure 24: Final energy demand by sector in the Reference Scenario 2020



Source: Eurostat, PRIMES model

Despite continued economic growth, final energy demand decreases by 18% between 2015 and 2050 (already by 2030 it decreases by more than 8%).

13.1.5 Scenarios for the "Fit for 55" policy analysis

13.1.5.1 From the Climate Target Plan scenarios to "Fit for 55" core scenarios

In the Climate Target Plan (CTP) impact assessment, the increase of efforts needed for the GHG 55% target was illustrated by policy scenarios (developed with the same modelling suite as the scenarios done for the "Fit for 55" package) showing increased ambition (or stringency) of climate, energy and transport policies and, consequently, leading to a significant investment challenge.

The first key lesson from the CTP exercise was that while the tools are numerous and have a number of interactions (or even sometimes trade-offs) a **complete toolbox of climate, energy and transport policies is needed** for the increased climate target as all sectors would need to contribute effectively towards the GHG 55% target.

The second key lesson was that even though policy tools chosen in the CTP scenarios were different - illustrating in particular the fundamental interplay between the strength of the carbon pricing and intensity of regulatory measures - **the results achieved were convergent**. All CTP policy scenarios that achieved a 55% GHG target[54] showed very similar levels of ambition for energy efficiency, renewables (overall and on sectoral level) and GHG reductions across the sectors indicating also the cost-effective pathways.

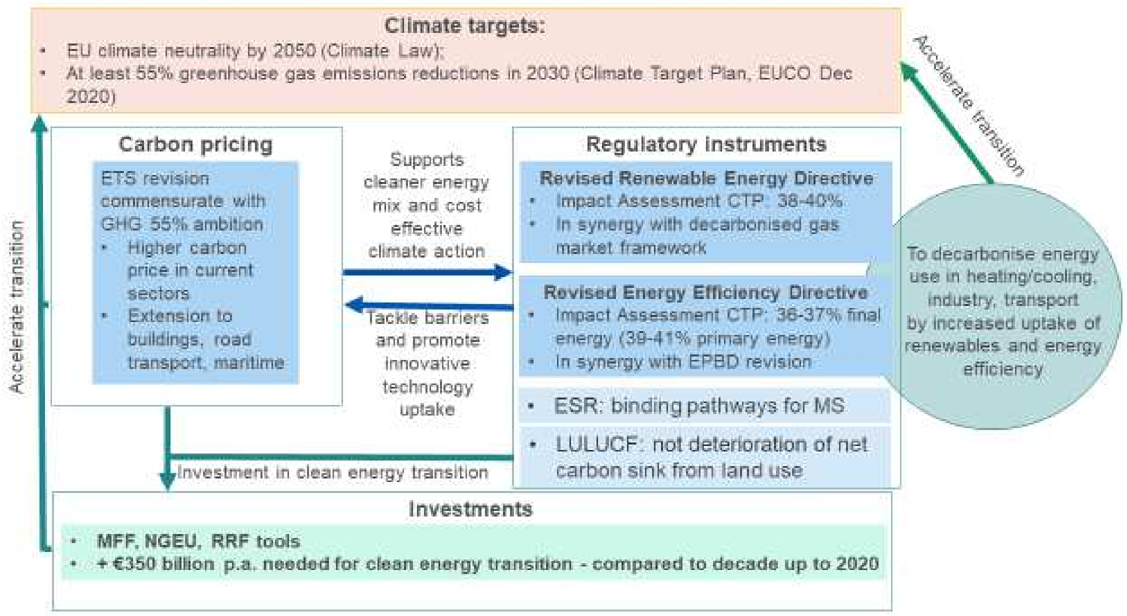
The third lesson was that carbon pricing working hand in hand with regulatory measures helps avoid "extreme" scenarios of either:

[54] A 50% GHG target was also analysed

- a very high carbon price (in absence of regulatory measures) that will translate into increased energy prices for all consumers,
- very ambitious policies that might be difficult to be implemented (e.g. very high energy savings or renewables obligations) because they would be costly for economic operators or represent very significant investment challenge.

Figure 25 below illustrates the interactions between different policy tools relevant to reach the EU's climate objectives.

Figure 25: Interactions between different policy tools



With the 55% GHG target confirmed by EU leaders in the December 2020 EUCO Conclusions[55] and the 2021 Commission Work Programme[56] (CWP 2021) that puts forward the complete toolbox to achieve the increased climate target (so-called "Fit for 55" proposals), the fundamental set-up of the CTP analysis was confirmed. This set-up is still about the interplay between carbon pricing and regulatory measures as illustrated above, and the extension of the ETS is the central policy question.

As described above, the policy scenarios of the CTP assessment are cost-effective pathways that capture all policies needed to achieve the increased climate target of 55% GHG reductions. This fundamental design remains robust and the CTP scenarios were thus used as the basis to define the "Fit for 55" policy scenarios.

In the context of the agreed increased climate target of a net reduction of 55% GHG compared to 1990, the 50% GHG scenario (CTP MIX-50) explored in the CTP has been discarded since no longer relevant. The contribution of extra EU aviation and maritime emissions in the CTP ALLBNK scenario was assessed in the respective sector specific impact assessments and was not retained as a core scenario. This leaves the following CTP scenarios in need of further revisions and updates in the context of preparing input in a coherent manner for the set of IAs supporting the "Fit for 55" package, ensuring the

[55] https://www.consilium.europa.eu/media/47328/1011-12-20-euco-conclusions-fr.pdf
[56] COM(2020) 690 final

achievement of the overall net 55% GHG reduction ambition with similar levels of renewable energy and energy efficiency deployment as in CTP:

- CTP REG (relying only on intensification of energy and transport policies in absence of carbon pricing beyond the current ETS sectors);
- CTP MIX (relying on both carbon price signal extension to road transport and buildings and intensification of energy and transport policies);
- CTP CPRICE (relying chiefly on carbon price signal extension, and more limited additional sectoral policies).

13.1.5.2 Scenarios for the "Fit for 55"package

Based on the Climate Target Plan analysis, some **updates were needed** though for the purpose of the "Fit for 55" assessment, in terms of:

- **Baseline**:
    - to reflect the most recent statistical data available, notably in terms of COVID impacts,
    - to capture the objectives and policies put forward by Member States in the NECPs, which were not all available at the time of the CTP analysis,

The baseline used in the Fit for 55 package is thus the "Reference Scenario 2020", as described in section 2.1.4.

- **Scenario design** in order to align better with policy options as put forward in the CWP 2021 and respective Inception Impact Assessments[57].

As a consequence, the three following core policy scenarios were defined to serve as common policy package analysis across the various initiatives of the "Fit for 55" policy assessments:

- **REG**: an update of the CTP REG case (relying only on very strong intensification of energy and transport policies in absence of carbon pricing beyond the current ETS sectors).
- **MIX**: reflecting an update of the CTP MIX case (relying on both carbon price signal extension to road transport and buildings and strong intensification of energy and transport policies). With its uniform carbon price (as of 2025), it reflects either an extended and fully integrated EU ETS or an existing EU ETS and new ETS established for road transport and buildings with emission caps set in line with cost-effective contributions of the respective sectors.
- **MIX-CP**: representing a more carbon price driven policy mix, combining thus the general philosophy of the CTP CPRICE scenario with key drivers of the MIX

[57] Importantly, all "Fit for 55" core scenarios reflect the Commission Work Programme (CWP) 2021 in terms of elements foreseen. This is why assumptions are made about legislative proposals to be made later on - by Quarter 4 2021. On the energy side, the subsequent proposals are: the revision of the EPBD, the proposal for Decarbonised Gas Markets and the proposal for reducing methane emissions in the energy sector. For transport they refer to the revision of the TEN-T Regulation and the revision of the ITS Directive. In addition, other policies that are planned for 2022 are also represented in a stylised way in these scenarios, similar to the CTP scenarios. In this way, core scenarios represent all key policies needed to deliver the increased climate target.

scenario albeit at a lower intensity. It illustrates a revision of the EED and RED but limited to a lower intensification of current policies in addition to the carbon price signal applied to new sectors.
Unlike MIX, this scenario allows to separate carbon price signals of "current" and "new" ETS. The relative split of ambition in GHG reductions between "current" ETS and "new ETS" remains, however, close in MIX-CP to the MIX scenario leading to differentiated carbon prices between "current" ETS and "new" ETS[58].

These three "Fit for 55" core policy scenarios have been produced starting from the Reference Scenario 2020 and thus use the same updated assumptions on post-COVID economics and international fuel prices.

Table 5 provides an overview of the policy assumptions retained in the three core policy scenarios. It refers in particular to different scopes of emissions trading system ("ETS"):

- "current+": refers to the current ETS extended to cover also national and international intra-EU maritime emissions[59]: this scope applies to all scenarios,
- "new": refers to the new ETS for buildings and road transport emissions: this scope applies in MIX and MIX-CP up to 2030,
- "large": refers to the use of emissions trading systems covering the "current" scope ETS, intra-EU maritime, buildings and road transport (equivalent to "current+" + "new"): this scope applies in MIX and MIX-CP after 2030.

The scenarios included focus on emissions within the EU, including intra-EU navigation and intra-EU aviation emissions. The inclusion or not of extra-EU navigation and extra-EU maritime emissions is assessed in the relevant sector specific Impact Assessments.

[58] This is a feature not implemented in the CTP CPRICE scenario.
[59] For modelling purposes "national maritime" is considered as equal to "domestic navigation", i.e. also including inland navigation.

Table 25: Scenario assumptions description (scenarios produced with the PRIMES-GAINS-GLOBIOM modelling suite)

<table>
<tr><th>Scenario</th><th>REG</th><th>MIX</th><th>MIX-CP</th></tr>
<tr><td rowspan="3">Brief description: ETS</td><td rowspan="3">Extension of “current” ETS to also cover intra-EU maritime navigation[60]

Strengthening of “current+” ETS in line with -55% ambition</td><td colspan="2"><u>By 2030</u>: 2 ETS systems:
- one “current+” ETS (current extended to intra-EU maritime)
- one “new” ETS applied to buildings and road transport

<u>After 2030</u>: both systems are integrated into one “large” ETS</td></tr>
<tr><td rowspan="2">Relevant up to 2030: the 2 ETSs are designed so that they have the same carbon price, in line with -55% ambition</td><td>Relevant up to 2030: “current+” ETS reduces emissions comparably to MIX</td></tr>
<tr><td>Lower regulatory intervention resulting in higher carbon price than in MIX, notably in the “new” ETS</td></tr>
<tr><td>Brief description: sectoral policies</td><td>High intensity increase of EE, RES, transport policies versus Reference</td><td>Medium intensity increase of EE, RES and transport policies versus Reference</td><td>Lower intensity increase of EE and RES policies versus Reference.

Transport policies as in MIX (except related to CO_2 standards)</td></tr>
<tr><td>Target scope</td><td colspan="3">EU27</td></tr>
</table>

[60] “Intra-EU navigation” in this table includes both international intra-EU and national maritime. Due to modelling limitations, energy consumption by “national maritime” is assumed to be the same as “domestic navigation”, although the latter also includes inland navigation.

Scenario	REG	MIX	MIX-CP
Aviation	Intra-EU aviation included, extra-EU excluded		
Maritime navigation	Intra-EU maritime included, extra-EU excluded		
Achieved GHG reduction of the target scope			
Including LULUCF	Around 55% reductions		
Excluding LULUCF	Around 53% reductions		
Assumed Policies			
Carbon pricing (stylised, for small industry, international aviation and maritime navigation may represent also other instruments than EU ETS such as taxation or CORSIA for aviation)			
Stationary ETS	Yes		
Aviation-Intra EU ETS	Yes		
Aviation - Extra EU ETS	Yes: mixture 50/50 carbon pricing (reflecting inclusion in the "current+" / "large" ETS, or taxation, or CORSIA) and carbon value (reflecting operational and technical measures); total equal to the carbon price of the "current+" (up to 2030) / "large" ETS		
Maritime-Intra EU ETS	Yes, carbon pricing equal to the price of the "current+" (up to 2030) / "large" EU ETS		

Scenario	REG	MIX	MIX-CP
Maritime-Extra EU ETS	As in MIX (but applied to the "current+" ETS)	Up to 2030: no carbon pricing. After 2030: 50% of extra-EU MRV[61] sees the "large" ETS price, while the remaining 50% sees a carbon value equal to the "large" ETS carbon price.	
Buildings and road transport ETS	No	Yes (in the "new" ETS up to 2030, and in the "large" ETS after 2030)	
CO_2 standards for LDVs and HDVs	CO_2 standards for LDVs and HDVs + Charging and refuelling infrastructure development (review of the Directive on alternative fuels infrastructure and TEN-T Regulation & funding), including strengthened role of buildings		
	High ambition increase	Medium ambition increase	Lower ambition increase
EE policies overall ambition	High ambition increase	Medium ambition increase	Lower ambition increase
EE policies in buildings	High intensity increase (more than doubling of renovation rates assumed)	Medium intensity increase (at least doubling of renovation rates assumed)	Lower intensity increase, no assumptions on renovation rates increases
EE policies in transport	High ambition increase	Medium intensity increase	As in MIX
RES policies overall ambition	High ambition increase	Medium intensity increase	Lower ambition increase except for transport (see below)

[61] 50% of all incoming and all outgoing extra-EU voyages

Scenario	REG	MIX	MIX-CP
RES policies in buildings + industry	Incentives for uptake of RES in heating and cooling	Incentives for uptake of RES in heating and cooling	No increase of intensity of policy (compared to Reference)
RES policies in transport and policies impacting transport fuels	Increase of intensity of policies to decarbonise the fuel mix (reflecting ReFuelEU aviation and FuelEU maritime initiatives). Origin of electricity for "e-fuels" under the aviation and shipping mandates: up to 2035 (inclusive) "e-fuels" (e-liquids, e-gas, hydrogen) are produced from renewable electricity, applying additionality principle. from 2040 onwards "e-fuels" are produced from "low carbon" electricity (i.e. nuclear and renewable origin). No application of additionality principle. CO_2 from biogenic sources or air capture.		
Taxation policies	Central option on energy content taxation of the ETD revision		
Additional non-CO_2 policies (represented by a carbon value)	Medium ambition increase		

13.1.5.3 Quantitative elements and key modelling drivers

Policies and measures are captured in the modelling analysis in different manners. Some are explicitely represented such as for instance improved product energy performance standards, fuel mandates or carbon pricing in an emission trading system. Others are represented by modelling drivers ("shadow values") used to achieve policy objectives.

The overall need for investment in new or retrofitted equipment depends on expected future demand and expected scrapping of installed equipment. The economic modelling of the competition among available investment options is based on:

- the investment cost, to which a "private" discount rate is applied to represent risk adverseness of the economic agents in the various sectors[62],
- fuel prices (including their carbon price component),
- maintenance costs as well as performance of installations over the potential lifetime of the installation,
- the relevant shadow values representing energy efficiency or renewable energy policies.

In particular, carbon pricing instruments impact economic decisions related to operation of existing equipment and to investment, in the different sectors where they apply. Table 6 shows the evolution of the ETS prices by 2030 in the Reference and core scenarios.

Table 26: ETS prices by 2030 in the difference scenarios (€2015/tCO2)

Scenarios	Carbon price "current" ETS sectors		Carbon price "new" ETS sectors	
	2025	2030	2025	2030
REF2020	27	30	0	0
REG	31	42	0	0
MIX	35	48	35	48
MIX-CP	35	52	53	80

The investment decisions are also taken considering foresight of the future development of fuel prices, including future carbon values[63] post 2030. Investment decisions take into account expectations about climate and energy policy developments, and this carbon value achieves in 2050 levels between €360/tCO_2 (in REG, where energy policy drivers play comparatively a larger role) and €430/tCO_2 (MIX-CP)[64].

[62] For more information on the roles and levels of discount rates applied per sector, see the EU Reference Scenario 2020 publication.

[63] Post 2030, carbon values should not be seen as a projected carbon price in emissions trading, but as a shadow value representing a range of policies to achieve climate neutrality that are as yet to be defined.

[64] The foresight and the discounting both influence the investment decisions. While in the modelling the discounting is actually applied to the investment to compute annualised fixed costs for the investment

In complement to carbon pricing drivers, the modelling uses "shadow values" as drivers to reach energy policy objectives of policies and measures that represent yet to be defined policies in the respective fields: the so-called "energy efficiency value" and "renewable energy value", which impact investment decision-making in the model. These values are thus introduced to achieve a certain ambition on energy efficiency, for instance related to national energy efficiency targets and renewable energy targets in the NECPs as represented in the Reference Scenario 2020, or increased renovation rates in buildings and increased sector specific renewable energy ambition related to heating and cooling in the policy scenarios.

Table 7 shows average 2025-2035 values for the different scenarios. The values in REF2020 reflect the existing policy framework, to meet notably the national energy targets (both energy efficiency and renewable energy) as per the NECPs. They are typically higher in policy scenarios that are based on regulatory approaches than in scenarios that are more based on carbon pricing. The "energy efficiency value" and "renewable energy value" also interact with each other through incentivising investment in options which are both reducing energy demand and increasing the contribution of renewables, like heat pumps. This is for instance the case in the REG scenario, where the comparatively higher "energy efficiency value" complements the "renewable energy value" in contributing to the renewable energy performance of the scenario, notably through the highest heat pump penetration of all scenarios.

Table 27: Energy efficiency value and renewable energy value (averaged 2025-2035)

Scenarios	Average renewables shadow value	Average energy efficiency shadow value
	(€'15/ MWh)	(€'15/ toe)
REF2020	62	330
REG	121	1449
MIX	61	1052
MIX-CP	26	350

Specific measures for the transport system

Policies that aim at improving the efficiency of the transport system (corresponding to row "EE in Transport" in the Table 5), and thus reduce energy consumption and CO_2 emissions, are phased-in in scenarios that are differentiated in terms of level of ambition (low, medium, high ambition increase). All scenarios assume an intensification of such policies relative to the baseline. Among these policies, the CO_2 emission standards for vehicles are of particular importance. The existing standards[65], applicable from 2025 and

decision, its effect can be illustrated if applied to the future prices instead: for example, the average discounted carbon price in 2030 for the period 2030-2050 for renovation of houses and for heating equipment, applying a 12% discount rate, is €65 in the MIX scenario and €81 in the MIX CP scenario.

