THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

BRIEFING

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The European Commission regulatory proposal for post-2020 CO_2 targets for cars and vans: A summary and evaluation

BACKGROUND

On November 8, 2017, the European Commission (EC) published its regulatory proposal for post-2020 carbon dioxide (CO_2) targets for new passenger cars and light-commercial vehicles (vans). The proposed regulation would be the third set of mandatory vehicle CO_2 performance standards in the European Union (EU).

The first set of regulations, implemented in 2009 after a voluntary commitment by the auto industry to reduce average vehicle CO_2 emissions had failed to produce adequate results, established average targets of 130 grams per kilometer (g/km) for new passenger cars in 2015 and 175 g/km for vans in 2017. Vehicle manufacturers met both targets several years in advance. A second set of regulations, passed in 2014, required average CO_2 emissions of new cars to fall to 95 g/km by 2021. For new vans, the target value is 147 g/km by 2020. This second regulation also required the EC to review CO_2 emission targets and prepare a regulatory proposal for the post-2020 period. This review was to have been completed by the end of 2015.

This briefing summarizes and evaluates the key elements of the recent EC proposal before it enters the political negotiation process between the European Parliament and the European Council.

SUMMARY OF KEY ELEMENTS OF THE PROPOSAL

In contrast to previous vehicle CO_2 regulations, the new EC proposal does not specify CO_2 targets in absolute g/km terms but instead defines CO_2 reduction requirements in percentage terms. Because of the ongoing transition to a new vehicle emissions' test

Prepared by Jan Dornoff, Joshua Miller, Peter Mock, and Uwe Tietge

procedure, the Worldwide Harmonized Light Vehicles Test Procedure (WLTP), the EC argues that it is difficult to predict future emission levels and therefore prefers percentage reduction values from a 2020/21 baseline.

Under the EC proposal, average new-vehicle CO_2 emission levels would have to fall by 15% by 2025 and 30% by 2030. These percentage reduction requirements are the same for cars and vans, but the starting point varies slightly (2020 for vans and 2021 for cars). If a manufacturer failed to meet its CO_2 reduction requirement, the EC proposal stipulates a penalty of 95 euros per g/km of exceedance for each newly registered vehicle, the same penalty imposed under the 2020/21 standard.

Although in principle percentage reduction targets are the same for every manufacturer, the regulatory proposal provides flexibility with regard to the distribution of effort among manufacturers. The heavier a manufacturer's new-vehicle fleet, the higher its target values (in g/km) in 2020/21, 2025, and 2030 will be. The EC proposal achieves this by comparing the average weight of each manufacturer's fleet with the average weight of the entire European Union fleet. The CO_2 target is raised for each kilogram by which a manufacturer's fleet average exceeds the EU fleet average. For example, in the case of cars registered by 2024, an additional 0.0333 g/km of CO_2 per kilo of additional average weight would be allowed. Conversely, if a manufacturer's fleet is lighter than average, its target is lowered. This weight adjustment mechanism is, in principle, the same as in current regulations. However, from 2025 onward the WLTP test mass, rather than mass in running order as defined under the New European Driving Cycle (which tends to be a lower value for the same vehicle), will be used for all calculations.

For vans, the EC proposes using two different slopes for the weight-based target calculation from 2025 onwards. Manufacturers with heavier-than-average van fleets would be subject to a different adjustment factor than those with a lighter fleet. In comparison, the 2020 standard applies only one common factor, 0.0960 g/km of CO_2 for every additional kg.

The EC also proposes a novel mechanism that rewards manufacturers that sell greater shares of zero-emission and low-emission vehicles (ZLEVs) with less stringent CO_2 requirements. ZLEVs are all vehicles that emit less than 50 g/km of CO_2 on a tank-to-wheel (TTW) basis, namely battery-electric (BEV), fuel cell electric (FCEV), and (some) plug-in hybrid electric (PHEV) vehicles. The EC proposal sets a target ZLEV market share of 15% for 2025 and 30% for 2030. The lower the CO_2 emission level of a ZLEV, the more it counts toward the market share target. A manufacturer exceeding these targets would see its CO_2 reduction requirements eased proportionally. The EC proposal defines an upper limit for this mechanism: If a manufacturer had more than 20% ZLEVs in 2025 and more than 35% in 2030, these additional ZLEVs would not be counted toward a further CO_2 reduction target adjustment. There is no penalty for failing to meet the ZLEV target, which is referred to as a one-way adjustment by the EC. A two-way adjustment would include a penalty for not meeting the ZLEV target.

For the first time in an EU vehicle emission regulation, the proposed post-2020 standards would mandate in-service conformity testing to ensure that CO_2 emission levels of vehicles on the market agree with the official type approval figures. The EC proposal would require EU member states' vehicle type approval authorities to report deviations in CO_2 emission levels found during in-service conformity tests to the EC. The EC may take these into account when determining whether a manufacturer has met its respective CO_2 reduction target. In addition, the proposal would give the EC a mandate to develop further measures and procedures to monitor real-world CO_2 emissions. In materials accompanying the proposed regulation, the EC refers to an obligation for manufacturers to equip new vehicles with standardized fuel consumption measurement devices, but no such obligation is formally defined in the EC proposal itself.

The EC proposal continues the practice of awarding eco-innovation credits for technologies that deliver CO_2 reductions outside of the official test procedure. For the first time, improvements of air-conditioning systems would count as eco-innovations, beginning in 2025. Furthermore, the EC proposal would allow revising the current 7 g/km CO_2 cap on eco-innovation credits.

The EC proposal includes a clause that would require a review of the regulation by 2024, with a specific focus on the real-world representativeness of vehicle CO_2 emission and energy consumption values as well as the deployment of ZLEV and the roll-out of recharging and refueling infrastructure.

The EC proposed post-2020 CO_2 standards for cars and vans is part of a Clean Mobility Package[1] that also includes other elements, such as a battery initiative and an action plan for the trans-European deployment of alternative fuel infrastructure. The documents published with respect to the cars and vans CO_2 standard include the proposal itself as well as the annex to the proposal, the accompanying impact assessment, and a series of underlying technical studies.[2]

EVALUATION OF KEY ELEMENTS OF THE PROPOSAL

LEVEL AND TIMING OF EMISSION TARGETS

The proposed cars and vans standards set a reduction target of 15% for 2025 and 30% for 2030 relative to 2021 reference targets. Because the 2025 and 2030 targets are defined in terms of WLTP measurements, each manufacturer's 2021 reference target will be converted to WLTP by adjusting its 2020 New European Driving Cycle (NEDC) target by the ratio of WLTP to NEDC CO_2 emission levels in 2020.

Figure 1 and Figure 2 plot the targets proposed for cars and vans in the context of historical emission values and existing targets for 2025 and 2030. The figures also show proposals from other stakeholders, for additional context. The figures do not consider the transition to the WLTP, in the interest of presenting simple and consistent results.

The 2020/21 regulation requires the EC to carry out a review and to propose post-2020 standards "maintaining a clear emissions-reduction trajectory comparable to that achieved in the period of up to 2020."[3] Compared with the existing standards, the proposed 2025 and 2030 passenger car standards are less ambitious than the current 2021 standard in terms of both absolute (g/km) and relative (percent) annual reduction rates. On average, the EC proposal would reduce new car CO_2 emissions by about 3.2 g/km (3.9%) per year between 2021 and 2030, compared to about 5.8 g/km (5%) per year between 2015 and 2021.

1 European Commission, "Energy Union: Commission takes action to reinforce EU's global leadership in clean vehicles," 8 November 2017, http://europa.eu/rapid/press-release_IP-17-4242_en.htm

2 For access to the individual documents, please see http://ec.europa.eu/info/law/better-regulation/initiatives/com-2017-676_en and https://ec.europa.eu/clima/policies/transport/vehicles/proposal_en#tab-0-2

3 Regulation (EC) No 333/2014 of the European Parliament and the Council of 11 March 2014 amending Regulation (EC) No 443/2009 to define the modalities for reaching the 2020 target to reduce CO_2 emissions from new passenger cars. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0333&from=EN

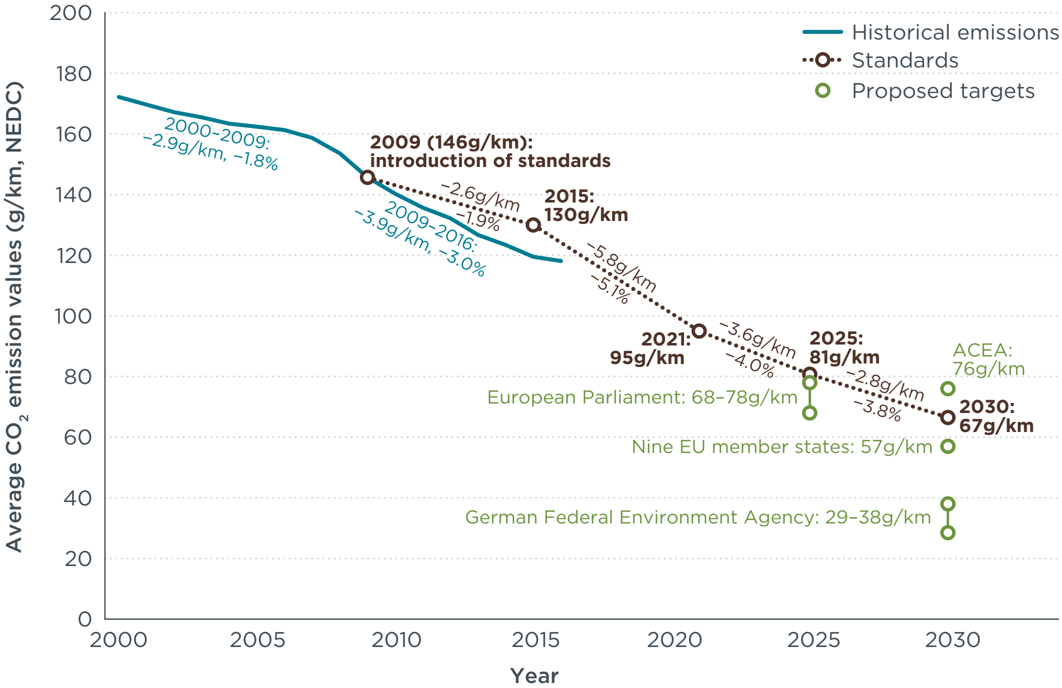

Figure 1. Historical average CO_2 emission values, standards, and proposed targets for European passenger cars, all in NEDC. Rates in g/km and percent refer to annual rates.