[65] The existing legislation sets for newly registered passengers cars, an EU fleet-wide average emission target of 95 gCO_2/km from 2021, phased in from 2020. For newly registered vans, the EU fleet-wide average emission target is 147 gCO_2 /km from 2020 onward. Stricter EU fleet-wide CO_2 emission targets, start to apply from 2025 and from 2030. In particular emissions will have to reduce by 15% from 2025 for both cars and vans, and by 37.5% and 31% for cars and vans respectively from 2030, as compared to 2021. From 2025 on, also trucks manufacturers will have to meet CO_2 emission targets.

from 2030, set binding targets for automotive manufacturers to reduce emissions and thus fuel consumption and are included in the Reference Scenario.

Medium ambition increase

In this case, the following policy measures are considered that drive improvements in transport system efficiency and support a shift towards more sustainable transport modes, and lead to energy savings and emissions reductions:

- Initiatives to increase and better manage the capacity of railways, inland waterways and short sea shipping, supported by the TEN-T infrastructure and CEF funding;
- Gradual internalisation of external costs ("smart" pricing);
- Incentives to improve the performance of air navigation service providers in terms of efficiency and to improve the utilisation of air traffic management capacity;
- Incentives to improve the functioning of the transport system: support to multimodal mobility and intermodal freight transport by rail, inland waterways and short sea shipping;
- Deployment of the necessary infrastructure, smart traffic management systems, transport digitalisation and fostering connected and automated mobility;
- Further actions on clean airports and ports to drive reductions in energy use and emissions;
- Measures to reduce emissions and air pollution in urban areas;
- Pricing measures such as in relation to energy taxation and infrastructure charging;
- Revision of roadworthiness checks;
- Other measures incentivising behavioural change;
- Medium intensification of the CO_2 emission standards for cars, vans, trucks and buses (as of 2030), supported by large scale roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 50% for cars and around 40% for vans.

Low ambition increase

In this case, the same policy measures as in the *Medium ambition increase* are included. However, limited increase in ambition for CO_2 emission standards for vehicles (passenger cars, vans, trucks and buses) as of 2030 is assumed, supported by the roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 40% for cars and around 35% for vans.

High ambition increase

Beyond measures foreseen in the medium ambition increase case, the high ambition increase case includes:

- Further measures related to intelligent transport systems, digitalisation, connectivity and automation of transport - supported by the TEN-T infrastructure;
- Additional measures to improve the efficiency of road freight transport;

In particular, the EU fleet-wide average CO_2 emissions of newly registered trucks will have to reduce by 15% by 2025 and 30% by 2030, compared to the average emissions in the reference period (1 July 2019–30 June 2020). For cars, vans and trucks, specific incentive systems are also set to incentivise the uptake of zero and low-emission vehicles.

- Incentives for low and zero emissions vehicles in vehicle taxation;
- Increasing the accepted load/length for road in case of zero-emission High Capacity Vehicles;
- Additional measures in urban areas to address climate change and air pollution;
- Higher intensification of the CO_2 emission standards for cars, vans, trucks and buses (as of 2030) as compared to the medium ambition increase case, leading to lower CO_2 emissions and fuel consumption and further incentivising the deployment of zero- and low-emission vehicles, supported by the large scale roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 60% for cars and around 50% for vans.

Drivers of reduction in non-CO2 GHG emissions

Non-CO_2 GHG emission reductions are driven by both the changes taking place in the energy system due to the energy and carbon pricing instruments, and further by the application of a carbon value that triggers further cost efficient mitigation potential (based on the GAINS modelling tool) in specific sectors such as waste, agriculture or industry.

Table 28: Carbon value applied to non-CO2 emissions in the GAINS model (€2015/tCO2)

Scenarios	Non-CO_2 carbon values	
	2025	2030
REF2020	0	0
REG	4	4
MIX	4	4
MIX-CP	5	10

13.1.5.4 Key results and comparison with Climate Target Plan scenarios

Table 29: Key results of the "Fit for 55" core scenarios analysis for the EU**2030 unless otherwise stated**		REF	REG	MIX	MIX-CP
Key results					
GHG emissions* reductions (incl. intra EU aviation and maritime, incl. LULUCF)	% reduction from 1990	45%	55%	55%	55%
GHG emissions* reductions (incl. intra EU aviation and maritime, excl. LULUCF)	% reduction from 1990	43.4%	53.0%	52.9%	52.9%
Overall RES share	%	33%	40%	38%	38%
RES-E share	%	59%	65%	65%	65%
RES-H&C share	%	33%	41%	38%	36%
RES-T share	%	21%	29%	28%	27%
PEC energy savings	% reduction from 2007 Baseline	33%	39%	39%	38%
FEC energy savings	% reduction from 2007	30%	37%	36%	35%

	Baseline				
Environmental impacts					
CO_2 emissions reductions (intra-EU scope, excl. LULUCF), of which	(% change from 2015)	-30%	-43%	-42%	-42%
Supply side (incl. power generation, energy branch, refineries and district heating)	(% change from 2015)	-49%	-62%	-63%	-64%
Power generation	(% change from 2015)	-51%	-64%	-65%	-67%
Industry (incl. process emissions)	(% change from 2015)	-10%	-23%	-23%	-23%
Residential	(% change from 2015)	-32%	-56%	-54%	-50%
Services	(% change from 2015)	-36%	-53%	-52%	-48%
Agriculture (energy)	(% change from 2015)	-23%	-36%	-36%	-35%
Transport (incl. domestic and intra EU aviation and navigation)	(% change from 2015)	-17%	-22%	-21%	-21%
Non-CO_2 GHG emissions reductions (excl. LULUCF)	(% change from 2015)	-22%	-32%	-32%	-33%
Reduced air pollution vs. REF	(% change)			-10%	
Reduced health damages and air pollution control cost vs. REF - Low estimate	(€ billion/year)			24.8	
Reduced health damages and air pollution control cost vs. REF - High estimate	(€ billion/year)			42.7	
Energy system impacts					
Primary Energy Intensity	toe/M€'13	83	75	76	76
Gross Available Energy (GAE)	Mtoe	1,289	1,194	1,198	1,205
- Solids share	%	9%	6%	5%	5%
- Oil share	%	34%	33%	33%	33%
- Natural gas share	%	21%	20%	20%	21%
- Nuclear share	%	10%	11%	11%	11%
- Renewables share	%	26%	31%	30%	30%
- Bioenergy share	%	13%	13%	12%	12%
- Other Renewables share	%	13%	18%	18%	18%
Gross Electricity Generation	TWh	2,996	3,152	3,154	3,151
- Gas share	%	14%	12%	13%	14%
- Nuclear share	%	17%	16%	16%	16%
- Renewables share	%	59%	65%	65%	65%
Economic impacts					
Investment expenditures (excl. transport) (2021-30)	bn €'15/year	297	417	402	379
Investment expenditures (excl. transport) (2021-30)	% GDP	2.1%	3.0%	2.9%	2.7%
Additional investments to REF	*bn €'15/year*		*120*	*105*	*83*
Investment expenditures (incl. transport) (2021-30)	bn €'15/year	944	1068	1051	1028
Investment expenditures (incl. transport) (2021-30)	% GDP	6.8%	7.7%	7.6%	7.4%
Additional investments to REF	*bn €'15/year*		*124*	*107*	*84*
Additional investments to 2011-20	*bn €'15/year*	*285*	*408*	*392*	*368*
Energy system costs excl. carbon	bn €'15/year	1518	1555	1550	1541

pricing and disutility (2021-30)					
Energy system costs excl. carbon pricing and disutility (2021-30)	% GDP	10.9%	11.2%	11.15%	11.1%
Energy system costs incl. carbon pricing and disutility (2021-30)	bn €'15/year	1535	1598	1630	1647
Energy system costs incl. carbon pricing and disutility (2021-30)	% GDP	11.0%	11.5%	11.7%	11.8%
ETS price in current sectors (and maritime)	€/tCO_2	30	42	48	52
ETS price in new sectors (buildings and road transport)	€/tCO_2	0	0	48	80
Average Price of Electricity	€/MWh	158	156	156	157
Import dependency	%	54%	52%	53%	53%
Fossil fuels imports bill savings compared to REF (2021-30)	bn €'15		136	115	99
Energy-related expenditures in buildings (excl. disutility)	% of private consumption	6.9%	7.5%	7.5%	7.4%
Energy-related expenditures in transport (excl. disutility)	% of private consumption	18.1%	18.1%	18.3%	18.5%

*Note: *All scenarios achieve 55% net reductions in 2030 compared to 1990 for domestic EU emissions, assuming net LULUCF contributions of 255 Mt CO_2-eq. in 1990 and 225 Mt CO_2-eq. in 2030 and including national, intra-EU maritime and intra-EU aviation emissions[66].*

Source: PRIMES model, GAINS model

Table 30: Comparison with the CTP analysis

Results for 2030	CTP 55% GHG reductions scenarios range (REG, MIX, CPRICE, ALLBNK)	"Fit for 55" core scenarios range (REG, MIX, MIX-CP)
Overall net GHG reduction (w.r.t. 1990)*	55%	55%
Overall RES share	38-40%	38-40%
RES-E	64-67%	65%
RES-H&C	39-42%	36-41%
RES-T	22-26%	27-29%
FEC EE	36-37%	35-37%
PEC EE	39-41%	38-39%
CO_2 reduction on the supply side (w.r.t. 2015)	67-73%	62-64%

[66] Emissions estimates for 1990 are based on EU UNFCCC inventory data 2020, converted to IPCC AR5 Global Warming Potentials for notably methane and nitrous oxide. However, international intra-EU aviation and international intra-EU navigation are not separated in the UNFCCC data from the overall international bunker fuels emissions. Therefore, 1990 estimates for the intra-EU emissions of these sectors are based on (a combination of) data analysis for PRIMES modelling and 2018-2019 MRV data for the maritime sector.

CO_2 reduction in residential sector (w.r.t. 2015)	61-65%	50-56%
CO_2 reduction in services sector (w.r.t. 2015)	54-61%	48-53%
CO_2 reduction in industry (w.r.t. 2015)	21-25%	23%
CO_2 reduction in intra-EU transport (w.r.t. 2015)	16-18%	21-22%
CO_2 reduction in road transport (w.r.t. 2015)	19-21%	24-26%
Non-CO_2 GHG reductions (w.r.t. 2015, excl. LULUCF)	31-35%	32-33%
Investments magnitude, excluding transport (in bn€/per year)	401-438 bn/year	379-417 bn/per year
Energy system costs (excl. auction payments and disutility) as share of GDP (%, 2021-2030)	10.9-11.1%	11.1-11.2%

*Note: *All scenarios achieve 55% net reductions in 2030 compared to 1990 for domestic EU emissions, assuming net LULUCF contributions of 255 Mt CO_2-eq. in 1990 and 225 Mt CO_2-eq. in 2030 and including national, intra-EU maritime and intra-EU aviation emissions[60] (except the CTP ALLBNK that achieves 55% net reductions including also emissions from extra-EU maritime and aviation).*

Source: PRIMES model, GAINS model

13.1.6 Results per Member State

This document is completed by detailed modelling results at EU and MS level for the different core policy scenarios:

- Energy, transport and overall GHG (PRIMES model)
- Details on non-CO_2 GHG emissions (GAINS model)
- LULUCF emissions (GLOBIOM model)
- Air pollution (GAINS model)

13.2 Specific analytical elements for this impact assessment

13.2.1 DIONE model (JRC)

The DIONE model suite is developed, maintained and run by the JRC. It has been used for the assessment of capital and operating costs presented in Chapter 6 of the Impact Assessment. The suite consists of different modules, such as:

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

Many of them were developed specifically for the analysis of the total cost of ownership of vehicles in the framework of EC impact assessments[67]. The DIONE model was previously used in support of the analytic work supporting the current regulations setting CO_2 standards for light-duty vehicles (Regulation (EU) 2019/631) and heavy-duty vehicles (Regulation (EU) 2019/1242).

For this Impact Assessment, the DIONE Cost Curve Model was run to update previous light-duty vehicle cost curves in several regards. In particular, recent battery development trends were reflected, in line with the assumptions made in the EU Reference scenario 2020, by updating the cost curves for advanced electrified vehicles (SI PHEV, SI REEV, CI PHEV, CI REEV, BEV). Moreover, variants of the cost curves were developed to include technology costs to meet more stringent air pollutant standards. These variants were developed for all vehicles disposing of a combustion engine, and respective cost differences to reference vehicles were included in the cost curves for BEV and FCEV. Cost curves for all powertrains, conventional as well as electrified, were extended up to the year 2050.

On the basis of the cost curves, the DIONE Cross-Optimization Module determines the optimal (i.e. cost minimizing) CO_2 and energy consumption reduction for each powertrain and segment, given the relevant targets, fleet compositions and cost curves. As the cost curves have positive first and second derivatives, this is a mathematical problem with a unique solution.

Outputs from the Cross-Optimization Module are optimal CO_2 (for conventional vehicles and PHEV, REEV) or energy consumption (for BEV, FCEV) reduction per segment and powertrain and the corresponding additional manufacturing costs.

The DIONE Energy Cost Module is used to calculate fuel and energy costs. For each powertrain and segment, the WLTP energy consumption (MJ/km) is derived from the CO_2 emission reduction (to comply with the targets) using specific energy conversion factors.

The fuel and energy cost per powertrain and segment is calculated taking into account the specific energy consumption, vehicle mileage and fuel costs (EUR/MJ fuel). Vehicle mileages per segment and powertrain as well as mileage profiles over vehicle lifetime are based on PRIMES. Costs of conventional fuels, and electricity and hydrogen are aligned with PRIMES outputs for the respective scenarios. They are discounted and weighted by powertrain / segment activity over vehicle age.

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

Main assumptions made for the costs assessment by DIONE are presented in **Table 31**.

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

Table 31: Main assumptions made for the costs assessment by DIONE

Element	Sub-category	Assumption	Notes
Discount Rate, %[68]	Societal	4%	This social discount rate is recommended for Impact Assessments in the Commission's Better Regulation guidelines[69].
	End user (cars)	11%	Consistent with the EU Reference Scenario 2020
	End user (LCVs)	9.5%	Consistent with the EU Reference Scenario 2020
Period/age, years	Lifetime	15	
	First end-user	0-5	
	Second end-user	6-10	
Capital costs		% sales weighted average from DIONE	Average marginal vehicle manufacturing costs (including manufacturer profit margins) calculated by DIONE for a given scenario.
Depreciation			Based on CE Delft et al. (2017)[70]
Mileage profile	Total, and by age profile		The overall mileage is distributed over the assumed lifetime of the vehicle in the analysis, according to an age-dependant mileage profile estimated based on PRIMES-TREMOVE
Mark-up factor	Cars	1.40	Used to convert total manufacturing costs to prices, including dealer margins, logistics and marketing costs and relevant taxes. Consistent with values used in previous IA analysis[71,72]. The mark-up for LCVs excludes VAT, as the vast majority of new purchases of LCVs are by businesses, where VAT is not applicable.
	LCVs	1.11	

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

[69] http://ec.europa.eu/smart-regulation/guidelines/tool_54_en.htm

[70] CE Delft and TNO (2017) Assessment of the Modalities for LDV CO_2 Regulations beyond 2020 (report for the European Commission, DG CLIMA) - https://ec.europa.eu/clima/sites/default/files/transport/vehicles/docs/ldv_co2_modalities_for_regulations_beyond_2020_en.pdf

[71] TNO, AEA, CE Delft, Ökopol, TML, Ricardo and IHS Global Insight (2011) Support for the revision of Regulation (EC) No 443/2009 on CO_2 emissions from cars (report for the European Commission, DG CLIMA) - https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/cars/docs/study_car_2011_en.pdf

[72] AEA, TNO, CE Delft, Öko-Institut (2009) Assessment with respect to long term CO_2 emission targets for passenger cars and vans (report for the European Commission, DG CLIMA) - https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/2009_co2_car_vans_en.pdf

O&M costs	By LDV segment, powertrain type.	% sales weighted average of updated O&M costs.	The calculation of the O&M costs is based on the assumptions made in PRIMES-TREMOVE. These are based on the TRACCS project database and have been revised in light of new evidence with respect to the costs for electrified powertrain types. The O&M costs are subdivided into three main components: (1) annual insurance costs, (2) annual maintenance costs, (3) other ownership costs, mainly including fixed annual taxes. The maintenance and insurance costs comprise the largest shares of the overall total O&M costs. The O&M cost assumptions used are based on recent estimates for maintenance and insurance costs[73]. No assumption is made on the evolution of the O&M costs over time, due to lack of available quantitative data.
VAT % rate		20%	Used to convert O&M costs including tax, to values excluding tax for social perspective.

13.2.2 Macroeconomic models (E3ME and GEM-E3)

13.2.2.1 Introduction

Two macroeconomic models have been used, representing two main different schools of economic thought. E3ME is a macro-econometric model, based on a post-Keynesian demand-driven non-optimisation non-equilibrium framework. GEM-E3 is a general equilibrium model that draws strongly on supply-driven neoclassical economic theory and optimising behaviour of rational economic agents who ensure that markets always clear[74].

Using multiple models with different strengths and weaknesses in representing the complexity of the economic system may lead to different conclusions, but this will help making fully informed policy decisions, as long as the key mechanisms behind the differences are well understood[75].

GEM-E3 assumes that capital resources are optimally allocated in the economy (given existing tax "distortions"), and a policy intervention to increase investments in a particular sector (e.g. energy efficiency) is likely to take place at the expense of limiting

[73] Sources: Aviva. (2017). Your car insurance price explained. Retrieved from Aviva: http://www.aviva.co.uk/car-insurance/your-car-price-explained/; FleetNews. (2015). Electric vehicles offer big SMR cost savings. Retrieved from FleetNews: http://www.fleetnews.co.uk/fleet-management/environment/electric-vehicles-offer-big-smr-cost-savings; UBS. (2017). Q-Series: UBS Evidence Lab Electric Car Teardown – Disruption Ahead? UBS Global Research. Retrieved from https://neo.ubs.com/shared/d1BwmpNZLi/

[74] Market clearance in GEM-E3 is achieved through the full adjustment of prices which allow supply to equal demand and thus a ‘general’ equilibrium is reached and maintained throughout the system.

[75] https://www.e3me.com/developments/choice-of-model-policy-analysis/

capital availability, as a factor of production, for other profitable sectors ("crowding out" effect). In other words, in GEM-E3, the total effect on the economy depends on the net effect of core offsetting factors, particularly between positive improved energy efficiency and economic expansion effects (Keynesian multiplier), on one hand, and negative economic effects stemming from crowding out, pressures on primary factor markets and competitiveness losses, on the other hand. A very detailed financial model has been added to GEM-E3 to represent the banking system, the bonds, the borrowing and lending mechanisms, projecting into the future interest rates of equilibrium both for public sector finance and for the private sector. This changes the dynamics of crowding out effects as opposed to standard computable general equilibrium (CGE) models without a banking sector.

E3ME does not adhere to the 'general' equilibrium rule; instead demand and supply only partly adjust due to persistent market imperfections and resulting imbalances may remain a long-run feature of the economy. It also allows for the possibility of non-optimal allocation of capital, accounting for the existing spare capacity in the economy[76]. Therefore, the level of output, which is a function of the level of demand, may continue to be less than potential supply or a scenario in which demand increases can also see an increase in output.

13.2.2.2 E3ME

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

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

The economic structure of E3ME is based on the system of national accounts, as defined by ESA95. In total there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment and international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

For the analysis presented in Section 6, the E3ME is calibrated to the Primes output for the main three scenarios representing different levels of ambition of CO2 emission standards. The PRIMES scenarios are based on a MIX policy scenario context and therefore consider the effect of different polcies acting on transport (see methodological paper referred to in Section 13.1)

The labour market is also covered in detail, with estimated sets of equations for labour demand, supply, wages and working hours. For the assessment of employment impacts across the different sectors, labour intensities (number of persons per unit of output) are based on Eurostat Structural Business Statistics (sbs_na_ind_r2). As a starting point, the labour intensity of battery manufacture (which is included in the electrical equipment manufacturing sector) at the EU level is around 3 jobs per €1 million output, compared to a labour intensity of around 5 jobs per €1 million output in the wider electrical equipment

[76] The degree of adjustment between supply and demand and the resulting imbalances are derived from econometric evidence of historical non-optimal behaviour based on the extensive databases and time-series underpinning the E3ME macro-econometric model.

manufacturing sector. The labour intensity of the automotive sector (excluding the battery manufacturing) is about 3.5 jobs per €1 million output, reflecting a high labour intensity for manufacture of vehicle parts and engines (5 jobs per €1 million output) but lower labour intensity for the assembly of the vehicle itself (less than 2 jobs per €1 million output). The model also accounts for labour productivity improvements (i.e. the ratio of sectoral employment to gross output over the projection period), based on PRIMES projections for output by sector and CEDEFOP projections for employment by sector.

13.2.2.3 GEM-E3

The GEM-E3 model has been developed and is maintained by E3MLab/ICCS of National Technical University of Athens[77], JRC-IPTS[78] and others. It is documented in detail but the specific versions are private. A full description of the model is available at https://ec.europa.eu/jrc/en/gem-e3/model

The model has been used by E3MLab/ICCS to provide the macro assumptions for the Reference scenario and for the policy scenarios. It has also been used by JRC-IPTS to assess macroeconomic impacts of target setting based on GDP per capita.

The GEM-E3 model is a multi-regional, multi-sectoral, recursive dynamic computable general equilibrium (CGE) model which provides details on the macro-economy and its interaction with the environment and the energy system. It is an empirical, large scale model, written entirely in structural form. GEM-E3 allows for a consistent comparative analysis of policy scenarios since it ensures that in all scenarios, the economic system remains in general equilibrium. In addition it incorporates micro-economic mechanisms and institutional features within a consistent macro-economic framework and avoids the representation of behaviour in reduced form. The model is built on rigorous microeconomic foundations and is able to provide in a transparent way insights on the distributional aspects of long-term structural adjustments. The GEM-E3 model is extensively used as a tool of policy analysis and impact assessment. It is updated regularly using the latest revisions of the GTAP database and Eurostat statistics for the EU Member States.

The version of the GEM-E3 model used for this Impact assessment features a significantly enhanced representation of the transport sector. The enhanced model version is referred to as GEM-E3T. The model is detailed regarding the transport sectors, representing explicitly transport by mode, separating private from business transport services, and representing in detail fuel production and distribution including biofuels linked to production by agricultural sectors.

GEM-E3 formulates separately the supply or demand behaviour of the economic agents who are considered to optimise individually their objective while market derived prices guarantee global equilibrium, allowing the consistent evaluation of distributional effects of policies. It also considers explicitly the market clearing mechanism and the related price formation in the energy, environment and economy markets: prices are computed by the model as a result of supply and demand interactions in the markets and different market clearing mechanisms, in addition to perfect competition, are allowed.

GEM-E3 has a detailed representation of the labour markets being able to project effects on employment. Labour intensities for 2015 were calculated by dividing the full time jobs by the value of production of each sector. The economic and employment data are

[77] http://www.e3mlab.National Technical University of Athens.gr/e3mlab/
[78] https://ec.europa.eu/jrc/en/institutes/ipts

from the Eurostat database. For 2015, the direct labour intensity for conventional vehicle is 3.6 person per million output (excluding the number of persons required to produce all the intermediate inputs, which are accounted for in the respective sectors), while for electric vehicles it is 2.8 person per million output (excluding the number of persons required to produce all the intermediate inputs, which are accounted for in the respective sectors). Labour intensity projections are based on the results of the GEM-E3 that includes sectoral production and employment by 5-year period until 2050.

14 ANNEX 5: REGULATORY CONTEXT

14.1 Main elements of Regulation (EU) 2019/631

<u>CO_2 target levels</u>

EU fleet-wide CO_2 emission targets are set to apply for five-year periods, i.e. for the years 2020 to 2024 (taken over from the previous Regulations), 2025 to 2029 and, from 2030 onwards, both for newly registered passenger cars and newly registered light commercial vehicles (vans).

EU fleet-wide targets

The 2025 and 2030 targets are defined as a percentage reduction from the EU fleet-wide target in 2021, as shown in **Table 32**.

Table 32: EU fleet-wide CO2 targets

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

The 2021 starting point is based on the average of the specific emission targets for all manufacturers in that year. However, in order to ensure the robustness of the starting point, the calculation is using the 2020 emission values as measured in the test procedure (WLTP) instead of the emission values declared by the manufacturers. The measured 2020 WLTP emission values will be reported by manufacturers in the course of 2021 and the 2021 starting point as well as the 2025 and 2030 WLTP target levels (g CO_2/km) will be published by the Commission by 31 October 2022 (Article 9(3) of Regulation (EU) 2019/631).

Annual specific emission targets for manufacturers

Each year, a specific emission target is set for each manufacturer on the basis of the applicable EU fleet-wide target and taking into account the average mass of the manufacturer's fleet of new vehicles registered in that year. The specific emission targets are determined on the basis of a limit value curve, which means that manufacturers of heavier vehicles are allowed higher average emissions than manufacturers of lighter vehicles. The curve is set in such a way that where all manufacturers comply with their specific emission targets, the EU fleet-wide target is achieved[79].

From 2025, the vehicle test mass will be used as the utility parameter instead of the mass in running order , in order to better reflect the actual mass of the vehicles.

<u>*Excess Emission Premiums*</u>

If the average specific emissions of a manufacturer exceed its specific emission target in a given year, an excess emission premium is imposed. The premium is set to 95 euro per gram of CO_2 per kilometre exceedance for each vehicle in the manufacturer's fleet of new vehicles registered in that year.

[79] Under the assumption that the average mass of the fleet is equal to the reference mass (M_0) used for the limit value curve in that year. That reference mass is adjusted every three years (every two years from 2025 onwards) to take into account the evolution of the average fleet mass over time.

Transition from NEDC test procedure to WLTP

Until 2020, the monitoring of the tailpipe CO_2 emissions of cars and vans and their assessment against the emission targets was based on measurements using the New European Driving Cycle (NEDC) test[80]. Since 1 September 2017, the NEDC has been replaced by the Worldwide Harmonised Light Vehicle Test Procedure (WLTP), which has been designed to better reflect real driving conditions in order to provide more realistic fuel consumption and CO_2 emissions values. The WLTP type approval test is fully applicable to all new cars and vans since 1 September 2019 and WLTP-based manufacturer CO_2 targets apply from 2021 onwards.

The WLTP test is likely to result in increased type approval CO_2 emission values for most vehicles, but the increase will not be evenly distributed between different manufacturers. This means that it is impossible to determine one single factor to translate NEDC into WLTP CO_2 emission values. A correlation procedure and a methodology for translating individual manufacturer CO_2 targets has therefore been put in place[81]. Based on the 2020 NEDC and WLTP monitoring data, the WLTP-based specific emission target for each individual manufacturer will be determined. The 2021 specific emission targets will be published by the Commission in October 2022[82].

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

A ZLEV is defined as a passenger car or a van with CO_2 emissions between 0 and 50 g/km. In order to incentivise the uptake of ZLEV, a “one-way” or “bonus-only” crediting system is introduced from 2025 on. This means that the specific CO_2 emission target of a manufacturer will be relaxed if its share of ZLEV, expressed as a percentage of its total number of vehicles registered in a given year, exceeds the benchmarks set out in the Regulation, and summarised in the table below (**Table 33**).

Table 33: ZLEV benchmarks

ZLEV benchmarks (% ZLEV in new vehicle fleet)		
	2025-2029	**2030-**
Passenger cars	15 %	35 %
Vans	15 %	30 %

A one percentage point exceedance of the benchmark level will increase the manufacturer’s CO_2 target (in g CO_2/km) by one percent. This target relaxation is capped at a maximum of 5%.

[80] The EU fleet-wide CO_2 targets set in Regulation (EU) 2019/631 for 2020 (95 g CO_2/km for cars and 147 g CO_2/km for vans) are based on the NEDC emission test procedure.

[81] Commission Implementing Regulations (EU) 2017/1152 and 2017/1153 and Commission Delegated Regulations (EU) 2017/1499 and 2017/1502. For the purpose of the analytical work supporting this impact assessment, the conversion factors from NEDC to WLTP emission values have been taken from the JRC Science for Policy Report "From NEDC to WLTP: effect on the type-approval CO_2 emissions of light-duty vehicles" (Tsiakmakis, S., Fontaras, G., Cubito, C., Anagnostopoulos, K., J. Pavlovic, Ciuffo, B. (2017), https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/nedc-wltp-effect-type-approval-co2-emissions-light-duty-vehicles)

[82] The data, on the basis of which the annual targets are calculated, has to be submitted by Member States in the year following that for which the targets apply, e.g. the 2021 monitoring data needed for calculating the 2021 targets, shall be submitted by Member States by the end of February 2022. Following a verification of the correctness of the data, the Commission shall confirm and publish the 2021 targets by 31 October 2022.

For calculating the share of ZLEV in a manufacturer's fleet to be compared against the benchmark levels, an accounting rule applies, which gives a greater weight to ZLEV with lower emissions:

- For both cars and vans, a zero-emission vehicle (ZEV) is counted as one ZLEV.
- For other ZLEV, the accounting rule differs between cars and vans:
  - A car emitting 50 g CO_2/km is counted as 0.3 ZLEV, while a van emitting 50 g CO_2/km is counted as 0 ZLEV.
  - Vehicles emitting more than 0 and less than 50 g/km are counted on the basis of a linear scale between the corresponding values. For example, a car and a van emitting 25 g CO_2/km will be counted as 0.65 and 0.5 ZLEV, respectively.

In addition, during the period 2025 to 2030 and for cars only, a multiplier of 1.85 is applied for counting ZLEV registered in a Member State with a ZLEV share in its new car fleet below 60% of the EU average in 2017, and with less than 1,000 ZLEV (cars) newly registered in that year[83]. Where, in any year between 2025 and 2030, the ZLEV share in such a Member State's fleet of newly registered cars exceeds 5%, vehicles registered in that Member State shall no longer be eligible for the application of the multiplier in the subsequent years.

Pooling, exemptions, derogations

Pooling offers the possibility for several manufacturers to be considered together as a single manufacturer for the purpose of meeting a common target. Pooling between car and van manufacturers is not possible. Pooling can be applied for by manufacturers, which are part of a group of connected undertakings, but also by other manufacturers.

Car and van manufacturers registering less than 1000 new vehicles per year are exempted from meeting a specific emission target.

For **"small volume" car and van manufacturers**, i.e. those registering between 1,000 and 10,000 cars or between 1,000 and 22,000 vans per year, it is possible to apply for a derogation from their "default" specific emission targets.

In 2019, 12 car manufacturers benefitted from this derogation, two of which had less than 1,000 registrations and could thus have been exempted instead[84]. Two van manufacturers[85] were granted such derogations in 2019. Four other eligible van manufacturers[86], did not apply for the derogation as they complied with their 'default' specific emissions target.

"Niche" car manufacturers, i.e. those registering between 10,000 and 300,000 new cars per year, may benefit from a derogation target until the year 2028. In the years 2025 to 2028, the derogation target for those manufacturers will be 15% below the 2021 derogation target, which is 45% below their emissions in the reference year 2007.

Eco-innovations

[83] CZ, EE, EL, LT, LV, MT, PL, SK, SI, RO

[84] Some manufacturers registering less than 1,000 new cars per year have continued to apply for derogations since EU derogations are required to avoid penalties when selling vehicles on the Swiss market (this may change under new Swiss legislation which is currently under preparation)

[85] Piaggio and Ssangyong

[86] Hyundai Pool (1 636 vans registered), Isuzu (13 102 vans registered), Jaguar Land Rover (1 868 vans registered) and Mitsubishi Pool (9 391 vans registered).

Manufacturers may benefit from fitting their vehicles with innovative emission reduction technologies for which the emission savings are not (or only in part) covered by the WLTP emission test procedure. In order to be eligible, such technologies have to be approved as "eco-innovations" by a Commission Decision. The manufacturer's average specific emissions in a calendar year may be reduced by the emission savings obtained through such eco-innovations up to a maximum of 7 g CO_2/km.

Efficiency improvements for air conditioning systems will become eligible as eco-innovation technologies as of 2025. The possibility for the Commission to adjust the cap of 7 g CO_2/km is also foreseen in the Regulation.

Governance

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

In-service verification of CO_2 emissions

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

Deviations found in the CO_2 emissions of vehicles in-service shall be reported to the Commission, who shall take them into account for the purpose of calculating the average specific emissions of a manufacturer.

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

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

In order to ensure the real-world representativeness of the CO_2 emissions determined using the WLTP type approval procedure, and prevent the gap between type approval emissions and real-world emissions to increase, the Commission shall, from 2021 on, regularly collect data on the real-world CO_2 emissions and fuel or energy consumption of light-duty vehicles using OBFCM.

The Commission shall monitor how that gap evolves between 2021 and 2026. On that basis, the Commission shall assess the feasibility of a mechanism to adjust the manufacturer's average specific CO_2 emissions as of 2030.

The detailed procedures for collecting and processing the data are set out in a Commission Implementing Regulation [87]. Subject to the consent of the vehicle owner, real world data will be collected by manufacturers when the vehicle is brought in for service or repairs, and by Member States during the roadworthiness tests. The first data

[87] Commission Implementing Regulation (EU) 2021/392 on the monitoring and reporting of data relating to CO_2 emissions from passenger cars and light commercial vehicles pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council

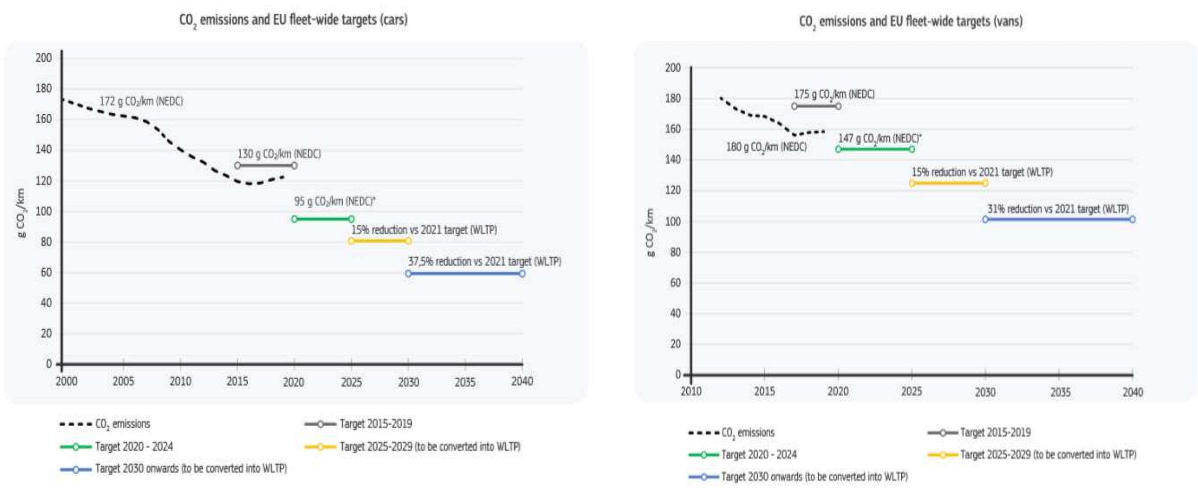
to be collected will be from new vehicles registered in 2021, and a first limited dataset is expected to become available in April 2022. The Commission will publish the data and present the differences between the real world average CO_2 emissions and fuel or energy consumption and the corresponding average type approval values at the level of the manufacturer fleet.