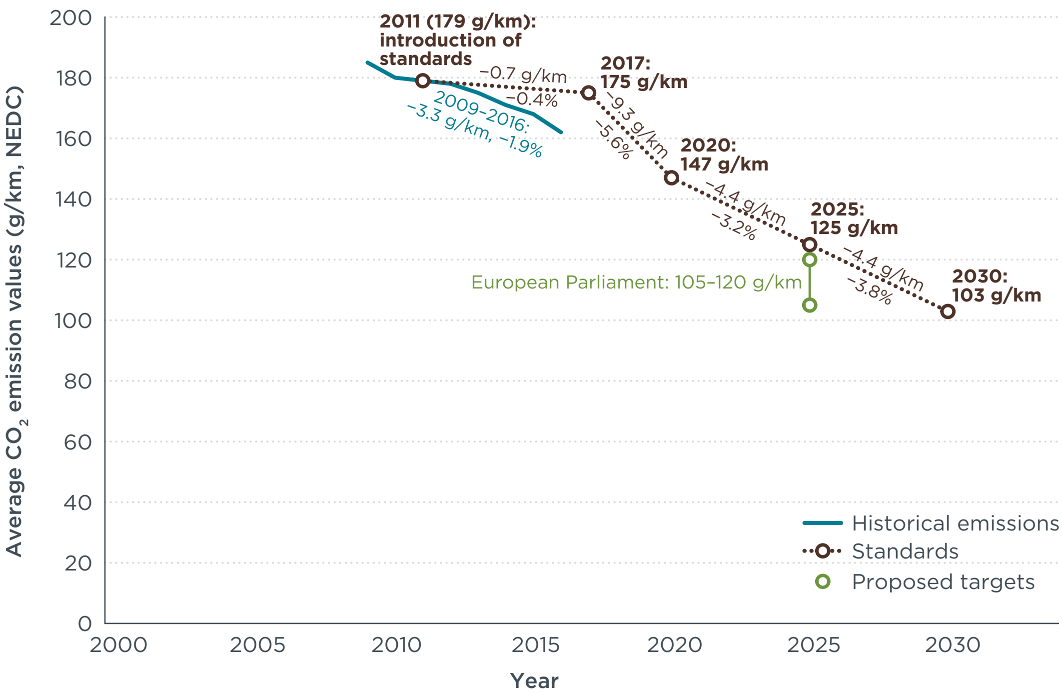

Figure 2. Historical average CO_2 emission values and standards for European vans, all in NEDC. Rates in g/km and percent refer to annual rates.

For vans, the 2025 and 2030 targets are a notable improvement over the 2017 standard in terms of annual reduction rates, but they fall short in both absolute (g/km) and relative (percent) annual reduction rates compared with the 2020 target. On average, new van CO_2 emission levels would decline by about 4.4 g/km (3.5%) per year between 2020 and 2030, compared to about 9.3 g/km (5.6%) per year between 2017 and 2020.

The proposed EC 2025 target is 5–20 g/km higher (i.e., less stringent) than the European Parliament's indicative range for the same year.[4]

In comparison with passenger car targets proposed by stakeholders, the 2025 and 2030 standards are more ambitious than the 20% reduction target (approximately 76 g/km in NEDC terms) for 2030 proposed by the European Automobile Manufacturers Association (ACEA),[5] but fall short of other notable proposals. In 2013, the European Parliament suggested limiting CO_2 emissions to 68–78 g/km in 2025.[6] The proposal exceeds the upper bound of this range by 3 g/km and the lower bound by 13 g/km. Furthermore, nine EU member states, representing approximately 30% of EU new passenger car sales in 2016, sent letters urging a 40% reduction target (57 g/km in NEDC terms) in 2030 and calling for 2025 interim targets in order to meet their greenhouse gas (GHG) emission reduction targets.[7] The proposed 2030 EC standards are more lenient than the nine member states' request. The German Federal Environment Agency (UBA) called for a 60%–70% reduction in CO_2 emissions and a 70% share of low-emission vehicles in 2030, more than double the levels of the proposed EC 2030 standard. UBA, similar to the nine member state request, cited the need for demanding EU-wide standards in lieu of national reduction targets for GHG emissions from the transportation sector.

OVERALL FLEET CO_2 EMISSION REDUCTIONS

In 2016, the EC proposed an Effort Sharing Regulation (ESR) that would set economy-wide binding GHG reduction targets for EU member states over the period 2021–2030.[8] The ESR covers the transport, buildings, agriculture, and waste management sectors, which are generally not covered by the EU Emissions Trading System (EU ETS). By 2030, the ESR aims to reduce GHG emissions from non-ETS sectors by 30% compared to the base year 2005. Individual member state GHG reduction targets range from 0% to 40%. The ESR does not specify targets for individual non-ETS sectors; instead, it aims to deliver these reductions "in the most cost-effective manner possible."[9] EC modeling estimates the most cost-effective reductions are "18%–19% for transport, 38%–43% for residential and tertiary (mainly buildings), 35%–37% for industry, and 29%–35% for non-CO_2 sectors (mainly agriculture and waste) by 2030 relative to 2005."[10]

The following estimates of direct CO_2 emissions from cars, vans, trucks, and buses in the EU are projected using ICCT's global transportation roadmap model. These estimates are an update to a previous analysis of policy options for reducing CO_2 from road transport

4 European Parliament, "Report on the Proposal for a Regulation of the European Parliament and of the Council Amending Regulation (EU) No 510/2011 to Define the Modalities for Reaching the 2020 Target to Reduce CO_2 Emissions from New Light Commercial Vehicles," May 13, 2013, http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A7-2013-0168+0+DOC+XML+V0//EN.

5 European Automobile Manufacturers' Association (ACEA), "CO_2 Targets for Cars: European Auto Industry Sets out Post-2021 Framework," September 13, 2017, http://www.acea.be/press-releases/article/co2-targets-for-cars-european-auto-industry-sets-out-post-2021-framework.

6 European Parliament, "Car CO_2: Mapping the Route to 95g and Beyond," April 24, 2013, http://www.europarl.europa.eu/news/en/press-room/20130422IPR07527/car-co2-mapping-the-route-to-95g-and-beyond.

7 Letter from Austria, Belgium, Ireland, Luxembourg, The Netherlands, Portugal, and Slovenia: Carole Dieschbourg et al., "European Environment and Transport Ministers' Joint Letter to the European Commission, Regarding the 2030 Greenhouse Gas Emissions Reduction Target and Emissions from Transport," October 25, 2017, https://g8fip1kplyr33r3krz5b97d1-wpengine.netdna-ssl.com/wp-content/uploads/2017/11/SPOLITICO-17110816540.pdf. France and Sweden issued separate letters (without reference).

8 European Commission, "Proposal for an Effort Sharing Regulation 2021-2030," November 23, 2016, https://ec.europa.eu/clima/policies/effort/proposal_en

9 Commission Staff Working Document accompanying "A European Strategy for Low-Emission Mobility" (2016), https://ec.europa.eu/transport/sites/transport/files/themes/strategies/news/doc/2016-07-20-decarbonisation/swd%282016%29244.pdf

10 Commission Staff Working Document accompanying "A European Strategy for Low-Emission Mobility" (2016), https://ec.europa.eu/transport/sites/transport/files/themes/strategies/news/doc/2016-07-20-decarbonisation/swd%282016%29244.pdf, p. 23.

in the EU.[11] Historical data for passenger and freight activity (passenger-km and tonne-km) and vehicle registrations are sourced from the International Energy Agency's Mobility Model[12] and checked for consistency with ICCT's European Vehicle Market Statistics Pocketbook.[13] Future activity levels of cars, vans, trucks, and buses are based on projected growth rates to 2050 from the EC's EU Reference Scenario 2016.[14] Load factors, defined as the number of passengers or tonnes of cargo per vehicle-km, have been calibrated to align with the European Environment Agency's data for historical CO_2 emissions from road transport.[15]

Figure 3 shows the projected impacts of adopted, proposed, and potential CO_2 standards for light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs) on direct CO_2 emissions[16] from the EU vehicle fleet to 2030. Under the adopted 2020/2021 standards for cars and vans, LDV emissions are projected to be 20% below 2005 levels by 2030. The impacts of the EC's proposal for 2025 and 2030 targets (equivalent to a 30% reduction from 2021 to 2030) depend on the actual ratio of the WLTP to NEDC test results in 2020, as well as on the effectiveness with which in-service conformity (ISC) testing ensures that in-use vehicles continue to meet the WLTP targets to which they were certified. In 2030, the EC's proposal could reduce an estimated 46 to 68 million tonnes (Mt) of CO_2 from the LDV fleet compared to a scenario with only the 2020/2021 targets.

The EC's proposal, however, does not necessarily exhaust the cost-effective potential for reducing CO_2 from cars and vans. In addition to the 30% reduction in CO_2 targets included in the EC's proposal, we evaluate the impacts of a 40% and 70% reduction from 2021 to 2030. As shown in Figure 3, strengthening the EC's proposed targets to a 40% or 70% reduction from 2021 to 2030 would reduce an additional 17 or 55 Mt CO_2 from the LDV fleet in 2030. Under those assumptions, CO_2 emissions from the LDV fleet would be 33% to 39% below 2005 levels in 2030.

Whereas car and van CO_2 emissions are projected to decline in response to adopted and proposed CO_2 standards, truck and bus emissions are projected to grow in the absence of mandatory CO_2 standards, in particular as the EU is currently the only major market worldwide without mandatory HDV CO_2 standards. Moderate improvements in truck efficiency, equivalent to a 20% reduction in new rigid truck emissions and a 27% reduction in tractor-trailer CO_2 emissions, could reduce HDV fleet emissions by approximately 26 Mt CO_2 in 2030 (equivalent to 9% below 2005 levels). More stringent HDV standards that take advantage of cost-effective technology potential, equivalent to a 32% reduction for rigid trucks and 43% for tractor-trailers, could reduce approximately 49 Mt CO_2 in 2030 compared to a baseline without standards (equivalent to 18% below 2005 levels).[17]

11 Joshua Miller, *Reducing CO_2 emissions from road transport in the European Union: An evaluation of policy options* (ICCT: Washington DC, 2016) http://www.theicct.org/sites/default/files/publications/ICCT_EU-CO2-policies_201606.pdf

12 OECD/IEA, "Energy Technology Perspectives 2017: Catalysing Energy Technology Transformations" (2017), http://www.iea.org/etp/

13 ICCT, *European Vehicle Market Statistics Pocketbook 2017/18* (ICCT: Berlin, 2017) http://theicct.org/sites/default/files/publications/ICCT_Pocketbook_2017_Web.pdf

14 European Commission, "EU Reference Scenario 2016," https://ec.europa.eu/energy/sites/ener/files/documents/ref2016_report_final-web.pdf

15 "EEA greenhouse gas—data viewer," European Environment Agency, accessed November 30, 2017, http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

16 Direct emissions of biofuels are similar to direct emissions of conventional fuels, so their impact on direct emissions is minimal. The upstream emissions impacts of biofuels are not evaluated in this analysis. For a previous analysis of fuel lifecycle CO_2 impacts of biofuels policies, see Miller, *Reducing CO_2 emissions from road transport in the European Union.*

17 Oscar Delgado, Felipe Rodríguez, and Rachel Muncrief, *Fuel efficiency technology in European heavy-duty vehicles* (ICCT: Washington DC, 2017), http://www.theicct.org/sites/default/files/publications/EU-HDV-Tech-Potential_ICCT-white-paper_14072017_vF.pdf

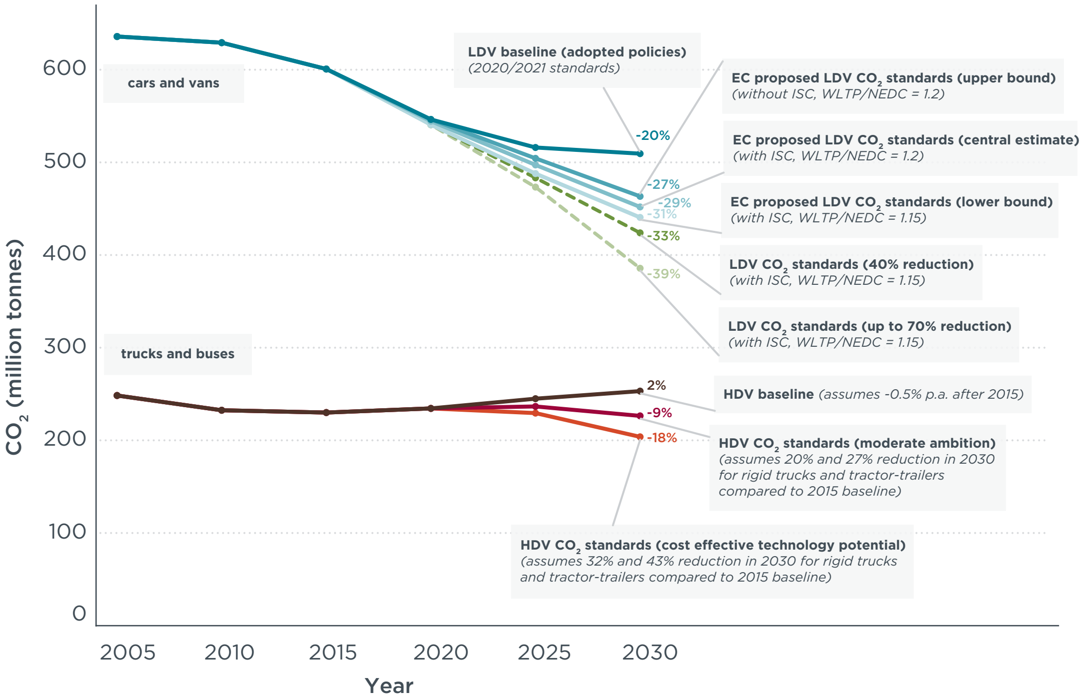

Figure 3. Direct CO_2 emissions in the EU from light-duty vehicles (cars and vans) and heavy-duty vehicles (trucks and buses) with adopted, proposed, and potential CO_2 standards. Data labels for 2030 show the percent change in emissions from 2005 levels. *LDV, light-duty vehicles; HDV, heavy-duty vehicles; ISC, in-service conformity testing. Results are estimated using the* **ICCT Roadmap Model.**

Figure 4 shows the combined effects[18] of adopted, proposed, and potential CO_2 standards on EU road transport CO_2 emissions to 2030, compared to a range of indicative targets for reducing emissions by 2030 and 2050. Under a baseline scenario, adopted 2020/2021 standards for cars and vans would reduce road transport CO_2 emissions to approximately 14% below 2005 levels by 2030.[19] The EC's proposal would further reduce road transport CO_2 emissions to approximately 20% below 2005 levels in 2030; the addition of moderately ambitious HDV standards would bring the total to 23% below 2005 in 2030. Under such policies, transport would likely meet its estimated "cost-effective" contribution to the ESR based on EC modeling (18%–19% below 2005 levels by 2030). However, end users of passenger and freight vehicles would lose out on substantial fuel savings benefits. Additionally, EU member states with stringent GHG reduction targets would still have to reduce GHGs by more than 30% in other non-ETS sectors.

Alternatively, the EC could set more stringent targets for LDVs and new standards for HDVs that take advantage of available cost effective technologies. ICCT's cost curve analyses indicate that a 70% CO_2 reduction for new cars and vans (2021–2030), a 32% reduction for rigid trucks, and a 43% reduction for tractor-trailers are achievable by 2030 and would result in payback of incremental technology costs to first vehicle owners. Introduction of equivalent standards in the EU could further reduce road transport CO_2 emissions to approximately 33% below 2005 levels in 2030. This level of emission reduction for road transport would be more in line with the emission reductions targeted by the EC for other non-ETS sectors.

18 Rebound effects are not evaluated. For details on the real-world CO_2 gap assumed for cars and vans, see the following section in this briefing on "Type-approval vs. real-world emission levels."

19 A 2016 ICCT working paper estimated road transport CO_2 emissions could be 7.6% higher in 2030 than in 2005 assuming no change beyond adopted policies. This baseline assumes new HDV CO_2 emissions decline 0.5% per annum (versus no change in the previous analysis) and assumes growth in passenger and freight activity matches the EU Reference Scenario projections, which assume less growth in freight truck activity demand. See Miller, *Reducing CO_2 emissions from road transport in the European Union.*

The benefits of more stringent targets are more salient when put into perspective with long-term climate goals. As illustrated in the EU Reference Scenario and the baseline shown below, continued policy action is necessary to reduce road transport CO_2 emissions post-2025. The EC's proposed LDV standards, together with potential HDV standards with moderate ambition, would reduce fleet-wide CO_2 emissions by approximately 1.4% per year from 2020 to 2035. To meet a long-term climate target such as the 60% reduction in total transport emissions from 1990 levels targeted in the EC 2011 Transport White Paper, fleet-wide CO_2 emissions would have to be reduced more than three times as quickly (5.5% per year) from 2035 to 2050. Setting more ambitious LDV and HDV CO_2 standards for 2021–2030 would increase the likelihood of meeting the long-term climate target: as depicted below, fleet-wide CO_2 emissions could be reduced by approximately 3.0% per year from 2020 to 2035. Although fleet-wide emissions would still need to fall at least 3.9% per year from 2035 to 2050, these reductions would likely be more achievable given the substantial share of zero-emission vehicles that would already be in production as a result of stringent 2030 targets. These findings are conceptually consistent with a previous report to the EC that found LDV CO_2 targets should be reduced by 54% to 100% from 2021 to 2030 to meet the ESR targets and long-term goals, respectively.[20]