If appropriate, the Commission may adopt a legislative proposal to put an adjustment mechanism in place and/or to adapt the procedures for measuring CO_2 emissions to reflect adequately the real world CO_2 emissions of cars and vans.

14.2 Implementation of Regulation (EU) 2019/631 and its predecessors

Figure 26 provides an overview of the trends in the average EU fleet-wide CO_2 emissions of new cars and vans until 2019 and the applicable EU fleet-wide emission targets.

Figure 26: Average specific emissions of new cars and vans (g CO_2/km) and applicable EU fleet-wide CO_2 targets



This shows that the CO_2 emission standards have been a driver for the improvement of the efficiency of new vehicles over the past decade. However, the average CO_2 emissions of newly registered cars has increased in the last years before the stricter 2020 targets started applying, in particular due to a shift from diesel to petrol cars and the increasing number of registrations of sport utility vehicles (SUVs)[88].

In contrast, in 2020, a very different development has taken place in the car market as a stricter EU fleet-wide target started to apply, which, in combination with COVID-19 recovery measures taken by many governments, has led to a spectacular increase in the registrations of new zero- and low-emission vehicles (see **Figure 27** below). In the EU, the number of registrations of new zero- and low-emission vehicles has been the highest in Germany, France, Netherlands Italy and Sweden. Registrations of new zero- and low-emission vehicles has been particularly high in Norway as well[89].

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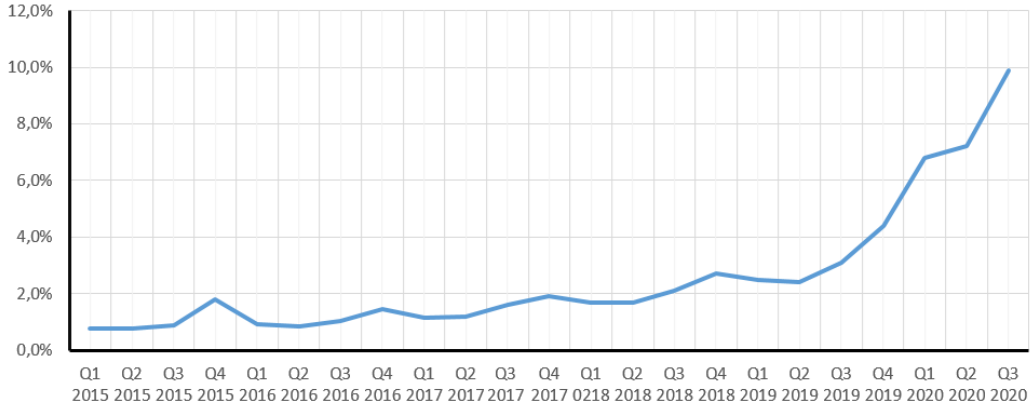
[88] EEA, Report of the provisional monitoring data for 2019 under Regulation (EU) 2019/631 https://www.eea.europa.eu/highlights/average-co2-emissions-from-new-cars-vans-2019; SUVs are typically heavier and have more powerful engines and larger frontal areas – all features that increase fuel consumption

[89] https://www.acea.be/uploads/press_releases_files/20210204_PRPC_fuel_Q4_2020_FINAL.pdf

Figure 27: Quarterly evolution of new electric passenger cars as a percentage of total new EU registrations[90]

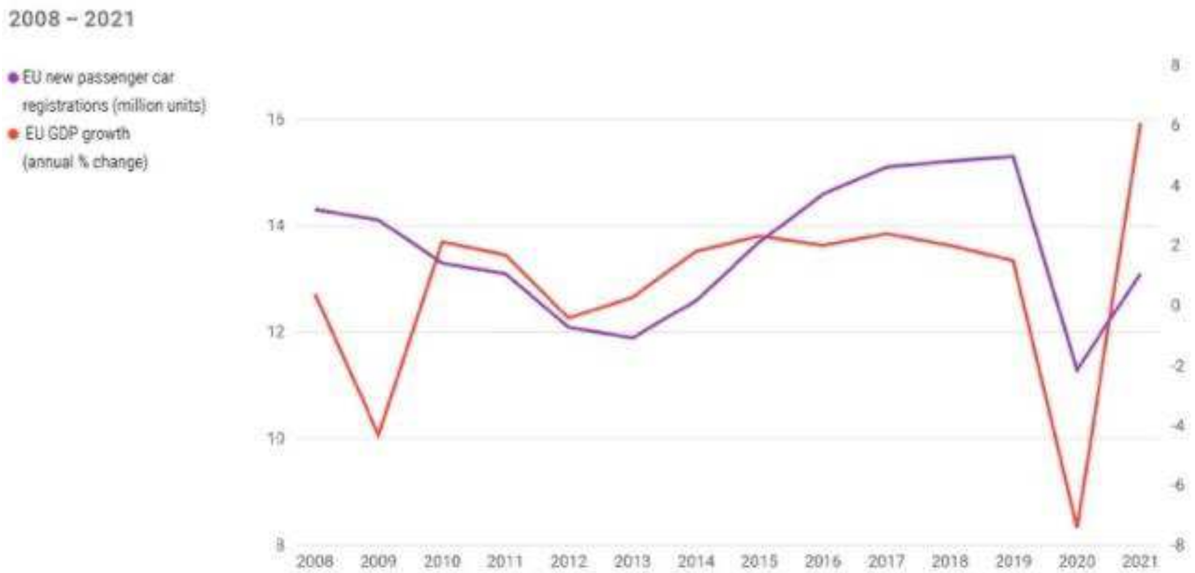


[90] The figure is based on the quarterly reports from ACEA on battery electric, plug-in hybrid electric and fuel cell electric vehicles registered in EU-28 (for 2020: EU-27, without UK). Registrations in a few smaller Member States may not be included due to a lack of data reported. To note that the number of fuel cell electric vehicles registered is very limited. Further details: https://www.acea.be/statistics/tag/category/electric-and-alternative-vehicle-registrations

15 ANNEX 6: IMPACTS OF COVID-19 ON AUTOMOTIVE SECTOR

The COVID-19 pandemic has heavily impacted the automotive sector world-wide, posing unprecedented challenges for the industry as a whole. In EU-27, registration of new passenger and commercial vehicles dropped by respectively -23.7% and -18.9%, with a trend following the GDP curve in the European Union (see **Figure 28** below, which shows that a close correlation between GDP and car registrations over the period in the EU, contrary to what happened during the previous 2008-2009 crisis with average GDP decline: -6.4% over 2020 in EU-27)[91]. For passenger cars, 9.9 million units were sold in 2020, which represents a drop of 3 million units compared to 2019[92]. For commercial vehicles, 1.7 million units were sold over the same period (i.e. 401,000 units less).

Figure 28: New passenger cars and GDP growth in the EU 2008-2021 (source: ACE, IHS Markit, European Commission DG ECFIN)



This has to be placed in the broader context of the economic crisis worldwide both from the demand- and supply-side perspectives. The automotive market weighs heavily on global manufacturing and on economies with a high exposure to this sector.

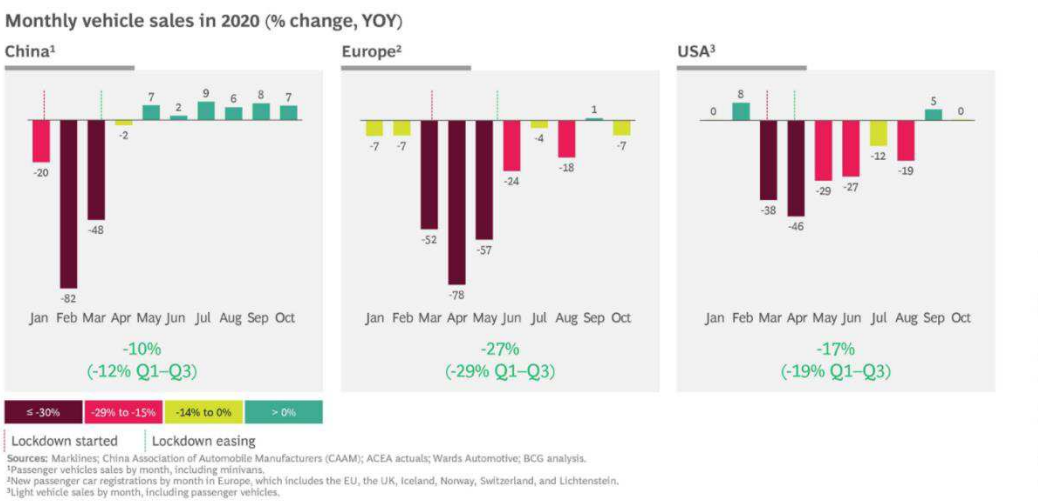
The global GDP has contracted by 4.2% in 2020. After an unprecedented sudden shock in the first half of 2020, the economy has recovered gradually in the third quarter as containment measures relaxed, allowing businesses and household spending to resume. Still, the global GDP in the second quarter of 2020, was 10% lower than at the end of 2019, which was immediately reflected in car sales globally.

Global sales of vehicles have fallen under 77 million units in 2020, down from 89.7 million units in 2019 with a previous peak of 94.3 million units in 2017 following 10 years of continuous growth (in 2020, 17.3 million less vehicles have been sold and 15 million units less have been produced compared to 2019)[93].

[91] Eurostat – newsrelease Euroindicators 17/2021 (2 February 2021)
[92] ACEA, January 2021
[93] IHS Markit, December 2020

The impact on sales and recovery pace differed for each key regional bloc and automotive market, respectively in China, Europe and the USA, as reflected in **Figure 29** below, also depending on the disease progression, overall sanitary situation and of the status and level of lockdown measures.

Figure 29: Monthly sales in 2020 (% change, Yoy) vs. GDP growth forecast in China, Europe and USA (source: BCG)



In Autumn 2020[94], economic forecasts projected that the EU economy would contract by 7.4% in 2020[95] before recovering with growth of 4.1% in 2021 and 3% in 2022[96]. All economic aggregates have been significantly impacted by the pandemic evolution and the containment measures with a direct effect on the automotive industry: for instance, a decline in consumer spending was foreseen in May 2020, up to 40% -50%, with numerous second- and third- order effects[97]. Beside decreasing sales and demand, this resulted in massive losses, liquidity shortages and changes in customers' behaviours. This was compounded by the already rapidly advancing technology shift in a competitive environment which required significant investment and strategic realignments.

In the EU, the economic consequences materialised through three main channels. First, the partial or full shut down of entire sectors due to the measures put in place to contain contagion has severely disrupted service sectors, including transport and mobility. Second, such disruptions also affected production and distribution activities and the access to extra-EU supply chains. Third, the consequent loss of income led to diminishing demand. Mobility patterns and customers behaviours have been also significantly modified in the long run.

Impact on transport services –As a consequence of global lockdown measures due to the COVID-19 crisis, mobility fell by an unprecedented amount in the first half of 2020[98]. Road transport in regions with lockdowns in place dropped between 50% and

[94] The automotive contributes indeed globally to an estimated 4% of all GDP output but also to a major part of the R&D expenses worldwide (83,34 Billion EUR in 2019) and of the turnover (2.66 Trillion EUR in 2019) of the manufacturing industry (Crescendo Worldwide Report Automotive 2020-2021)

[95] GDP decreased finally by 6.4% over 2020 in EU-27, see above footnote 1

[96] European Commission - European Economic Forecast Autumn 2020, Institutional Paper 136 (November 2020)

[97] Mc Kinsey - The-impact-of-COVID-19-on-future-mobility-solutions (May 2020)

[98] Compared to the period between 3 January and 6 February 2020 - before the outbreak of the pandemic in Europe - average mobility in the EU was about 17% lower in the fourth quarter of 2020, and declined further (to -26%) in January 2021. This compares to -25% and -9% on average in the second and third

75%, with global average road transport activity almost falling to 50% of the 2019 level by the end of March 2020. Immediately after the crisis outbreak, public-transit ridership has fallen 70 to 90% in major cities across the world, and operations have been significantly impacted by uncertainty and strict hygiene protocols—such as compulsory face masks and health checks for passengers, or restricting the number of riders in trains and stations to comply with space requirements. Ride hailers have also experienced declines of up to 60 to 70 percent, and many micro-mobility and carpooling players have suspended their services. As well, fleet leasing and car rental have been hit harder than most by the travel bans to stem the spread of COVID-19.

Road freight transport has been significantly and negatively impacted by the epidemic outbreak, at global level and in Europe in particular. Sales in the land transport sector (which also includes freight and passenger rail transport in addition to road transport) in the EU and other Western European countries contracted by 10.3% in 2020, in real terms[99].

The greatest disruption occurred during the first wave of the pandemic in spring 2020 but the sector recovered from the summer, with the lifting of border closures and the return of business activity and household consumption. However, the activity underwent another slowdown as the virus spread for a second time and many countries in the region were forced to implement new guidelines, partially closing economies once more. The impact through the year was greater for international than for domestic transport. A difference according to the transported products can also be observed, with the trade in pharma and ICT products having remained significant through last year. As an exception, e-commerce and last-mile delivery have increased, which seems to correspond to a long term trend.

Standstill in production and supply disruption – The impact of the COVID-19 crisis has been sudden and universal. For Original Equipment Manufacturers (OEM), initial concerns over a disruption in Chinese parts exports quickly pivoted to large-scale manufacturing interruptions across Europe. Global production stopped and the supply chain was critically disrupted. The most immediate and visible effect in the traditional automotive sector was subsequently the standstill of many OEM and supplier factories.

The COVID-19 pandemic has had a severe impact on Europe’s vehicle manufacturing sector[100]. During the first half of 2020 alone, EU-wide production losses (cars and vans) due to COVID-19 amounted to 3.6 million vehicles[101], worth around €100 billion and around 20% of the total production in 2019. These losses were the result of both factory shutdowns (especially during the 'lockdown' months of March, April and May) and the fact that production capacity did not return to pre-crisis levels once the lockdown measures have been eased[102].

quarters of 2020, respectively. See: European Economic Forecast – Winter 2021 (Interim) – European Commission Institutional Paper 144 February 2021 – also Google Mobility Index and Finish Ministry of Finance – Economic Effects of the COVID-19 Pandemic – Evidence from Panel Data in the EU Discussion papers – Publications of the Ministry of Finance – 2021:11

[99] IHS Markit

[100] SWD (2020) 98 final

[101] ACEA

[102] https://www.acea.be/news/article/interactive-map-covid-19-impact-on-eu-auto-production-first-half-of-2020

Approximately, 24 million less vehicles are expected to be produced globally between 2020 and 2022 [103]. The industry would thus be hit two times harder by the coronavirus pandemic than during the 2008-2009 financial crisis: indeed, benchmarked against pre-COVID 19 forecasts made in January 2020, COVID-19 led to over 12 million units of losses.

At the height of the crisis, over 90 percent of the factories in China, Europe, and North America closed. With the stock market and vehicle sales plummeting, automakers and suppliers have laid off workers or relied on public intervention, particularly short-time work schemes and similar arrangements to support paying employees.

Several carmakers[104] had to be bailed out due to liquidity problems. The massive use of furlough schemes did not prevent the announcement of several plant closures/job losses[105] at manufacturer or supplier level.

Most factories and plants have reopened and relaunched production after the first lockdown and have remained in operation.

Impact on demand – The sanitary COVID-19 crisis also had a direct impact on consumer demand and distribution channels. The exogenous shock of the pandemic has indeed exacerbated the already present downshift in the global demand. Dealers were subject to regulations imposing an immediate closure of showrooms and retail network. For customers, the impact was multifaceted as people, facing financial uncertainty, reduced their purchasing, stayed home and postponed major investments. The confidence indicator of the Transport-Mobility-Automotive Ecosystem was one of the most hit[106] amongst all EU Industrial Ecosystems. Significantly the purchase intent for both new cars and used cars remains low across all countries in the Union, with the least impact in France (e.g. new car purchase intent decrease by -11% (France), -21% (Germany) and -25% (Italy) compared to pre-COVID-19 crisis intent whereas used car purchase intent decreased respectively by 11% (France), -31% (Germany) and -28% (Italy)). There was still a positive net impact in maintenance and repair.

Consequently, the **automotive market**, that was already on a downward trend, facing structural challenges (CO_2, pollutant emissions, electrification), was hard-hit and suffered an unprecedented 23.7%[107] decrease of passenger car sales in 2020. It is expected that COVID-19 will negatively affect sales volumes for years to come.

In April 2020 alone, vehicle sales in Europe dropped by around 80% compared to the same period in 2019 (see **Figure 30**). It also followed a decline of sales and production over the previous period in 2019-2018: car sales had seen their steepest year-over-year decline in 2019 (-4%)[108] since the 2008/2009 financial crisis as consumer demand from the U.S. to China softened.

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[103] IHS Markit, December 2020

[104] FCA and Renault received state aid under the Temporary Framework to support the economy in the context of the coronavirus outbreak.

[105] Examples include plants operated by car manufacturers such as Nissan, Renault, Bridgestone, Continental, etc.