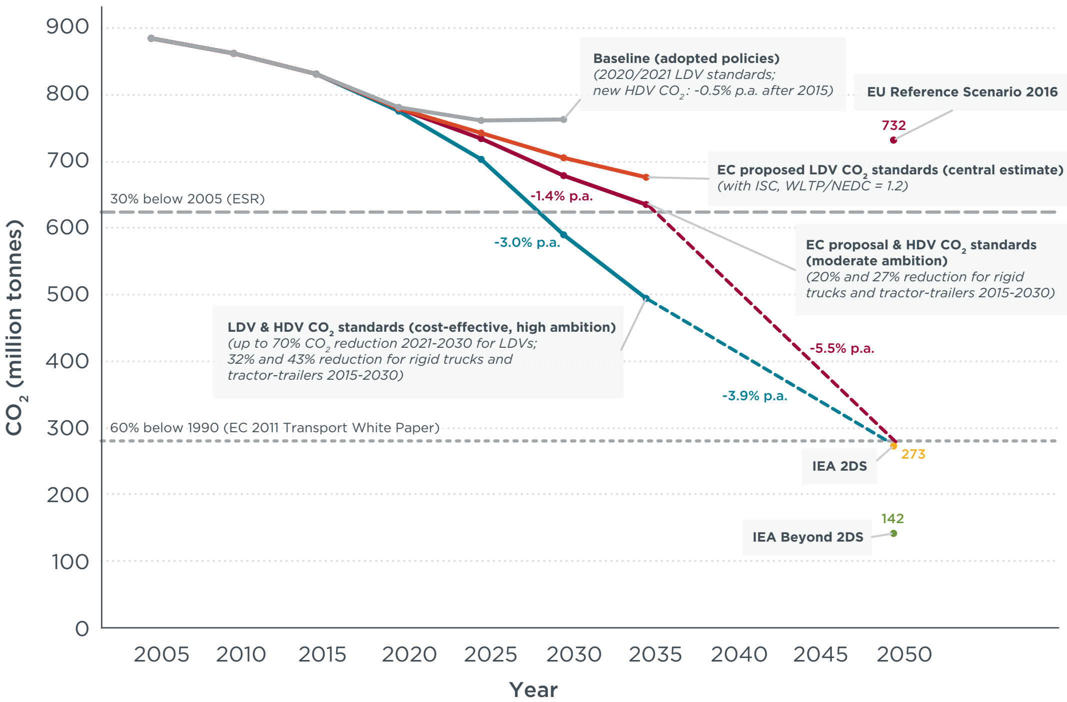

Figure 4. Direct CO_2 emissions in the EU from road transport (excluding motorcycles) with adopted, proposed, and potential CO_2 standards, including a range of indicative targets for reducing emission levels by 2030 and 2050. IEA estimates are from **Energy Technology Perspectives 2017.**[21] **EU Reference Scenario 2016** projections include motorcycles. ESR and Transport White Paper targets are indicative, since these not limited to road transport. *LDV, light-duty vehicles; HDV, heavy-duty vehicles; ISC, in-service conformity testing. Results are estimated using the* **ICCT Roadmap Model.**

20 Huib van Essen et al., *Assessment of the Modalities for LDV CO_2 Regulations beyond 2020* (CE Delft and TNO: 2017), http://www.cedelft.eu/en/publications/2026/assessment-of-the-modalities-for-ldv-co2-regulations-beyond-2020. The 54% reduction in LDV CO_2 targets to meet the 2030 goal corresponds to a 'mid'-scenario that includes 25% biofuels. The 100% reduction corresponds to a target level that is "fully robust" for potential developments in the transport sector (i.e. activity growth, biofuels, HDV efficiency) to 2030 and 2050.

21 Based on IEA data from the Mobility Model ETP 2017 Version © OECD/IEA 2017, www.iea.org/statistics. Licence: www.iea.org/t&c; as modified by ICCT.

TECHNOLOGY POTENTIAL AND COST, BENEFITS FOR CONSUMERS AND SOCIETY

The EC commissioned a consortium under the lead of the consultancy Ricardo-AEA to gather, review, and analyze data on available CO_2 emission abatement technologies and their costs, per vehicle segment and with respect to a 2013 baseline vehicle.[22] Main sources for the study were a literature review as well as stakeholder consultations. The European Commission Joint Research Centre (JRC) built on the cost curves developed by Ricardo-AEA and integrated them into an in-house model (DIONE).[23]

Like previous cost studies,[24] recent cost estimates may overestimate compliance costs. Ricardo-AEA notes that "unfortunately, the approach adopted by the majority of OEMs [vehicle manufacturers], i.e. to only provide generali[z]ed feedback via their trade association, somewhat hampered the ability to explore in more detail the reasons for disagreement with some of the cost estimates (e.g. those derived by tear-down studies) for certain technologies." It was this dissatisfaction with generalized feedback from vehicle manufacturers, often leading to overly pessimistic estimates for future technology cost-benefit ratios, that led the U.S. Environmental Protection Agency (EPA) to instead rely on using detailed computer simulations of CO_2 reduction technologies and bottom-up "tear-down" cost assessments of individual parts. This assessment method is more transparent and robust, but also more expensive and time-consuming.[25]

The ICCT commissioned the German engineering services provider FEV to carry out similar detailed computer simulations and bottom-up cost estimates for individual powertrain technologies and technology packages with the potential to reduce CO_2 emissions of European passenger cars and vans in the 2025 timeframe.[26] The ICCT supplemented the FEV powertrain results with additional information: estimates of the cost-benefit impacts of road-load reductions (reducing vehicle weight, rolling resistance, and aerodynamic resistance); indirect costs and learning effects out to 2030; type-approval test procedure flexibilities and performance-based adjustments; off-cycle technologies; and electric vehicles (EVs).[27]

Figure 5 compares the EC (including the original Ricardo cost curves) and ICCT cost curves for passenger cars for the 2030 timeframe (a similar comparison for 2025 is included as an annex to this paper). An aggregated cost curve for the average new vehicle was derived for both data sets. All CO_2 reductions and additional costs are relative to a 2013 baseline. The EC makes use of four cost curve scenarios: "very low", "low", "typical" and "high." The CO_2 reduction potential is constant for all scenarios, but the associated costs vary. The "very low" and "low" scenarios only differ in terms of battery cost assumptions, but the "typical" and "high" scenarios also differ in terms of costs

22 Nikolas Hill et al. "Improving understanding of technology and costs for CO_2 reductions from cars and LCVs in the period to 2030 and development of cost curves," report for DG Climate Action by Ricardo Energy & Environment (2016), https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/ldv_co2_technologies_and_costs_to_2030_en.pdf

23 Jette Krause, Alberto Donati, Christian Thiel, *Light Duty Vehicle CO_2 Emission Reduction Cost Curves and Cost Assessment – the DIONE Model* (Joint Research Centre: 2017) http://publications.jrc.ec.europa.eu/repository/bitstream/JRC108725/kjna28821enn.pdf

24 For example, industry studies in 2003 and 2009 estimated that reducing average new-car CO_2 emissions to 120 g/km in the EU would cost €1,000 to €3,900 per vehicle and require hybrid-electric vehicles to exceed 20% of new vehicle sales. In reality, when new-car CO_2 emissions fell to 123 g/km in 2014, the hybrid market share was less than 3%, and the average additional cost per vehicle was €200. See Paul Wolfram et al., *Deployment of passenger car technology in Europe and the United States* (ICCT: Washington DC, 2016), http://www.theicct.org/EU-and-US-PV-technology-deployment

25 U.S. Environmental Protection Agency (EPA) "Light-Duty Technology Cost Analysis Pilot Study – Peer Review Report" (2009), https://www3.epa.gov/otaq/climate/fev-peerreview-rpt.pdf

26 FEV, "2025 Passenger Car and Light Commercial Vehicle Powertrain Technology Analysis" (2015), retrieved from http://www.theicct.org/2025-passenger-car-and-light-commercial-vehicle-powertrain-technology-analysis

27 Dan Meszler et al., *CO_2 reduction technologies for the European car and van fleet, a 2025-2030 assessment* (ICCT: Washington DC, 2016), http://www.theicct.org/co2-reduction-technologies- european-car-and-van- eet-2025-2030-assessment

for combustion engine vehicles. Most of the calculations in the EC regulatory impact assessment rely on the "typical" cost curves. For the ICCT cost curves, two scenarios are shown, labeled as "low" and "high," which are explained in more detail below.

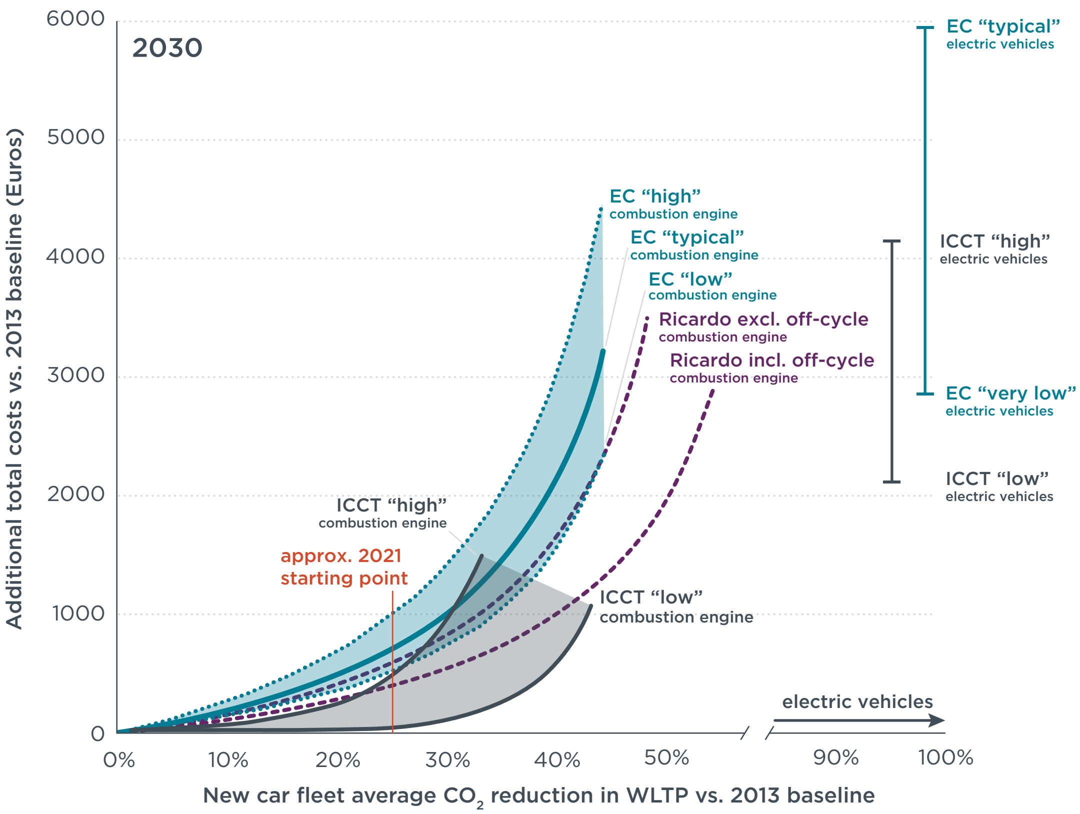

Figure 5. Additional costs (including direct and indirect manufacturing costs, excluding value added tax) of reducing the WLTP CO_2 emission level of the average new car in 2030 relative to a 2013 baseline.[28]

The shape of the cost curve sets is, in principle, similar: Initially conventional combustion engine vehicles are equipped with CO_2 reduction technologies with associated costs increasing exponentially. When the CO_2 reduction potential of combustion vehicles is fully exploited (typically after all vehicles are equipped with full hybrid technology in combination with light-weighting and other measures), further CO_2 reductions can be achieved by deploying an increasing share of electrified vehicles (PHEVs, BEVs, and FCEVs[29]). The cost increase from this point onwards would follow a linear trend.

It is possible to reduce the compliance cost for intermediate CO_2 reduction targets by not fully exploiting the remaining efficiency potential of combustion vehicles and instead transitioning to electrified vehicles earlier. For some scenarios in its impact assessment, the EC assumes a 2030 market share of electric vehicles of around 20% for passenger cars, which helps to reduce overall compliance costs but is still below the 30% ZLEV

28 The coefficients for the EC cost curves as well as the maximum achievable CO_2 reduction and maximum additional cost were taken from Krause, Donati, and Thiel, *Light Duty Vehicle CO_2 Emission Reduction Cost Curves and Cost Assessment,* and exclude off-cycle technologies. The coefficients for the original Ricardo cost curves prepared as input for EC were taken from Hill et al. "Improving understanding of technology and costs for CO_2 reductions from cars and LCVs in the period to 2030 and development of cost curves," and are available in two versions, including and excluding off-cycle technologies. The ICCT "high" cost curve excludes off-cycle technologies while the "low" cost curve includes off-cycle technologies. For aggregation to a comparable average cost curve for the entire new vehicle fleet, the same (constant) market shares per segment were assumed for the EC, Ricardo and ICCT cost curves.

29 For the ICCT cost curves, and also for replicating the EC cost curves, it was assumed that lower medium and smaller vehicles will be BEVs and vehicles larger than lower medium will be PHEVs.

benchmark for the same year. For its standard scenario though, the EC assumes a market share of electric vehicles of about 9% by 2030.

The original Ricardo cost curves for the EC are markedly lower than the final set of "typical" curves applied in the regulatory impact assessment. The difference is particularly noticeable for the Ricardo cost curve that takes into account off-cycle technologies, i.e., technologies whose impact on CO_2 emissions is not adequately measured by the test procedure. The uptake of off-cycle technologies is incentivized by credits for eco-innovation technologies. While their impact has been negligible in the past, the proposed 2025 and 2030 standards extend the scope of eco-innovations to air-conditioning systems and would allow revising the 7 g/km cap on their total contribution toward manufacturer CO_2 targets. Even though eco-innovations are identified and applied by the EC as a mechanism designed to support the cost-effective implementation of the regulation, they are not taken into account for the cost curves of the regulatory impact assessment, thereby unnecessarily increasing the estimated compliance cost of the regulation.

As another mechanism to lower the compliance cost of the regulation, the EC assesses switching to a regulatory target system based on vehicle footprint or a uniform target for all manufacturers (i.e. not normalizing for mass nor footprint). Nevertheless, for its actual policy proposal, the EC decided to stick to the current mass-based system, thereby undervaluing the benefits of mass reduction and increasing compliance cost.[30]

With respect to the assumptions regarding future battery cost developments, the ICCT cost curves consider a range of 100 ("low" scenario) to 160 ("high" scenario) euros per kWh (€/kWh) for 2030.[31] The EC applies a value of 146 €/kWh for its "low" and "typical" scenarios.[32] For the "very low" scenario, the EC considers battery costs as low as 65 €/kWh for 2030.[33] However, in its regulatory impact assessment, the EC assumes that these "very low" battery costs will only materialize if additional policy instruments are introduced that help to increase the market share of EVs to at least 10% in 2025 and 15% in 2030.

Overall, while the original set of Ricardo cost curves including off-cycle technologies lies well within the ICCT cost curve range, the final set of "typical" curves for combustion engine vehicle technologies used by the EC generally exceed the ICCT cost estimates. For electric vehicles, the EC "very low" estimates applied for some more advanced scenarios in the impact assessment are well within the range identified by ICCT, while the EC "typical" cost estimates for electric vehicles as a whole are significantly above the ICCT estimates, even though battery price estimates by themselves are closer together for both sources.

Based on the underlying cost curves, the EC estimates that the incremental manufacturing cost for achieving a 30% CO_2 reduction between 2021 and 2030 would be about 1,000 euros per passenger car. In comparison, the discounted fuel savings over the lifetime of the vehicle would be about 1,800 euros. Furthermore, the EC estimates the avoided CO_2 cost to be about 450 euros per vehicle, assuming a value of 70 euros per tonne CO_2 for external costs of climate change. As a result, a 30% CO_2 reduction by 2030 would come at negative CO_2 abatement costs, since fuel savings offset the additional manufacturing costs. Furthermore, there would be an overall

30 European Commission, "Impact Assessment Accompanying the Document Proposal for a Regulation of the European Parliament and of the Council Setting Emission Performance Standards for New Passenger Cars and for New Light Commercial Vehicles as Part of the Union's Integrated Approach to Reduce CO_2 Emissions from Lightduty Vehicles and Amending Regulation (EC) No 715/2007 — Part 1/2" (2017), https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/swd_2017_650_p1_en.pdf, p. 114.

31 Paul Wolfram and Nic Lutsey, *Electric Vehicles: Literature review of technology costs and carbon emissions* (ICCT: Washington DC, 2015), http://www.theicct.org/lit-review-ev-tech-costs-co2-emissions-2016

32 See Hill et al. "Improving understanding of technology and costs for CO_2 reductions from cars and LCVs in the period to 2030 and development of cost curves," p. 215

33 See European Commission, "Impact Assessment," p. 117.

net benefit from a societal perspective of about 1,300 euros per vehicle (Table 1). This societal net benefit, using the EC cost curves, would be highest for a 30% CO_2 reduction by 2030, while also a 40% or 50% scenario would still deliver a net benefit for society. In contrast, ICCT's cost curves indicate much higher CO_2 reductions are achievable at reasonable additional manufacturing costs. With ICCT cost curves, both consumer benefits (fuel savings minus technology costs) and net benefits for society (consumer benefits plus the value of avoided CO_2) would be highest with a CO_2 reduction of 70% by 2030. For vans, the EC figures show the highest consumer benefit (from a societal perspective) for the 40% CO_2 reduction scenario, which conflicts with the proposal's target of only a 30% reduction for 2030.

Table 1. Net benefits per vehicle of tightened 2030 targets from a societal perspective (excluding taxes, applying a 4% per year discount rate).

Decrease of CO_2 target level (2021-2030)	EC Additional manufacturing costs in 2030 (EUR/car)	ICCT Additional manufacturing costs in 2030 (EUR/car)	Net operation & maintenance savings in 2030 (EUR/car)	Avoided CO_2 cost in 2030 (EUR/car)	EC Net benefits in 2030 (EUR/car)	ICCT Net benefits in 2030 (EUR/car)
20%	419	264	1,221	303	1,105	1,260
30%	1,020	691	1,898	451	1,329	1,658
40%	1,812	927	2,377	593	1,158	2,043
50%	2,752	1,163	2,750	728	726	2,315
70%*		1,636	4,000	1,000		3,364

EC additional manufacturing costs, net operation and maintenance savings and avoided CO2 cost are taken directly from the EC impact assessment
ICCT additional manufacturing costs are an average between the "low" and "high" cost curve scenarios
*For 70% reduction scenario, net operation and maintenance savings and avoided CO2 cost are based on a linear extrapolation of EC calculations

INCENTIVES FOR ZERO-EMISSION AND LOW-EMISSION VEHICLES

Key global electric vehicle markets, foremost China and California, have introduced sales quotas for electric vehicles. The EC proposal recognizes the strategic importance of electric power trains for car manufacturers, and calls for EU automakers to become global leaders in new technologies. To this end, the proposal includes sales targets and incentives for ZLEVs for both passenger cars and vans. ZLEVs are defined as vehicles with CO_2 emission values below 50 g/km.

The proposed CO_2 standard sets a 15% sales target for 2025–2029 and a 30% target for 2030. These targets are broadly in line with manufacturer announcements on EV sales. Major European manufacturer groups—including BMW, Daimler, Renault-Nissan, and Volkswagen—have electric vehicle sales targets exceeding the proposed 2025 ZLEV target of 15%.[34] Under the proposal, ZLEVs are counted proportional to their zero-emission capability: zero-emission vehicles count as full vehicles; vehicles with CO_2 emission values with 50 g/km count as zero; and vehicles between 0 and 50 g/km are assigned partial values according to a linear function based on CO_2 emissions (see $ZLEV_{specific}$, left panel of Figure 6).