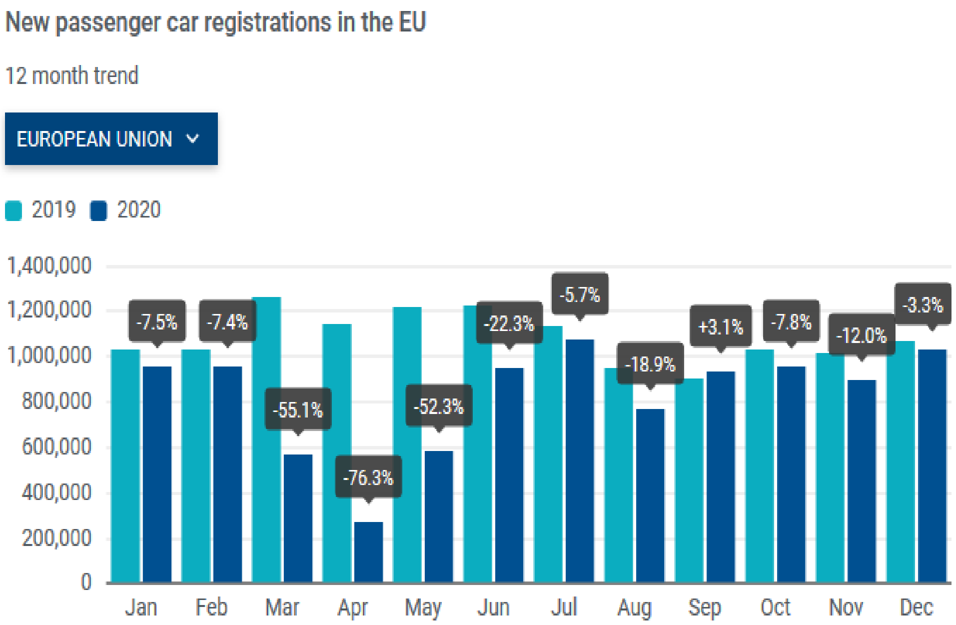
[106] SWD(2020)98 final Chart 1 Confidence Indicator of EU industrial Ecosystems; Current and Expected Supply and Demand Factors, April 2020 – Confidence Indicator for Mobility-Transport-Automotive -35

[107] ACEA, 2020

[108] IHS Markit, December 2020

- Passenger Cars: Demand for new vehicles slumped during the peak of the crisis, with new registrations of passenger cars down 32% in the first 8 months of 2020 compared to the previous year[109].

Figure 30: New passenger car registrations in the EU 2020 vs. 2019 (monthly registrations – source: ACEA)



Spain posted the sharpest drop (-32.3%), followed closely by Italy (-27.9%) and France (-25.5%), while full-year losses were significant but less pronounced in Germany (-19.1%).

Despite uncertainties in the near term, demand still showed some signs of recovery after the summer 2020, with new registrations higher in September by 3.1% (cars) and 13.3% (vans) compared to 2019. New car registrations in Germany, EU's largest market, were 8.4% above levels of September 2019[110], with impressive growth in all electrified segments, thanks in particular to government stimulation measures aimed at electric and hybrid vehicles. However, demand declined again in October, with EU-wide registrations down 7.8% in October. New restrictions put in place in several EU countries in autumn 2020, due to the resurgence of the virus, put the recovery of economies under question.

The downwards trend continued for the whole October- December period despite incentives and recovery packages: in December, high, double-digit losses were seen in countries such as France (down 11.8%), Italy (down 14.7%), Portugal (down 19.6%). Germany showed the best performance, with a solid gain of 9.9%, followed by Spain, with a tiny loss of 0.01%.

All other segments have been impacted with un-even performances and recovery trends from one EU Member State to the other:

[109] https://www.acea.be/press-releases/article/passenger-car-registrations-32.0-eight-months-into-2020-5.7-in-july-and-18

[110] https://www.kba.de/DE/Presse/Pressemitteilungen/2020/Fahrzeugzulassungen/pm23_2020_n_09_20_pm_komplett.html?nn=646300

- **New light commercial vehicles (LCV) up to 3.5t**: From January to December 2020, new van registrations declined by 17.6% across the European Union, standing at 1.4 million units. Spain recorded the sharpest drop (-26.5%) so far this year, while losses were less strong in France (-16.1%), Italy (-15.0%) and Germany (-12.2%).

In November, demand for new light commercial vehicles in the EU remained stable (-0.5%) compared to same period in 2019, whereas it weakened in December 2020 compared to December 2019 (-6%). Results in the EU's top four markets were mixed: in November 2020, registrations in Italy and Germany were positive, growing by 10.3% and 6.2% respectively, while LCV demand contracted in Spain (-8.1%) and France (-3.8%). In December 2020, registrations fell by 10.4% and 2.3% respectively in Italy and France, while Germany (+2.5%) and Spain (+1.6%) recorded modest gains.

- New heavy commercial vehicles (HCV) of 16t and over: all through 2020, 198,352 new heavy commercial vehicles were registered across the European Union, a decline of 27.3% compared to 2019. Despite the 2 last months' positive performance, each of the 27 EU markets recorded double-digit drops so far this year, including Germany (-26%), France (-25.8%) and Spain (-22.1%).

The two last months of the year showed positive results: in November 2020 alone, the EU market for heavy trucks improved, with new registrations up by 6.0% to 20,620 units. Central European countries (+28.6%) largely contributed to this result. Among the largest Western European markets however, only Italy (+28.5%) managed to post growth. During the month of December, 16,839 new heavy commercial vehicles were registered across the EU, a year-on-year rise of 11.8%. Central European markets continued to provide a strong boost to this growth; Poland, one of the leading markets, saw a 48.4% increase in heavy-truck registrations in December 2020. Among the largest Western European markets, Germany also made a sizeable contribution (+27.4%), followed by Spain (+8.3%) and France (+2.6%).

- **New medium and heavy commercial vehicles (MHCV) over 3.5t**: 2020, registrations of new trucks declined sharply across the European Union including in the four major markets: France (-24.1%), Germany (-24.0%), Spain (-21.7%) and Italy (-14.0%). This contributed to a cumulative decline of 25.7% to a total of 247,499 trucks registered in 2020.

In December 2020, demand for new medium and heavy trucks posted a solid growth (+7.1%) following a modest upturn (+3.7%) in November 2020, benefiting from the positive performance of the heavy-duty segment (which makes up the bulk of total truck demand). As for the biggest EU markets, Germany saw the highest percentage growth (+12.3%), followed by Spain (+3.8%) and France (+2.9%). By contrast, MHCV registrations slid fell slightly in Italy (-1.8%)

- New medium and heavy buses & coaches (MHBC) over 3.5t: from January to December 2020, EU demand for buses and coaches contracted by 20.3%,, counting 29,147 new registrations in total. Among the largest EU markets, Spain (-35.9%) and Italy (-24.9%) ended the year in negative, while losses were more limited in France (-10.8%) and Germany posted a slight growth over the same period (+0.4%).

In December 2020, new bus and coach registrations in the EU increased by 13.4% compared to December 2019. With the exception of France (-20.9%), all major EU markets gave a significant boost to the overall performance of the region: Italy (+13.4%), Germany (+22.1%) and Spain (+60.9%) in particular.

Impact of Incentives and recovery packages - Member States and the Commission announced a series of measures to support the economic recovery of the private sector, including the automotive segment. Noticeably, the recession was finally not as deep as expected in 2020[111] despite reintroduction and tightening of containment measures by Member States in response to the 2nd wave. Stimulus packages and recovery measures have also been instrumental for attenuating the recession.

Lessons have been learned from the 2008-2009 crisis in this respect[112]: electric vehicle targeted measures have been designed in countries such as Austria, France, Germany, Greece, Italy, Romania and in the Netherlands whereas other measures already in place and targeting also clean vehicles (e.g. *bonus malus* in Sweden) have been continued. They were all cornerstones of the respective demand stimulus packages, aimed at stimulating the recovery of the automotive sector, in particular through demand and supply of zero and low emission vehicles and recharging infrastructure.

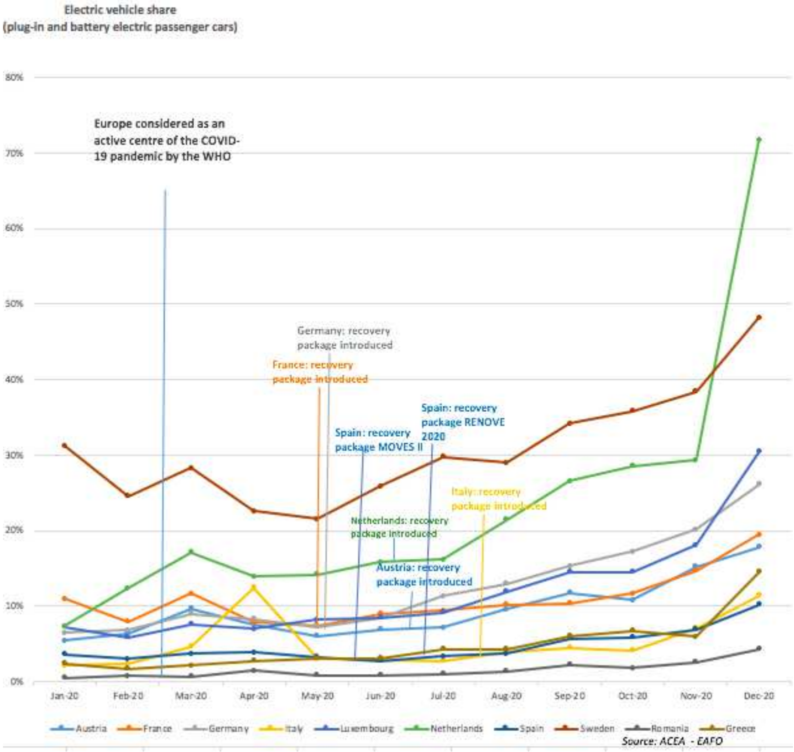
These measures may have contributed to avoiding steeper drops in demand of vehicles in the EU: indeed, contrary to other markets, the electric passenger car markets in Europe has increased since the outbreak of the COVID-19 pandemic. On the contrary, in March and April when mobility was most limited in many European countries, electric vehicles still recorded high registration shares, up to 12% in France and Italy, as shown in **Figure 31** below. Even with fluctuations over 2020, electric passenger car registrations recorded all-time highs.

Up to the end of May, before the introduction of the first recovery packages, this was likely partially a result of more favourable taxes or cost benefits for electric vehicles in markets. After June 2020, electric passenger car shares have rebounded the most in France and Germany after a slight downfall since April 2020. Both countries introduced recovery packages for electric car purchases in June, which had a positive effect on consumer choices. There seems to be similar effects with the Spain's program MOVES II introduced in June 2020 as well as with the stimulus packages in Austria, Spain (RENOVE 2020 Program), and Italy, introduced after June 2020, as well as in other EU Member States having introduced similar measures (Greece, the Netherlands, Romania - see figure below).

[111] See Winter 2021 Economic Forecast: A challenging winter, but light at the end of the tunnel (https://ec.europa.eu/commission/presscorner/detail/en/ip_21_504)

[112] International Council on Clean Transportation – Briefing (May 2020) – Green Vehicle Replacement Programs as a response to the COVID-19 crisis: Lessons learned from past programs and guidelines for the future; Georg Bieker, Peter Mock

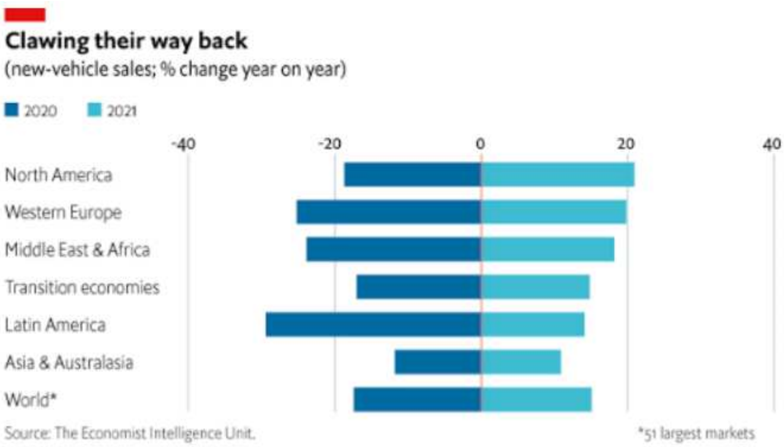
Figure 31: Electric Vehicle shares in the EU and EU Member States' Recovery packages (Summer 2020)



Outlook and perspectives

Global new-vehicle sales (**Figure 32**) will return to double-digit growth in 2021, but will fail to recover fully[113]. EU economy would barely return to pre-pandemic levels in 2022[114].

Figure 32: New Vehicle Sales 2020-2021 (source: The Economist Intelligence Unit)



As regards new vehicle sales, a recovery of demand in the EU at the same level as 2019 is foreseen by 2023[115]. It is anticipated that the unprecedented shift away from fossil fuel vehicles, in favour of low- emission or electric vehicles will continue and that Europe's share of global Electric Vehicle market will keep increasing. Global Electric Vehicle

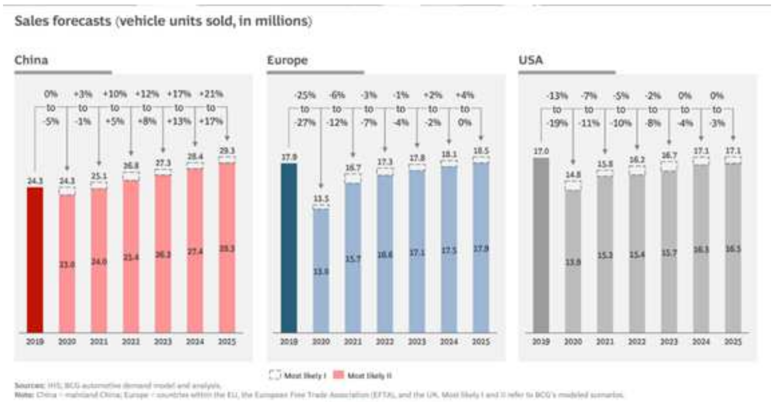
[113] The Economist Intelligence Unit – Industries in 2021 (Automotive)
[114] European Commission Winter 2021 Economic Forecast
[115] BCG COVID-19's Impact on the Automotive Industry (December 2020)

sales are expected to rise sharply in 2021, to around 3.4 million units, supported by the above-mentioned government incentives, and new launches.

Figure 33 illustrates the perspectives of recovery in China, USA and Europe[116]:

- A significant demand rebound was recorded in China already, with 2020 corresponding to 23.6 million units, down by 4.9% compared to 2019. 2021 forecast is set at 24.9 million units (+5.6% compared to 2020).
- Despite adverse COVID-19 trends, the automotive demand should continue to recover in the USA, supported by OEM and dealer incentives, online sales, government stimulus and improving economics. A positive trend of demand should continue in 2021 with a forecast of 16 million units for 2021 (+10% compared to 2020). Risks remain, notably from weak fleet sales and tight inventories; restocking efforts, which remain vulnerable to any further potential virus restrictions.
- European recovery prospects are mixed, with worrying virus resurgences, varied economic and stimulus support, ongoing restrictions and uncertainties as regards the sanitary situation (potential third wave). It is anticipated that the Western and Central European automotive demand for 2021 achieves 15.3 million units for 2021, with a 11% growth compared to 2020. Governmental support measures should be maintained in the EU Member States with major automotive markets (e.g. France, Germany, Italy, Spain).

Figure 33: Sales forecast for China, EU and USA (2019-2025-source BCG, IHS)



Impact on mobility patterns and behaviour

Many uncertainties also exist on how the COVID-19 crisis may affect future mobility, from the capacity of governments and companies to promote transport electrification to what consuming and behavioural changes could potentially be expected from it. The long-lasting impact of the crisis may differ significantly though from other earlier crisis circumstances, particularly 2008-2009 as the automotive industry was already facing multiple huge transformations across global markets when hit by the pandemic outbreak.

Still, beside challenges and economic immediate downturn, the COVID-19 has undoubtedly led to an acceleration of the twin transition in the automotive sectors and to some positive outcome:

- **There is evidence already that the current crisis will not slow down the current ongoing move to electrification**. On the contrary, industry and

[116] IHS (2021)

technological innovation experts expect the crisis to become a catalyst for the transformation. Experts anticipate that "*the next two or three years will be weak years for sales of still-prevalent ICE (internal combustion engine) vehicles on traditional technology platforms."* And *"demand for the current car lineup will be sluggish due to economic impairments and, at the point demand recovers, customers will return to a more favourable environment for xEVs (battery electric and plug-in hybrid) and demand 2023/2024 state-of-the-art technology.*"[117]

- **Reinforced individual mobility**: in the short term, the COVID-19 crisis has raised the importance of safety and the sense of security for consumers. There is thus anecdotal evidence that car ownership will remain very important for individuals in a market which remains on the rise overall. On the other hand, long lasting trends to be noted towards more flexible models of use, financing and subscriptions of cars, and mobility, also with effects on automotive after-sales.
- **Powertrain electrification**: Demand and supply were already shifting towards electric and electrified vehicles, driven by CO2 regulation and technological progress, e.g., improved battery chemistry, increased range, high-performance charging.
- **Digitalisation of automotive sales and services**: Consumer trends are changing the way we buy and drive cars and consume mobility, e.g., connected cars, assisted driving.
- **e-Commerce.** Widespread confinement has given a massive boost to e-commerce and home deliveries. More people are shopping online, accelerating a pre-existing long-term trend which should last.
- **Last mile delivery and autonomous cargo transportation.** Companies involved in last mile delivery, which were quite active prior to the pandemic crisis, are set to gain from the Retail, e-commerce and logistics companies should increase investment in technologies and innovation. The positive impact of the crisis on the long-term e-commerce trend should also drive more investment in autonomous driving tech and complete solutions for goods deliveries, in particular for last mile delivery.
- **Customer experience and dealership tools.** During this period there was a push towards pure online sales and contactless deliveries. Customers will likely benefit from less friction in the sales process. Customer behavioural shift towards more online is expected to last, as it parallels other shopping experiences. Most dealers and repair shops are trying to adapt extremely
- **Push to cross-sectorial innovation towards smart and green mobility.** Combined with strengthened smart charging station infrastructure and innovation in battery technologies, there will be opportunities for uptake of advanced technologies and new entrant technologies and new entrant players with new business models and consumers opportunities at stake (e.g. Vehicle to Grid, Smart grids).