To incentivize the transition to ZLEVs, manufacturers that outperform the sales targets will be rewarded with higher CO_2 emission targets using the so-called *ZLEV factor*. The ZLEV factor can range from 1, for manufacturers that fail to meet the ZLEV target, to 1.05, for manufacturers that exceed the ZLEV target by 5 percentage points or more. The ZLEV factor scales proportionally to the exceedance of the ZLEV target between these two limits (see right panel of Figure 6). A ZLEV factor of 1.05 implies that the emission target is increased by 5%, whereas a ZLEV factor of 1 implies that the emission target remains unchanged.

34 European Commission, "Impact Assessment." Part 1/2, p. 44

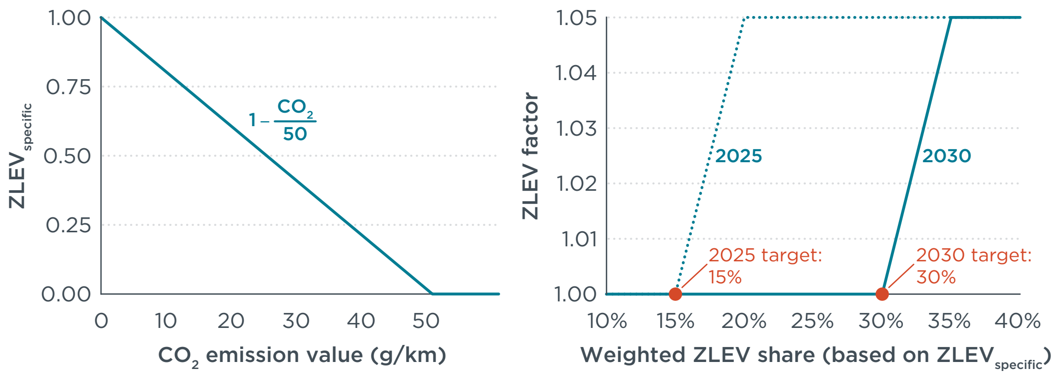

Figure 6. Left: Weight ($ZLEV_{specific}$) used to count each vehicle in calculation of ZLEV shares. Right: ZLEV factor used to adjust manufacturer CO_2 emission targets.

The effect of the ZLEV factor on CO_2 targets is illustrated in Figure 7. The plot shows the maximum allowable CO_2 emission level of conventional passenger cars as a function of the share and average CO_2 emission level of ZLEVs. Assuming that all ZLEVs are zero-emission vehicles, their share has to exceed 15% in 2025 and 30% in 2030 in order to trigger a ZLEV factor higher than one. At 20% and 35%, respectively, the ZLEV factor tops out at 1.05. Between these thresholds, the ZLEV factor grows, increasing the allowable CO_2 emission level of conventional passenger cars at a heightened rate. At a 0% ZLEV share, a manufacturer would have to meet a target of 81 g/km in 2025 and 67 g/km in 2030 over the NEDC. At a 20% ZLEV share in 2025, a manufacturer's conventional vehicles would be allowed to emit 106 g/km on average, as opposed to a 101 g/km limit in the absence of the ZLEV factor. If, unlike in the foregoing example, not all ZLEVs are zero-emission vehicles, more low-emission vehicles are needed to make use of the ZLEV factor due to the weighting function.

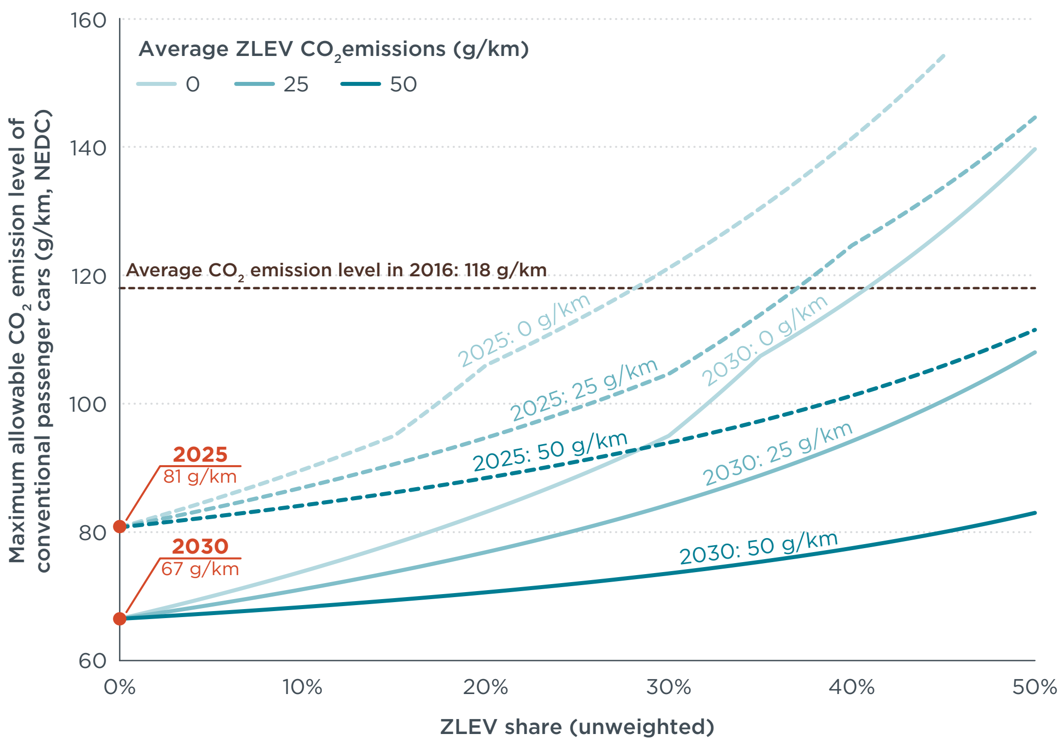

Figure 7. Maximum allowable CO_2 emission level of conventional passenger cars to meet the 2025 and 2030 CO_2 targets as a function of ZLEV share (not weighted by $ZLEV_{specific}$) and average ZLEV CO_2 emission levels.

Past CO_2 standards included so-called super credits for ZLEVs. Super credits inflate the impact of ZLEVs in the calculation of car manufacturers' average CO_2 values. Both the 2015 and the 2020/21 passenger car standards included super credits, but their level was gradually reduced over time. In 2013, each low-emitting car counted as 3.5 cars; By 2022, each low-emitting car will count as 1.3 cars. Figure 8 shows the historical super credit levels and the maximum super credit equivalent of the ZLEV factor in 2025–2030. Super credit equivalents were determined by calculating the super credit level that would yield the same effect as the ZLEV factor on fleet-average CO_2 emission values. The calculation assumed that only zero-emission vehicles will be used to reach a ZLEV factor of 1.05, which returns the maximum super credit level. Depending on the fleet composition in 2025–2030, super credit equivalents could be lower. Figure 8 shows that the proposed 2025–2030 CO_2 standards would continue the trend of phasing out special treatment of ZLEVs, with super credit equivalents dropping off to 1.1 in 2030. The maximum impact of ZLEV incentives is also being phased out with the ZLEV factor: While the total impact of super credits was capped at 7.5 g/km per manufacturer in the 2020–2021 targets, the ZLEV factor is de facto limited to approximately 4 g/km in 2025–2030.

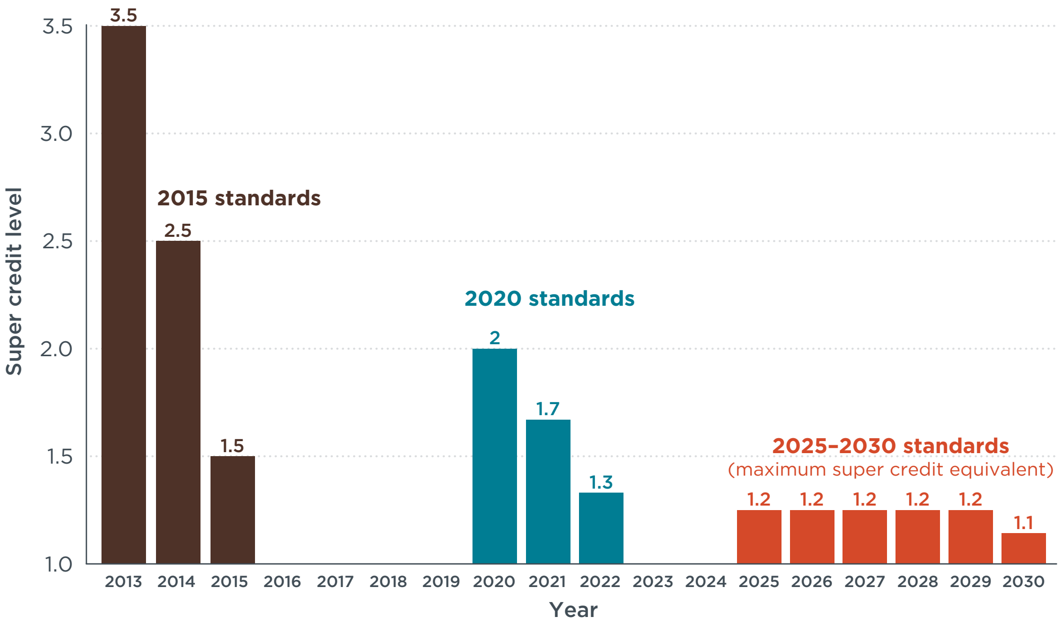

Figure 8. Historical super credit levels in EU passenger car CO_2 standards.

The proposed regulation improves how ZLEVs are incentivized compared to existing CO_2 standards. For one thing, weighting ZLEVs by their CO_2 emission value in the ZLEV factor calculation incentivizes increased electric range capacity and efficiency improvements in ZLEVs. In contrast, the 2015 and 2020 standards awarded super credits to all ZLEVs, which incentivized a significant uptake of PHEVs with limited electric range. Approximately one-third of ZLEVs registered in 2016 had CO_2 emission values between 40 g/km and 50 g/km, including larger and relatively shorter-range PHEVs like the Mitsubishi Outlander PHEV and Volvo XC90 T8. Shifting to a linear weighting function removes the incentive to design vehicles that fall just below the 50 g/km threshold. Lastly, by using the ZLEV factor and limiting it to 1.05, the proposed regulation continues the trend of phasing down special treatment of ZLEVs in EU CO_2 standards (see Figure 8), which otherwise could dilute CO_2 standards as the share of ZLEVs increases over time.

Despite this progress, the proposed ZLEV incentives could be further improved. Because the ZLEV factor is limited to the range 1–1.05, manufacturers that fail to meet ZLEV targets are not penalized, in contrast to the ZLEV mandates in California and China. Changing the range to 0.95–1.05, described in the impact assessment as a "two-way adjustment," would increase pressure on car manufacturers to market low-emission vehicles.

In such a two-way scenario, car makers that failed to meet the ZLEV target would be penalized with a lower emission target (see Figure 9). In 2025, manufacturers with a 15% ZLEV share (adjusted by $ZLEV_{specific}$) would see unchanged emission targets. Manufacturers with a ZLEV share of 10% or less would have to meet a lower emissions target, at fleet average 77 g/km instead of 81 g/km (in NEDC). In 2030, a two-way ZLEV factor would reduce the fleet average emission target from 67 g/km to 63 g/km for manufacturers with a ZLEV share of 25% or less. In short, introducing a two-way ZLEV factor, ranging from 0.95 to 1.05, would provide stronger incentives for car manufacturers to shift to low-emission vehicles and would align the proposal with regulations in leading EV markets, a conclusion that is echoed in the impact assessment but not reflected in the EC proposal.

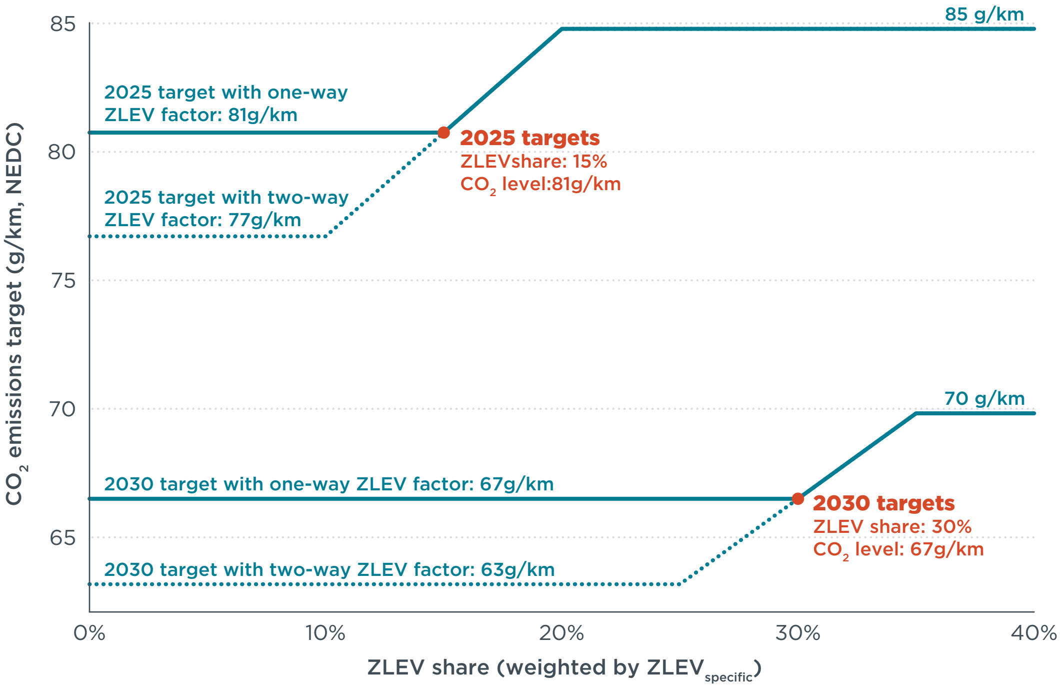

Figure 9. Effect of changing ZLEV factor range from 1–1.05 (one-way factor) to 0.95–1.05 (two-way factor) on CO_2 emission passenger car targets in 2025 and 2030.

TYPE-APPROVAL VS. REAL-WORLD EMISSION LEVELS

Beginning in September 2017, the WLTP is being introduced as the new vehicle emissions' testing procedure in the EU. On average, type-approval CO_2 emission values are expected to be about 20% higher under WLTP than under NEDC. This is due to the use of a more dynamic speed profile, a more realistic vehicle test mass, lower ambient temperature, and other test conditions that reflect more closely typical real-world driving conditions.[35]

35 Stefanos Tsiakmakis et al., "A simulation-based methodology for quantifying European car fleet CO_2 emissions," *Applied Energy* 199 (2017): 447-465. http://dx.doi.org/10.1016/j.apenergy.2017.04.045.

Following the introduction of the WLTP, consumers are expected to experience fuel consumption values closer to the type-approval values. However, the regulation requires that the stringency of the CO_2 targets before and after the introduction of the WLTP be comparable. That is to say, a vehicle manufacturer cannot be made worse off by the introduction of WLTP, so the 2020 (for vans) and 2021 (for cars) CO_2 target values will be adjusted to compensate for the effect of the WLTP.

Even though the procedure for the WLTP adjustment is technically sound, it entails a political compromise, partly allowing vehicle manufacturers to take credit for exploiting tolerances and flexibilities in the test procedure in the past. In consequence, we estimate the average NEDC-WLTP adjustment factor to be around 15%.[36] This is lower than the estimated 20% overall effect of the introduction of WLTP but higher than the 10% effect estimated earlier by ICCT taking into account only technical differences between NEDC and WLTP and not adjusting for the closing of regulatory loopholes and flexibilities.[37]

With respect to the post-2020 CO_2 standards for cars and vans, the transition to WLTP introduces an element of uncertainty regarding the de facto outcome achieved by the regulation. While the percentage reduction targets in the EC proposal are fixed, the absolute CO_2 emission level to be met by a manufacturer in 2025/30 depends on the fleet average WLTP starting point of all manufacturers in 2021. This starting point, in turn, depends on the NEDC-WLTP adjustment factor, which is not fixed yet but will be determined for the 2020 new vehicle fleet.

It is conceivable that, until 2020, vehicle manufacturers will aim at deploying technologies that deliver higher CO_2 reductions in NEDC terms than in WLTP terms (such as engine turbocharging and downsizing, optimized gearbox design) in order to maximize their respective NEDC-WLTP adjustment factor and thereby secure as high a WLTP CO_2 starting point for 2021 as possible. At the same time, however, manufacturers' potential ability to exploit this option is limited by the fact that EU member states will increasingly base their vehicle taxation schemes on WLTP CO_2 emissions, and by the fact that WLTP CO_2 figures will become increasingly relevant for marketing material directed at consumers. Nevertheless, the average NEDC-WLTP adjustment factor by 2020, we estimate, will likely end up closer to 20%. Figure 10 illustrates the effect of such a scenario. A 30% CO_2 reduction between 2021 and 2030, as proposed by the EC, would result in an absolute target of 67 g/km in NEDC terms, which would be 77 g/km in WLTP terms assuming an adjustment factor of 1.15 but 80 g/km assuming a factor of 1.20. This would move the proposed EC target values further away from the CO_2 range originally envisioned by the European Parliament.

36 ICCT estimate based on Tsiakmakis, S. et al.

37 Peter Mock et al., *The WLTP: How a new test procedure for cars will affect fuel consumption values in the EU*, (ICCT: Washington DC, 2014), http://www.theicct.org/wltp-how-new-test-procedure-cars-will-affect-fuel-consumption-values-eu

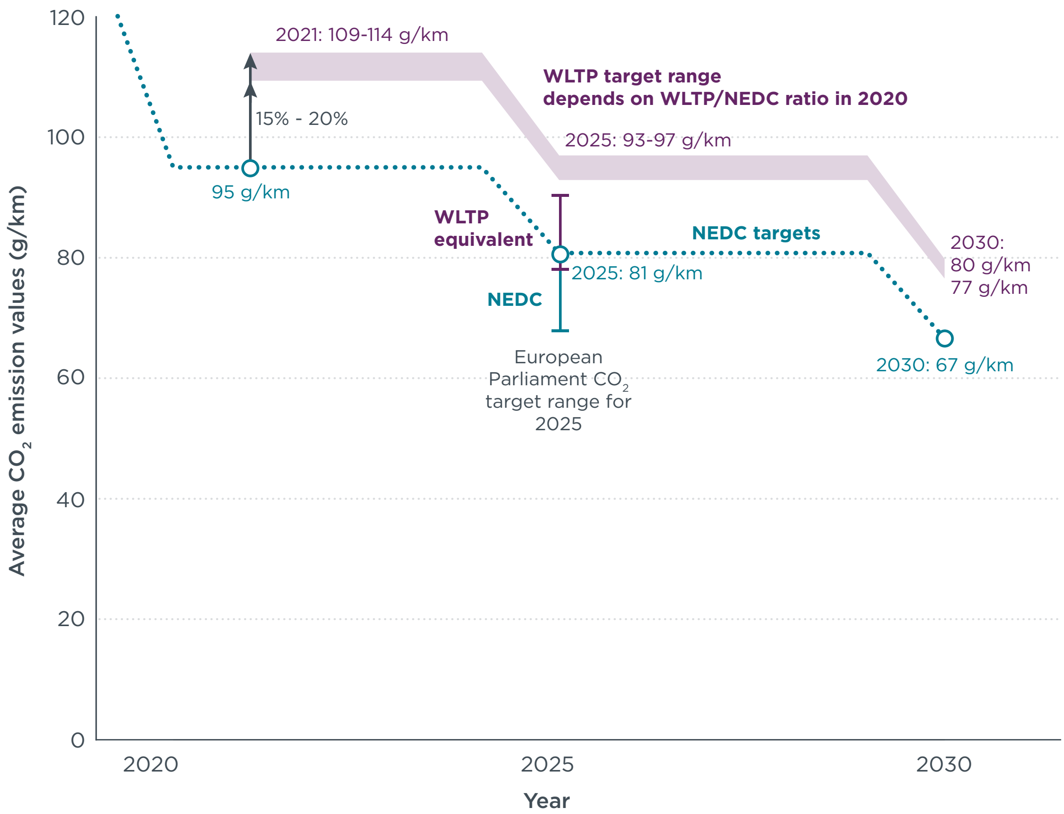

Figure 10. Schematic illustration of the expected effect of the transition from NEDC to WLTP on post-2020 CO_2 targets for passenger cars.