[117] Arthur D Little (2020)

16 Annex 7: Introduction, Problems and drivers – complementary information

16.1 Introduction – information on batteries and raw materials

Accelerating electrification will further increase demand for batteries and battery raw materials[118]. Lithium, cobalt, and natural graphite (three of the main raw materials used for the production of EV batteries) are listed as critical raw materials with an increased risk of supply[119]. Raw materials used for EV batteries are sourced dominantly from non-EU countries due to current gaps in EU capacity. There are a number of EU initiatives (such as the recently adopted proposal on the Batteries Regulation[120]) to address these concerns by focussing on developing a resilient EU value chain and increasing EU sourcing, ensuring sustainable sourcing from non-EU countries, as well as increasing circularity of battery raw materials[121].

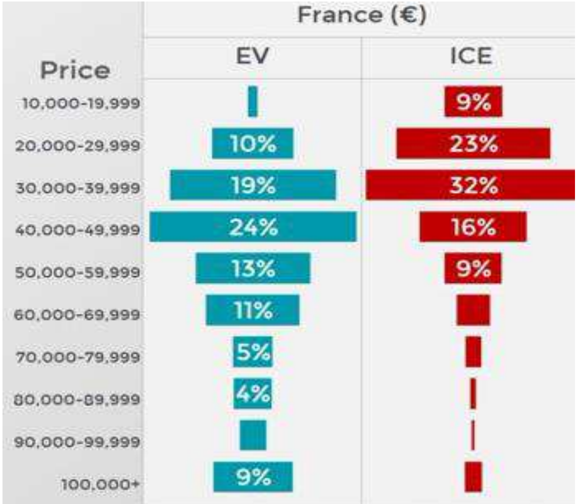
Meanwhile, the EU battery market is already mobilising for the ramped up production of EV batteries. If this takes places on schedule, battery supply could meet demand already in 2021, and even surpass European demand in the mid-2020s[122]. The European Battery Alliance has announced the aim to invest €15 billion in securing the domestic sourcing and processing of raw materials necessary to boost the EU production of batteries[123]. With battery technology evolving, less raw materials are expected to be needed to produce each kWh of an EV battery, along with recycling further mitigating raw material needs (especially from 2035 onwards with more cars coming to their end of life).

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

As illustrated in **Figure 34** below, current prices of ZEV are still significantly above those of comparable ICEV and there is little offer at the lower end of the price range.

[118] World Economic Forum and Global Batteries Alliance (2019) 'A vision for a sustainable battery value chain in 2030: Unlocking the potential to power sustainable development and climate change mitigation'
[119] Study on the EU's list of Critical Raw Materials (2020)
[120] COM(2020) 798/3
[121] COM (2020) 474 final (Communication on Critical Raw Materials)
[122] Transport & Environment (2021), *From dirty oil to clean batteries*
[123] https://ec.europa.eu/commission/presscorner/detail/en/speech_21_1142

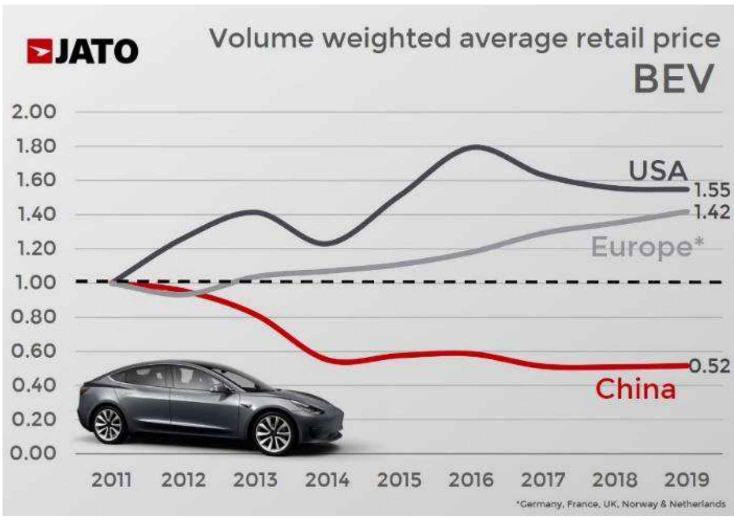
Figure 34: Distribution of new Electrified Vehicles (EV) and Internal Combustion Engine Vehicles (ICE) sold in France across different price classes[124].



JATO also noted that ZEV retail prices have not been falling over the past years. As illustrated in **Figure 35**, only in China battery electric cars became more affordable during the last decade, mostly due to government incentives, and the launch of small and very cheap models.

In Europe, the average Battery Electric Vehicles (BEV) price increased by more than 40% as manufacturers were focusing on premium and larger mid-size cars, leaving very few offerings in the entry-level segments. The average retail price (excluding any kind of incentive) of BEV sold in Europe and the US in 2019 was 58% and 52% higher than in China, respectively.

Figure 35: Evolution of BEV average retail prices in Europe, China and the US (2011 = 100%)[125]

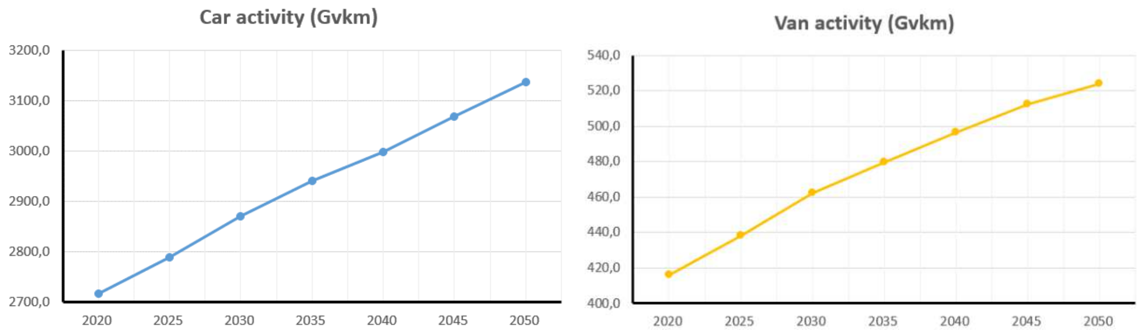


[124] From https://www.jato.com/ev-prices-have-been-growing-during-the-last-8-years/
[125] https://www.jato.com/ev-prices-have-been-growing-during-the-last-8-years/

16.3 Driver 3: Activity is increasing in the light-duty vehicle sector

Figure 36 below represents the increase in activity projected during the period 2020-2050 for cars and vans.

Figure 36: Cars and vans activity in the Baseline scenario (2020-2050)[126]



[126] Source: Baseline scenario in the Climate Target Plan

17 ANNEX 8: ADDITIONAL INFORMATION CONCERNING THE ASSESSMENT OF THE ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS OF THE DIFFERENT POLICY OPTIONS

17.1 Economic impacts of options regarding CO_2 target levels (TL)

17.1.1 Methodology

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

(i) Net economic savings from a societal and end-user perspective

These savings are calculated as the difference, between the policy options and the baseline, of the total costs, averaged over the EU-wide new vehicle fleet of cars and vans registered in 2030, 2035 or 2040. The total costs include the capital costs, the fuel or electricity costs, and the operation and maintenance (O&M) costs of the vehicles.

The savings from a societal perspective is the change in average costs over the lifetime (15 years) of a new vehicle without considering taxes and using a discount rate of 4%. In this case, the costs considered also include the external cost of CO_2 emissions (WTW).

The savings from an end-user perspective are presented for the first user (first five years after first registration) and the second user (years 6-10). In these cases, taxes are included and a discount rate of 11% (cars) or 9.5% (vans) is used. The calculation also takes account of the residual value of the vehicle (and the technology added) with depreciation.

(ii) Costs for automotive manufacturers

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

(iii) Energy system impacts

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

(iv) Investment in alternative fuels infrastructure

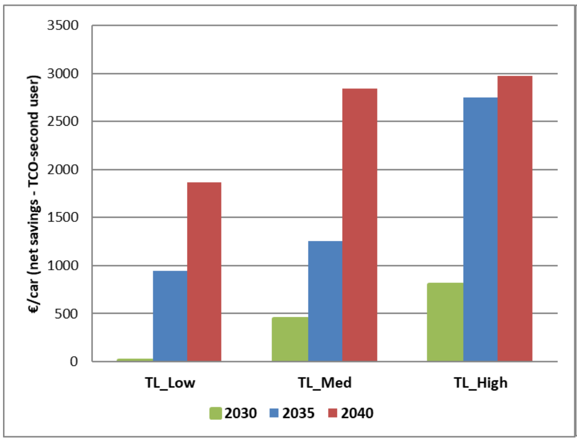
The investments needed for recharging and refuelling infrastructure have been analysed, to ensure consistency with the revision of the Alternative Fuels Infrastructure Directive.

(v) Macro-economic impacts, including employment

17.1.2 TCO-second hand user

Figure 37 shows the average net savings (EUR per vehicle) resulting from the CO_2 emission standards from a second end-user perspective, considering that second users on average purchase the vehicle after 5 years of use and resell it after 10 years. **Figure 38** shows the effect of the interaction with the other policies of the 'fit for 55%' package, in particular the EU ETS and RED.

Figure 37: Average net economic savings from a TCO-second user perspective (EUR/vehicle) resulting from the CO_2 emission standards (in a MIX policy scenario context) (cars (l) and vans (r))



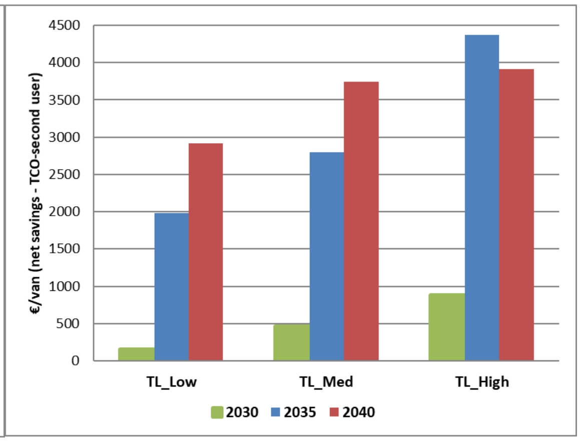
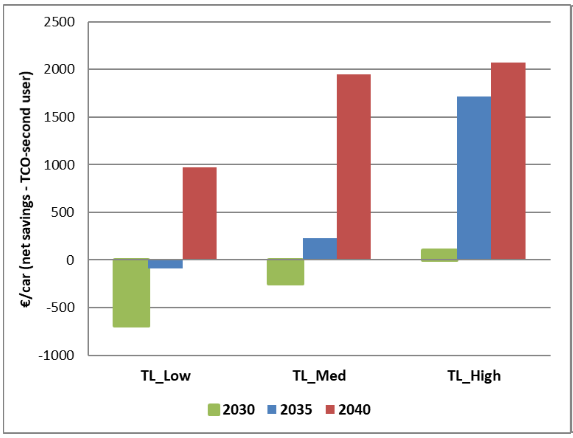
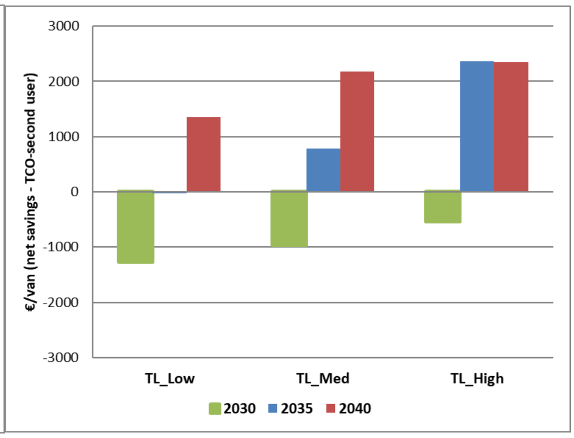


Figure 38: Average net economic savings in TCO-second user (EUR/vehicle) resulting from the combination of policies (cars (l) and vans (r))





17.1.3 Macro-economic impacts, GEM-E3 sectoral results

Table 34 below show the sectoral impacts (sectoral output and employment) of the scenarios analysed through the GEM-E3 model (see Section 6), in percentage changes with respect to the baseline. The sectoral impacts are shown for the loan-based variants. They are driven by the switch between different vehicle technologies and fuels. Production and employment of the electric vehicles sector increases compared to baseline in all variants. Sectors producing the respective products and services for the operation and maintenance of these vehicles, such as electricity and batteries, increase their output and employment. For the sectors which supply fuels for road transport, the production is found to decrease, especially in the scenario with higher penetration of BEVs, displacing ICEVs and limiting the fuels use.

Table 34: EU27 production by sector

EU27 production by sector (in % change from Baseline)				
Sectors	**Scenario**	**2030**	**2035**	**2040**
Electric vehicles	MIX55_LSTD	1.2	2.5	4.3
	MIX55	4.5	7.8	12.2
	MIX55_HSTD	7.6	27.9	14.6
Transport Equipment (excl. EVs)	MIX55_LSTD	-0.3	-0.7	-1.2
	MIX55	-1.2	-2.2	-3.5
	MIX55_HSTD	-1.9	-8.4	-4.2
Batteries	MIX55_LSTD	1.3	2.8	5.1
	MIX55	4.8	8.9	14.3
	MIX55_HSTD	8.2	31.7	18.1
Fossil Fuels	MIX55_LSTD	0.0	-0.3	-1.6
	MIX55	-0.2	-0.7	-3.5
	MIX55_HSTD	-0.2	-2.1	-5.2
Electricity	MIX55_LSTD	0.0	0.1	0.4
	MIX55	0.2	0.3	1.2
	MIX55_HSTD	0.2	0.9	1.5
Clean fuels (H2, Clean Gas, P2X, Biofuels)	MIX55_LSTD	0.0	1.0	8.5
	MIX55	-0.2	0.3	5.6
	MIX55_HSTD	-0.3	-1.9	-0.4
Other sectors	MIX55_LSTD	0.01	0.02	0.05
	MIX55	0.05	0.06	0.16
	MIX55_HSTD	0.07	0.29	0.20
EU27 employment by sector (in % change from Baseline)				
Sectors	**Scenario**	**2030**	**2035**	**2040**
Electric vehicles	MIX55_LSTD	1.3	2.5	4.4
	MIX55	4.6	7.9	12.6
	MIX55_HSTD	7.8	28.5	15.0
Transport Equipment (excl. EVs)	MIX55_LSTD	-0.3	-0.7	-1.1
	MIX55	-1.1	-2.2	-3.3
	MIX55_HSTD	-1.8	-8.1	-4.0
Batteries	MIX55_LSTD	1.3	2.8	5.0
	MIX55	4.9	8.7	14.2
	MIX55_HSTD	8.3	31.7	16.8
Fossil Fuels	MIX55_LSTD	0.0	-0.2	-1.1
	MIX55	0.0	-0.5	-2.9
	MIX55_HSTD	-0.1	-1.4	-4.5
Electricity	MIX55_LSTD	0.0	0.1	0.4
	MIX55	0.2	0.3	1.2
	MIX55_HSTD	0.2	0.9	1.5
Clean fuels (H2, Clean Gas, P2X, Biofuels)	MIX55_LSTD	0.0	0.4	2.54
	MIX55	0.0	0.2	1.93
	MIX55_HSTD	0.0	-0.4	0.55
Other sectors	MIX55_LSTD	0.03	0.03	0.13
	MIX55	0.10	0.11	0.37
	MIX55_HSTD	0.14	0.55	0.39

17.2 Social Impacts of options regarding CO_2 target levels (TL) –Assumptions and Methodologies

17.2.1 Introduction and data used

The analysis of the social impacts takes into account particular characteristics of consumers from different income groups and is aimed to highlight when and how these particularities have implications in terms of impacts on consumers' welfare. The whole analysis was performed by Ricardo for the European Commission[127].

Income groups

To analyse the potential impacts of different scenarios on consumers, they are split into several consumer groups according to income (five income quintiles)[128]. Each group is characterised in terms of economic characteristics, such as average annual income, average savings[129], interest rates they face, discount rates used for intertemporal analysis; as well as driving behaviour (in this case average annual mileage). **Table 35** shows the average annual disposable income and savings by income quintile expressed in EUR 2020[130]. Within each income quintile, the mean was chosen as the input to the modelling (instead of the median) as it synthetizes the information contained in every observation, so it is more representative of the class as a whole and, by design minimizes prediction errors.

Table 35: Average disposable income and savings by income quintile, EUR 2020

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Average disposable income (EUR 2020)	10,419	18,139	25,228	36,439	55,147
Average savings	1,003	5,513	16,716	55,259	104,234

Source: Ricardo, based on (Eurostat, 2015) and (European Central Bank, 2017)

Access to financing

As **Table 35** shows, consumers in lower income quintiles have lower savings, on average. That is why, to purchase a vehicle, lower income groups are first, more likely to need a loan, and second, more likely to request larger loan amounts, leading to higher loan to income ratios. As lower income limits the capacity to quickly repay the loan, these households will likely need loans with longer maturities.

[127] Ricardo report (to be published)

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

[129] Average savings reflect total financial assets of each income quintile and include deposits (sight and saving accounts), mutual funds, bonds, shares, money owed to the households, value of voluntary pension plans and whole life insurance policies of household members, and other financial assets items (ECB, 2017).

[130] Original data has been sourced from Eurostat and corresponds to year 2015, as the most recent year available with information on average disposable income by income quintile. Ricardo has converted year 2015 data to year 2020 assuming a 2% annual growth rate in average income. This growth rate reflects the observed average growth rate (CARG) in household income over the last decade in EU27 countries.

Importantly, they are also likely to have overall higher debt to assets or debt to income ratios and are less likely to be a homeowner. This translates to, on average, lower credit scores for lower income groups, and higher interest rates as a consequence[131].

Table 36 shows the assumptions on average annualised percentage rate (APR or average interest rate) for different income groups. These assumptions were made using the information on average interest rates for consumption loans across Euro-area Member States published by the ECB[132] and the information from a benchmark of EU Member States online car loan price comparators[133]. Although not all the tools are perfectly comparable, most of them report the best interest rate available on the market and number of different financing options available, based on the requested loan amount, loan maturity and the borrower's credit score, reflected directly in the inputs or through the loan conditions.

Table 36: Interest rate distribution and assumed averages by income quintile

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Assumed average	12.5%	10.0%	7.5%	5.0%	2.5%

Source: Ricardo, based on benchmark of online comparison tools

Great variability of interest rates is observed inside and across different Member States, and future rates may be influenced by different factors[134]. Although the observed ranges were acknowledged, for the purposes of modelling, it was assumed that the interest rate declines monotonously with the income, that is Q1 faces an interest rate of 12.5% and each next quintile sees an interest rate which is 2.5% lower than the previous quintile. This equal-spacing assumption with respect to the interest rate makes the results more illustrative as it avoids placing Q1 and Q2 too closely together and decreases the distance between Q4 and Q5.

Discount rate

Lower income households or individuals are shown to value the present more, when compared to higher income groups[135]. There is no common understanding or a general rule on how to translate differences in individual preferences over time into subjective discount rates. In line with the approach of the EU Reference Scenario 2020, differentiated discount rates are used to analyse different consumer groups (e.g. 11% for cars and 9.5% for vans, acknowledging the difference between households and firms or self-employed professionals).

[131] Although there should not necessarily be causal relationship between credit score and household income, in practice, a strong correlation is observed between these two variables according to the results of 'The Household Finance and Consumption Survey' (European Central Bank, 2017).

[132] https://www.euro-area-statistics.org/bank-interest-rates-loans?cr=eur&lg=en&page=0&charts=M..B.A2B.I.R.A.2250.EUR.N+M..B.A2B.F.R.A.2250.EUR.N+M..B.A2B.I.R.A.2250.EUR.N&template=1

[133] The information from the following online comparison tools has been collected between 30 November and 9 December 2020:
https://prestiti.segugio.it/prestito-migliore/miglior-prestito-auto.asp
https://finanzas.kelisto.es/prestamos-personales
https://finance.lelynx.fr/credit-consommation/simulation/credit-auto/simulation-credit-auto/comparateur/
https://www.vergleich.de/autokredit-vergleich.html

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

[135] Samwick, A. (1998). Discount rate heterogeneity and social security reform. Journal of Development Economics, 57(1): 117-146; and Gustman, A. a. (2005). The social security early entitlement age in a structural model of retirement and wealth. Journal of Public Economics, 89(2-3): 441-463

The academic literature suggests that utility discount rate is higher for the first income quintile (estimates point around 15%), because in general they are composed by more impatient individuals who value current consumption more. The opposite would be true for the 5th quintile individuals, whose discount rate is estimated at 5%. In line with the literature, our methodology assumes a private discount rate of 16% for 1st quintile individuals, 6% for the 5th and applies a linear interpolation for the quintiles in between, being 11% the average. **Table 37** shows subjective discount rate assumptions by income quintile, based on the negative relationship between household income and the discount rate.

Table 37: Subjective discount rate assumptions by income quintile[136]

	1st quintile	**2nd quintile**	**3rd quintile**	**4th quintile**	**5th quintile**
Discount rate	16%	13.5%	11%	8.5%	6%

Other assumptions

Mileage assumptions are presented in **Table 38**. Average mileage is assumed to be 13,000 km/year. Although there is no EU statistics on annual mileage by household income, it is recognised internationally that higher income households make more trips and travel more miles than lower income households and the differences are substantial[137].

Assuming higher annual mileages for high income households is also consistent with user group statistics. By economic characteristics of the income groups described above and anticipating the conclusions of affordability analysis, lowest income households are most likely to represent 3rd users, medium income households - 2nd users, and high-income households – 1st users, with 2nd and 4th quintiles falling in between. For this analysis constant mileage assumptions per income group were used to be able to analyse potential choices of a single representative consumer, deciding between different powertrains, segments, user group from subjective point of view.

Table 38: Annual mileage assumptions

	Mileage (km/ year)
ALL	13,000
Q1	8,000
Q2	10,500
Q3	13,000
Q4	15,500
Q5	18,000

136 Based on: Samwick, A. (1998). Discount rate heterogeneity and social security reform. Journal of Development Economics, 57(1): 117-146; and Gustman, A. a. (2005). The social security early entitlement age in a structural model of retirement and wealth. Journal of Public Economics, 89(2-3): 441-463

137 https://www.bts.gov/archive/publications/special_reports_and_issue_briefs/special_report/2007_10_03/entire

Table 39: Other assumptions

OEM mark-up	**1.4 ***
Ownership duration	5
Savings spent	90%
Maximum loan quota (% of income)	36%
Maximum loan maturity (years)	5

17.2.2 Methodology

The income dimension and the vehicle dimension were analysed jointly, as consumer behaviour differs significantly across income groups with respect to their choices of segment, powertrain and age of the car. It is also important to consider the fact that the vehicle age groups are interconnected through the market for used cars, where 2nd and 3rd users purchase their vehicles from the 1st and 2nd users respectively. All Q1 and half of Q2 are 1st users, half Q2, all Q3 and half Q4 are 2nd users (purchasing from Q1 and half Q2), and half Q4 and all Q5 are 3rd users (purchasing from Q2, Q3 and Q4 2nd users). This is reflected in the assumptions made with respect to purchase patterns across income groups[138].

For the used cars market to function properly, that is to have a balanced supply and demand for all user groups, different user groups should have sufficiently aligned preferences and incentives. Otherwise, either selling or buying party would obtain higher bargaining power over the other party, with potentially positive implications for some income groups and negative for other groups. .

The analysis of the social impacts looks at the impacts of the options considered on different income groups in terms of (i) affordability of vehicles, and (ii) 'subjective TCO'.

Affordability reflects the variety of vehicle choice available to the consumer groups[139]. It is defined in terms of financial capacity for a given income group compared to the vehicle upfront price. A vehicle model/powertrain/segment is thought to be affordable when a household has enough savings and annual income to be able to repay the loan for upfront capital costs in five years, provided that no more than 36% of annual income can be designated to the loan repayment.

Subjective TCO reflects total costs associated to the ownership of the vehicle. It takes into account income group-specific parameters and is considered in relation to average annual income.

First, affordable options are determined and analysed for each income group, user group and powertrain combination. This analysis gives an overview of choice available to each of the income groups, as the function of their financial capacity.

For the affordable options, two key metrics were calculated for each of the combinations of income quintile, vehicle segment, powertrain, user group and year:

[138] It is implicitly assumed that Q1 and Q2 consumers purchasing new cars are more likely to have more than one car in the household, and that not all cars have 3rd users.

[139] Analysis includes four vehicle segments (Small (S), Lower Medium (LM), Upper Medium (UM), Large (L)), six powertrains (SI+Hybrid, CI+Hybrid, SI PHEV, CI PHEV, BEV, FCEV) and three vehicle age groups (1st user, 0-5 years; 2nd user, 6-10 years; 3rd user, 11-15 years).

- **Extra capital costs** are calculated as discounted sum of interest payments for a loan (when the loan takes place) during the whole loan period until its maturity. Loan amount and interest rates vary across income groups.
- **Subjective TCO** is calculated as discounted sum of purchase price or loan payments, operation, maintenance and insurance costs, fuel costs minus residual value of the vehicle at the end of 5-year ownership period.

These two metrics are compared in the baseline scenario and policy scenarios, in order to conclude about the impacts on consumers.

In addition, some other barriers were considered, combining a range of non-monetary factors that are likely to have unequal impacts for different income groups. The factors assessed include unequal access to off-street parking (and home charging), access to information and the level of consumer awareness about potential monetary savings. These factors are analysed qualitatively.

Extra capital costs

For vehicles with higher initial purchase prices, consumers will require access to higher initial capital, which is more limited for lower income groups.

As long as access to finance and financing conditions are linked to household and/or personal income, lower income groups would find it harder to be able to acquire a car due to credit restrictions. That is, some consumers may not be able to afford a vehicle with lower TCO, some will only be able to do so with a loan, and others will have enough savings to cover the full upfront price.

Those who need a loan would also need to pay interests, which in its turn increases total capital costs that the consumers face over the lifetime/ownership period. Extra capital costs were calculated for each of the combinations as follows:

- First, how much each consumer group can **afford to pay upfront** is calculated assuming that up to 90% of household savings can be used for this first payment[140]. This assumption is made to reflect the fact that households tend to keep a minimum buffer of savings in order to be protected in case of unexpected negative shocks.
- Second, how much needs **to be financed** is calculated as the difference between total upfront costs and the part covered by savings.
- Third, **loan maturity** is determined. It is assumed that up to 36% of household income can be used for loan repayment, following common practice by banks with respect to Debt-to-Income ratio[141]. This maximum quota is used to calculate loan maturity, as the number of periods needed to pay the loan given the payment. If calculated loan maturity is more than 5 years, it is concluded that this particular vehicle model cannot be afforded by the corresponding consumer, as the banks usually do not extend car loans for a longer period. Only for the borrowers with excellent credit score, banks offer longer maturities, up to 7 or 8 years[142]. In the

[140] The assumption that less than 100% of savings can be used was made to reflect the fact that some of the savings can be more difficult to mobilise. The lower is this percentage, the higher loans the consumers will request, and the more interest payments they will face, as the consequence.

[141] 36% debt-to-income ratio has been derived from the benchmark among online resources in the EU and the UK.

[142] 5 years loan maturity has been derived from the benchmark among online resources in the EU and the UK.

model, however, average consumers from higher income quintiles do not need these longer maturities.

- Finally, **extra capital costs** are calculated for the cases when the calculated loan maturity is 5 years or less. Income-group specific interest rate is used to calculate total interest paid until the loan matures. The present value of all those interests paid is calculated using social discount rate of 4%. This social discount rate is used in this case in order to be able to compare total extra capital costs across different income groups.

Subjective TCO

A number of parameters need to be adjusted to depart from TCO calculated for average user and aim at estimating TCO as perceived by each particular income group. In addition to differences in mileage, different consumers have different discount rates, reflecting time patience regarding their cash flows. This exercise essentially will allow to compare potential purchase choices of a representative consumer across powertrains, segments and user groups (1^{st}, 2^{nd} and 3^{rd} user).

Subjective TCO was calculated according to standard TCO formula, but with three modifications:

- In addition to capital costs, extra capital costs described above were incorporated. At the end of user life, it is assumed that the vehicle is sold and subtract residual value of the vehicle.
- For variable costs, fuel costs are calculated using user-specific annual mileage.
- User-specific discount rate is used to calculate present value of future loan payments, fuel costs and operation, maintenance and insurance costs. Discount rates are income-group specific in this case, in order to better reflect preferences and decisions of each income group regarding different powertrains. Higher discount rates for lower income groups mean that these groups value future fuel savings less and upfront capital costs more compared to higher income groups.

Non-financial barriers

It has been already mentioned access to credit representing a financial barrier for some income groups and costs associated with home xEV charging being important determinants of TCO. There are, however, also non-financial barriers for xEV uptake for some income groups.

High income groups are more likely to have access to off-street parking, compared to lower income groups. As long as home charging is cheaper than public charging (and it usually is, in part, due to electricity prices and charging profiles, and in part because of the infrastructure costs), lower income groups will not be able to enjoy the TCO savings of xEV vehicles fully, as the part of savings will not be present due to higher electricity costs, compared to households with private parking and charging points.

Other non-financial barriers that may limit uptake of alternative powertrains for lower income households, despite of them being affordable financially and having lower TCO, may include access to information and luck of consumer awareness about potential savings.

17.3 Fuel Crediting System – Assumptions and Methodologies for the economic impacts

Introduction and data used

A cost impact analysis was carried out for the option FUEL2, on the basis of various cost scenarios for low-carbon fuels (LCF), to assess the cost impact for the manufacturer, as well as for the vehicle users and society[143].

Methodology and Assumptions

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

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

To estimate the amount of LCF credits that an OEM needs to buy, a frontloading approach is considered, which ensures that enough credits are available for the entire lifetime of the vehicles. For these calculations, A lifetime mileage of 200,000 km (passenger cars) and 240,000 km (vans) is assumed for all vehicle segments. In the cost calculations, the RFNBO emission factors used are all are significantly better than this compliance threshold.

In order to determine the level of emission savings from additional quantities of LCF, the GHG emission values according to the RED calculation methodology[144] are used, i.e. the emission reduction is calculated from the difference between the respective LCF and the RED fossil comparator of 94.1 g CO_2e/MJ. For the RFNBO, the GHG emission calculation methodology is not yet defined. In order to qualify for LCF emission savings crediting, fuels must at least comply with the RED II crediting threshold. This is a 70% GHG reduction compared to the fossil comparator. In the cost calculations, it is assumed that the RFNBO emission factors are significantly lower than this threshold.

Production costs estimates for biofuels used in the analysis are based on literature review[145], and they consider ranges for different feedstocks and processes.

[143] Technical support for analysis of some elements of the post-2020 CO_2 emission standards for cars and vans (Ricardo, 2021)

[144] Apart from biomethane (SNG) produced from gasification of wood, where no value is available. For this production route, data is taken from JRC Publications Repository - JEC Well-to-Tank report v5 (europa.eu)-, which employs a similar methodology to REDII.

[145] Sources:

(1) https://www.dbfz.de/fileadmin/user_upload/Referenzen/DBFZ_Reports/DBFZ_Report_11_4.pdf
(2) https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailDoc&id=33288&no=1
(3) https://www.ieabioenergy.com/wp-content/uploads/2013/10/IEA-Biofuel-Roadmap.pdf
(4) https://www.e4tech.com/uploads/files/e4tech/resources/127/E4tech_ICLE_Final_Report_Dec17.pdf

For well-established production routes (FAME, HVO and bioethanol from starch and sugar crops) which are commercially mature, costs estimates are generally consistent across sources, and the same production costs are therefore taken for all three price scenarios.

In the case of advanced biofuels (lignocellulosic bioethanol and gasification + Fischer Tropsch routes for production of gasoline and diesel), as the technology is not commercially mature, a wider range of cost estimates are found in the literature. These are partly driven by assumptions about capital costs but also by differing assumptions about the exact feedstock and price of that feedstock. For these fuels a low and high price are therefore used.

For biomethane, the low cost estimate reflects a typical cost for biomethane produced via an anaerobic digestion route. The high and very high costs reflect production via a gasification route; the latter may be required if use of biomethane (both in the transport sector and to decarbonise gas supply in other sectors) increases significantly in the future as the potential for sustainably produced anaerobic digestion from biomethane may be limited by the availability of waste feedstocks. The costs have been adjusted to 2020 prices where necessary.

Concerning the production costs of RFNBO diesel and petrol, though many of the necessary processes are well developed and are used in industrial processes today, no complete industrial-scale process chain is available today. Demonstration-scale plants exist, and the first small-scale industrial plants are being built. The commissioning of the first large-scale industrial plants capable of producing larger quantities of RFNBO is not expected until the end of the 2020s due to the development and construction times[146] [147]. Accordingly, this type of LCF would only be available for larger emission savings crediting at that time.

The production costs of RFNBO[148] [149] today are multiple times the costs of fossil fuels. Due to decreasing investment costs, especially for electrolysers, increasing process efficiency and decreasing electricity generation costs, the production costs of RFNBO can be expected to decrease significantly over time. However, the expected cost range of different studies and scenarios is considerable, so that ranges are considered in the following cost considerations in order to depict different possible cost developments.

The same assumptions are also used for the user and societal perspective, through the calculation of the total cost of ownership (TCO). This includes not only the technology costs that are decisive for the manufacturer to comply with the CO_2 emission standards and that are reflected in the purchase price of the vehicles, but also the costs that arise during the use of the vehicles. These consist of the costs for the fuel or electricity used as well as O&M costs for insurance, vehicle taxes and vehicle maintenance. The additional technology costs compared to an ICEV, which are caused by either the crediting of emission savings from LCF or an additional BEV, are part the cost comparison from the user's and the societal perspective between the two possible compliance strategies of the

[146] Ausfelder, F., & Dura, H. (2019). Optionen für ein nachhaltiges Energie-System mit Power-to-X-Technologien. Nachhaltigkeitseffekte - Potenzial Einsatzmöglichkeiten. Frankfurt am Main.

[147] NPM. AG 1 "Klimaschutz im Verkehr". (2020). Werkstattbericht Alternative Kraftstoffe. Klimawirkungen und Wege zum Einsatz Alternativer Kraftstoffe. Berlin.

[148] Frontier Economics. (2018). The Future Cost of Electricity-Based Synthetic Fuels. Agora Energiewende; Agora Verkehrswende.

[149] Prognos AG. (2020). Kosten und Transformationspfade für strombasierte Energieträger. Endbericht zum Projekt “Transformationspfade und regulatorischer Rahmen für synthetische Brennstoffe“.

manufacturer. In these calculations it is also considered that both strategies have the same emission reduction impact for meeting the CO_2 emission standards.

17.4 Life-cycle analysis (LCA) approaches

A study titled "**Determining the environmental impacts of conventional and alternatively fuelled vehicles through Life-Cycle Assessment (LCA)**", was initiated in 2017 as a pilot project requested by the European Parliament. It was undertaken by a consortium led by Ricardo on behalf of DG Climate Action.

The full report and accompanying documents and datasets can be found here: https://ec.europa.eu/clima/policies/transport/vehicles_en#tab-0-1

The aim of the study was to improve the understanding of the environmental impacts of road vehicles and the methodologies to assess them. It had two main objectives:

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

The assessment of impacts included 14 different impact categories, ranging from impacts associated with airborne emissions (e.g. the mid-point indicator GWP for greenhouse gas emissions) to impacts from resource use.

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

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

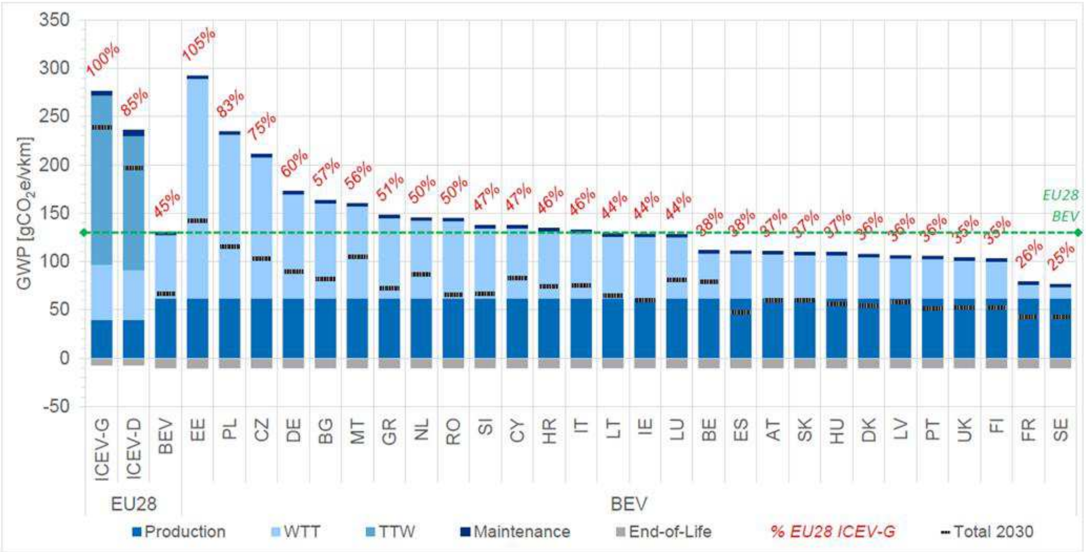
However, the methodology developed is not immediately suited for calculating the individual lifecycle emissions of individual vehicles, which would require an even more detailed and disaggregated approach.

In broad terms, the analysis shows that xEV powertrains have significantly lower environmental impacts across all vehicle types and most impact categories, with BEVs consistently performing better than all other powertrains. The higher impacts in some categories for xEVs (e.g. abiotic resource depletion, minerals and metals) are generally due to the use of particular materials (particularly copper and electronic components). The analysis also demonstrates that xEV benefits in terms of lower environmental impacts vary depending on regional and operational circumstances

The dataset allows for the further investigation of individual impacts, as well as for comparing across different impact categories. This is shown inFigure 39, which illustrates GHG impacts of lower medium cars (market segment C), comparing ICEV (EU average) and BEV (EU and MS averages). It shows that the average EU lifecyle GWP impact of a BEV in 2020 is around 45% of that of a gasoline car (ICEV-G) and 53% of a diesel car (ICEV-D). For all MS except Estonia the BEV scores better than the ICEV. In 2030, the difference becomes even bigger as the electricity mix becomes more decarbonised.

Figure 39: Comparing the GHG impacts of lower medium cars

Figure ES5: Comparison of Lower Medium Car lifecycle GWP impacts for conventional gasoline/diesel ICEVs and BEVs for different EU countries, Baseline scenario. Breakdown shown for new 2020 vehicles, and the total only for new 2030 vehicles.



Notes: Results shown for the lower medium car in the baseline scenario. Production = production of raw materials, manufacturing of components and vehicle assembly; WTT = fuel/electricity production cycle; TTW = impacts due to emissions from the vehicle during operational use; Maintenance = impacts from replacement parts and consumables; End-of-Life = impacts/credits from collection, recycling, energy recovery and disposal of vehicles and batteries. Additional information on key input assumptions and derived intermediate data include the following: a lifetime activity of 225,000 km over 15 years. 2020 BEV battery of 58 kWh, with 300km WLTP range (and with 64 kWh and 460 km WLTP electric range for 2030); an average lifetime EU28 fuel/electricity mix (age-dependant mileage weighted). No battery replacement is needed for BEVs.

The results of the analysis generally confirm the ongoing EU policy approach to move to a more circular economy and the initiatives aimed at developing a sustainable value chain for xEV batteries in Europe and driving down industrial emissions. There are also further opportunities to improve existing policy instruments, e.g. related to battery re-use or recycling, as well as finding ways to further incentivise improvements in the operational energy efficiency of powertrains.

17.5 Announcement by car manufacturers on zero emission vehicles

This annex presents information on recent announcement by car manufacturers, on the basis of publicly available information and sources (see **Table 40** below).

Table 40: Announcement of car manufacturers on zero-emission vehicles

Manufacturer	Announcements	Type of vehicles	Year
Volvo Cars	50% 100%	BEV BEV	2025 2030
Volkswagen group ***Volkswagen*** ***Porsche*** ***Audi***	 *More than 70%* *100%* *100%* *100%*	 *BEV* *BEVBEV, PHEV,* *HEV* *BEV*	 *2030* *2035* *2030* *2033*
General Motors	100%	BEV	2035
Jaguar Land Rover ***Jaguar***	100% *100%*	BEV, PHEV(unclear) *BEV, PHEV*	2030 *2025*
Ford	100% 100%	BEV, PHEV Only BEV	2026 2030
Stellantis	70%	BEV, PHEV	2030
BMW ***Mini***	At least 50% *100%*	BEV *BEV*	2030 *2030*
Nissan	100%	BEV, PHEV, HEV	2030
Renault Group (Renault brand)	65% 90%	ZEV, PHEV, HEV ZEV, PHEV, HEV	2025 2030
Daimler	Up to 25%	BEV	2025
Honda	100%	BEV, PHEV, HEV	2040
Toyota	1 million BEV globally	BEV	2030

Volkswagen Group[150]

- All-electric vehicles expected to exceed 70% of European sales by 2030. To achieve this, Volkswagen will bring out at least one new BEV model every year (according to ACCELERATE Strategy)[151]. Volkswagen will stop selling cars with combustion engines in Europe by 2035[152].
- Audi brand: By the middle of the coming decade, Audi to sell about a million electrified cars each year[153]. Starting in 2026, Audi will only launch new all-electric models on the global market, and will phase out the production of the last internal combustion engines by 2033[154].

[150] https://www.volkswagenag.com/en/news/stories/2020/10/29-climate-measures-of-the-volkswagen-group.html

[151] https://www.volkswagen-newsroom.com/en/press-releases/volkswagen-is-accelerating-transformation-into-software-driven-mobility-provider-6878

[152] https://www.reuters.com/business/sustainable-business/vw-end-sales-combustion-engines-europe-by-2035-2021-06-26/

[153] https://www.audi.com/en/company/strategy.html

[154] https://www.audi-mediacenter.com/en/press-releases/audi-ceo-duesmann-at-berlin-climate-conferenceaccelerated-transition-to-e-mobility-14069

- Porsche brand: all electrified (ZEV, PHEV, HEV) by 2030[155].

Volvo[156]

- Fully electric by 2030, phasing out any car in its global portfolio with an internal combustion engine, including hybrids.
- By 2025, 50% of global sales fully electric cars, rest hybrids.

Stellantis (merger PSA, FCA)

- 70% of the vehicles sold in EU in 2030 electric (including PHEVs)[157].
- The Group has announced that an electrified version (BEV and PHEV) is to be offered for 98 per cent of its models in Europe by 2025. By 2030, there will be at least one battery-electric version for all models[158].

Group Renault

- According to its new Climate Plan[159], the Renault Group plans to sell 65% electrified vehicles (BEV, PHEV, Hybrid Electric Vehicles) of the Renault brand by 2025, and 90% by 2030 (other brands such as Dacia are not covered by this announcement).[160]

BMW

- Fully electric models to account for at least 50 percent of global deliveries by 2030[161].
- Mini brand: MINI to become a fully electric brand by the early 2030s.
- BMW is aiming to have more than seven million EVs on roads by the end of the decade – two-thirds of them being pure-electric. It will launch five pure-electric vehicles by the end of 2021 and additional models in the coming years, resulting in a portfolio of 25 EV models by the end of 2023[162].

Daimler

- 2025: Up to 25 percent of unit sales to be accounted for by all-electric vehicles (depending on the framework conditions)[163].
- Daimler official website states: "We are convinced that diesel will continue to be a fixed element of the drive-system mix in the future, not least due to their low CO_2 emissions. It makes more sense to improve diesel than to ban it, because the

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[155] https://www.bloomberg.com/news/articles/2021-02-07/most-porsche-sales-will-be-electric-vehicles-by-2030-bild-says
[156] https://www.media.volvocars.com/global/en-gb/media/pressreleases/277409/volvo-cars-to-be-fully-electric-by-2030
[157] https://www.electrive.com/2021/04/18/stellantis-reveals-key-details-of-electrification-plans/
[158] https://www.electrive.com/2021/04/18/stellantis-reveals-key-details-of-electrification-plans
[159] https://www.renaultgroup.com/wp-content/uploads/2021/04/rapport-climat-renault-group.pdf
[160] https://fr.media.groupe.renault.com/actualites/renault-group-inscrit-sa-strategie-environnementale-et-societale-au-coeur-de-sa-performance-d46d-e3532.html
[161] https://www.press.bmwgroup.com/global/article/detail/T0327929EN/a-new-era-a-new-class:-bmw-group-steps-up-technology-offensive-with-comprehensive-realignment-%E2%80%93-uncompromisingly-electric-digital-and-circular
[162] From Audi to Volkswagen: How are big carmakers approaching the EV transition? (edie.net)
[163] https://www.daimler.com/sustainability/climate/ambition-2039-our-path-to-co2-neutrality.html

biggest lever for reducing consumption and emissions is still the energy-efficient combustion engine. It will remain the backbone of our mobility for many years to come."[164].

Toyota

- To reduce the CO_2 emissions from vehicles by 90 per cent by 2050, compared to the levels in 2010[165]. (Promote the development of next-generation vehicles with low or zero carbon emissions: HEV, PHEV, BEV and FCEV, making conventionally powered models more fuel-efficient).
- By 2030 to annually sell more than 5.5 million electrified vehicles around the world, including more than 1 million zero-emission vehicles (battery electric and fuel cell electric vehicles).

JLR (Jaguar + Land Rover)[166]

- JLR to go entirely electric by 2030 (most likely BEV, PHEV but definition unclear).
- Jaguar brand will be entirely electric by 2025.

Ford

- All electric by 2030[167] (BEV).

General Motors:

- Eliminate tailpipe emissions from new LDVs by 2035[168]

Honda

- All electrified vehicles (BEV, PHEV and HEV) by 2040[169].

Nissan:

- Nissan aims to electrify (BEV, PHEV and HEV) all new models launched in major markets by the early 2030s[170].

[164] https://www.daimler.com/innovation/diesel/en/
[165] https://www.toyota-europe.com/world-of-toyota/feel/environment/environmental-challenge-2050
[166] https://media.jaguar.com/news/2021/02/jaguar-land-rover-reimagines-future-modern-luxury-design
[167] https://media.ford.com/content/fordmedia/fna/us/en/news/2021/02/17/ford-europe-goes-all-in-on-evs.html
[168] https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/jan/0128-carbon.html
[169] https://global.honda/newsroom/news/2021/c210423eng.html
[170] https://global.nissannews.com/en/releases/210226-01-e

18 ANNEX 9: 2030 CLIMATE TARGET PLAN POLICY CONCLUSIONS

The Communication on stepping up Europe's 2030 climate ambition - the Climate Target Plan (CTP)[171] and its underpinning impact assessment are the starting point for the initiatives under the Fit for 55 package.

The plan concluded on the feasibility - from a technical, economic and societal point of view - of increasing the EU climate target to 55% net reductions of greenhouse gases (GHG) emissions by 2030 compared to 1990. It also concluded that all sectors need to contribute to this target.

In particular, with energy supply and use responsible for 75% of emissions, the plan put forward ambition ranges for renewables and energy efficiency, which correspond in a cost-efficient manner to the increased climate target. The climate target plan also established that this increase in climate and energy ambition will require a full update of the current climate and energy policy framework, undertaken in a coherent manner.

As under the current policy framework, the optimal policy mix should combine, at the EU and national levels, strengthened economic incentives (carbon pricing) with updated regulatory policies, notably in the field of renewables, energy efficiency and sectoral policies such as CO_2 standards for new light duty vehicles. It should also include the enabling framework (research and innovation policies, financial support, addressing social concerns).

While sometimes working in the same sectors, the policy tools vary in the way they enable the achievement of the increased climate target. The economic incentives provided by strengthened and expanded emissions trading will contribute to the cost-effective delivery of emissions reductions. The regulatory policies, such as the Renewable Energy Directive (RED), the Energy Efficiency Directive (EED), the Regulation on CO_2 standards for vehicles supported by the Directive on the alternative fuels infrastructure, and the Re(FuelEU) aviation and maritime initiatives, aim at addressing market failures and other barriers to decarbonisation, but also create an enabling framework for investment, which supports cost-effective achievement of climate target by reducing perceived risks, increasing the efficient use of public funding and helping to mobilise and leverage private capital. The regulatory policies also pave the way for the future transition needed to achieve the EU target of the climate neutrality. Such a sequential approach from the CTP to the Fit for 55 initiatives was necessary in order to ensure coherence among all initiatives and a collective delivery of the increased climate target.

With the "MIX" scenario, the impact assessment included a policy scenario that largely reflects the political orientations of the plan.

The final calibration between the different instruments is to be made depending, *inter alia* on the decision on the extension of emissions trading beyond the maritime sector and its terms.

Table 41 below shows the summary of the key CTP findings:

[171] COM (2020) 562 final.

Table 41: Key policy conclusions of the Climate Target Plan

POLICY CONCLUSIONS IN THE CTP	
GHG emissions reduction	• At least 55% net reduction (w.r.t. 1990) • Agreed by the European Council in December 2020 • Politically agreed by the European Council and the European Parliament in the Climate Law
ETS	• Corresponding targets need to be set in the EU ETS and the Effort Sharing Regulation to ensure that in total, the economy wide 2030 greenhouse gas emissions reduction target of at least 55% will be met. • Increased climate target requires strengthened cap of the existing EU ETS and revisiting the linear reduction factor. • Further expansion of scope is a possible policy option, which could include emissions from road transport and buildings, looking into covering all emissions of fossil fuel combustion. • EU should continue to regulate at least intra-EU aviation emissions in the EU ETS and include at least intra-EU maritime transport in the EU ETS. • For aviation, the Commission will propose to reduce the free allocation of allowances, increasing the effectiveness of the carbon price signal in this sector, while taking into account other policy measures.
ESR	• Corresponding targets need to be set in the Effort Sharing Regulation and under the EU ETS, to ensure that in total, the economy wide 2030 greenhouse gas emissions reduction target of at least 55% will be met.
LULUCF	• Sink needs to be enhanced. • Agriculture forestry and land use together have the potential to become rapidly climate-neutral by around 2035 and subsequently generate removals consistent with trajectory to become climate neutral by 2050.
CO2 standards for cars and vans	• Transport policies and standards will be revised and, where needed, new policies will be introduced. • The Commission will revisit and strengthen the CO_2 standards for cars and vans for 2030. • The Commission will assess what would be required in practice for this sector to contribute to achieving climate neutrality by 2050 and at what point in time internal combustion engines in cars should stop coming to the market.
Non-CO2 GHG emissions	• The energy sector has reduction potential by avoiding fugitive methane emissions. The waste sector is expected to strongly reduce its emissions already under existing policies. Turning waste into a resource is an essential part of a circular economy, as is prevention of waste, addressed by both Circular Economy and the Zero Pollution Action Plans. Under existing technology and management options, agriculture emissions cannot be eliminated fully but they can be significantly reduced while ensuring food security is maintained in the EU. Policy initiatives have been included in the Methane Strategy.

Renewables	• 38-40% share needed to achieve increased climate target cost-effectively. • Renewable energy policies and standards will be revised and, where needed, new policies will be introduced. • Relevant legislation will be reinforced and supported by the forthcoming Commission initiatives on a Renovation Wave, an Offshore Energy strategy, alternative fuels for aviation and maritime as well as a Sustainable and Smart Mobility Strategy. • EU action to focus on cost-effective planning and development of renewable energy technologies, eliminating market barriers and providing sufficient incentives for demand for renewable energy, particularly for end-use sectors such as heating and cooling or transport either through electrification or via the use of renewable and low-carbon fuels such as advanced biofuels or other sustainable alternative fuels. • The Commission to assess the nature and the level of the existing, indicative heating and cooling target, including the target for district heating and cooling, as well as the necessary measures and calculation framework to mainstream further renewable and low carbon based solutions, including electricity, in buildings and industry. • An updated methodology to promote, in accordance with their greenhouse gas performance, the use of renewable and low-carbon fuels in the transport sector set out in the Renewable Energy Directive. • A comprehensive terminology for all renewable and low-carbon fuels and a European system of certification of such fuels, based notably on full life cycle greenhouse gas emissions savings and sustainability criteria, and existing provisions for instance in the Renewable Energy Directive. • Increase the use of sustainably produced biomass and minimise the use of whole trees and food and feed-based crops to produce energy through inter alia reviewing and revisiting, as appropriate, the biomass sustainability criteria in the Renewable Energy Directive,
Energy Efficiency	• Energy efficiency policies and standards will be revised and, where needed, new policies will be introduced. • Energy efficiency improvements will need to be significantly stepped up to around 36-37% in terms of final energy consumption[172]. • Achievement of a more ambitious energy efficiency target and closure of the collective ambition gap of the national energy efficiency contributions in the NECPs will require actions on a variety of fronts. • Renovation Wave will launch a set of actions to increase the depth and the rate of renovations at single building and at district level, switch fuels towards renewable heating solutions, diffuse the most efficient products and appliances, uptake smart systems and building-related infrastructure for charging e-vehicles, and improve the building envelope (insulation and windows). • Action will be taken not only to better enforce the Energy Performance of Buildings Directive, but also to identify any need for targeted revisions. • Establishing mandatory requirements for the worst performing buildings and gradually tightening the minimum energy performance requirements

[172] The Impact Assessment identifies a range of 35.5% - 36.7% depending on the overall design of policy measures underpinning the new 2030 target. This would correspond to a range of 39.2% - 40.6% in terms of primary energy consumption.

	will also considered.