Another element of uncertainty is introduced by the fact that the fleet 2025/30 CO_2 targets will depend on the average mass of the new vehicle fleet in 2020/21. In principle, there is an incentive to increase average vehicle mass to secure a higher CO_2 target. If, for example, the fleet in 2020/21 is on average 35 kg (about 2.5%) heavier than the average fleet reference mass (which the EC proposal defines as 1,380 kg), then the fleet WLTP target for 2025/30 will be approximately 1.2% higher than it would otherwise be.

The 2015 cars' CO_2 standard aimed at preventing manufacturers from increasing the mass of their vehicles by discounting the CO_2 credit provided for each kilo added. Taking a least-squares fit through the CO_2 vs. mass data for 2006, the resulting slope was flattened by 40% to result in a regression coefficient of 0.0457 g/km allowed for every additional kilo above the average fleet reference mass. For the 2020 standard, it was decided that—now taking a least-squares fit through 2009 sales data—the slope (0.0333 g/km per kg) was flat enough to discourage mass increase, without any adjustment necessary. The EC proposal for 2025/30 uses a least-squares fit through 2021 sales data, to determine the slope applied for calculating 2025 and 2030 CO_2 target values.

As Figure 11 illustrates, this approach is problematic because the relationship between CO_2 and mass flattens over time. That is, a vehicle today does not emit as much CO_2 during type-approval as one of the same mass did in previous years. Without accounting for this technical progress by regularly adjusting the slope in the vehicle CO_2 regulation, it is to be expected that by 2021 the regression coefficient of the new car fleet will be lower than the slope used for the regulation. As a result, manufacturers would have an incentive to increase the mass of their vehicles to comply with the regulatory requirements and to gain a competitive advantage. Already today we expect the actual slope to be below the coefficients defined in the regulation. Therefore this incentive will at least persist until 2021, as the reference average fleet mass is already fixed until that year and the slope even until 2024.

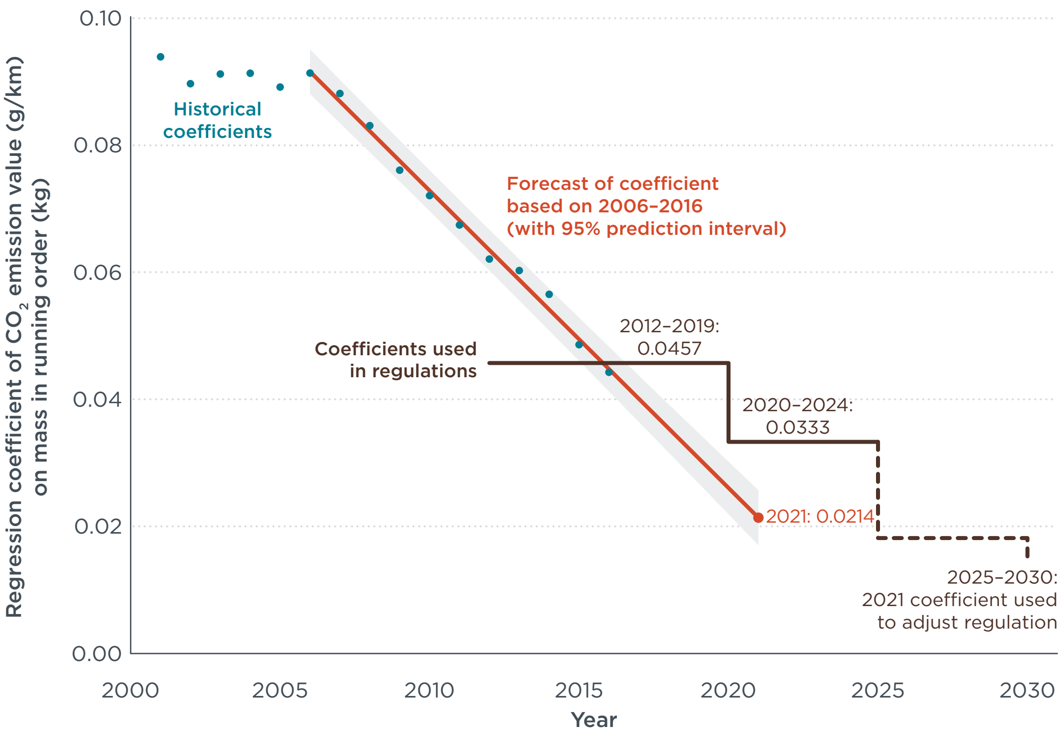

Figure 11. Historical and projected development of the regression coefficient of CO_2 emission vs. vehicle mass in running order and therefrom derived utility factor.

The introduction of the WLTP by itself will not be enough to ensure that in the future real-world CO_2 emission levels of new vehicles will decline to the same extent as official type-approval figures. Like any other test procedure, the WLTP is susceptible to gaming, and we are likely to face an increasing gap between WLTP and real world CO_2 emission levels unless further action is taken. In its proposal, the EC sees in-service conformity testing as a means of ensuring that the gap does not widen again in future years. As part of in-service conformity testing—which already exists for air pollutant emissions but not for CO_2—type-approval authorities would be required to re-test vehicles in use to verify that the emissions measured are in line with the original test results obtained for the vehicle type during type approval. The details of the in-service conformity testing for CO_2 remain to be defined. Testing vehicle CO_2 emissions on the road, rather than in a laboratory environment—as the Real Driving Emissions (RDE) regulation began to require for air-pollutant emissions in 2017—is still not foreseen in the EC proposal. Meanwhile, the EC proposal is linked to a separate policy that would require manufacturers to deploy fuel consumption meters on their vehicles, which would help to obtain a more accurate and more complete picture of real-world fuel consumption and CO_2 emissions of vehicles on the road.

SUMMARY

The EC's proposed 2025 and 2030 standards for cars and vans aim to contribute cost-effectively to the EU's commitments under the Paris Agreement, reduce fuel consumption costs for consumers, and strengthen the competitiveness of the EU automotive industry. The annual CO_2 reduction rates in the EC proposal are less ambitious in absolute and relative terms than the current 2020/21 regulations and fall short of the rate of reduction recommended by the European Parliament in 2013. According to the EC's impact assessment, meeting its long-term climate goal (a 60% reduction in total transport emissions from 1990 levels) would require that "by 2050, electrically chargeable vehicles [. . .] represent about 68–72% of all light duty vehicles on the roads." Yet EC modeling estimates electrically chargeable vehicles would account for less than 20% of new car sales by 2030 under the LDV proposal.

ICCT modeling indicates that the EC proposal, together with potential HDV standards with moderate ambition, would reduce CO_2 emissions from road transport by approximately 1.4% per year from 2020 to 2035. To meet the 2050 climate goal, road transport CO_2 emissions would then have to be reduced more than three times as quickly (5.5% per year) from 2035 to 2050. More ambitious LDV and HDV CO_2 standards for 2021–2030 would reduce road transport CO_2 emissions by 3.0% per year from 2020 to 2035 and substantially increase the likelihood of meeting the 2050 climate goal.

The EC's technology cost curves for passenger cars indicate a 30% CO_2 reduction by 2030 would maximize consumer benefits (fuel savings minus technology costs), whereas up to a 40% reduction by 2030 is cost-effective (fuel savings exceed technology costs). Yet the EC's final cost curves discount the benefit of mass reduction and do not consider the cost reductions achievable by eco-innovation technologies. ICCT's cost curves indicate much higher CO_2 reductions are achievable at reasonable additional manufacturing costs. With ICCT cost curves, both consumer benefits and net benefits for society (consumer benefits plus the value of avoided CO_2) would be highest with a CO_2 reduction of 70% for cars by 2030. For vans, all scenarios assessed by the EC result in a net benefit for society. The highest consumer benefits (from a societal perspective) are achieved, according to the EC figures, with a 40% reduction by 2030. Hence, the EC's analysis justifies a more ambitious target for vans than is included in the EC proposal.

The proposed sales targets for zero-emission and low-emission vehicles (ZLEVs) incentivize greater deployment of electric vehicles and also, importantly, push these future electric vehicles to achieve greater electric range over time. However, the ZLEV provisions do not take into account some recent announcements of higher future market share goals by major European manufacturer groups. Essentially the ZLEV credits are rewarding car manufacturers with less stringent CO_2 reduction requirements for deploying electric vehicles in numbers consistent with what they have already announced they plan to do. To ensure a greater and more predictable market penetration of electric vehicles that is more in line with long-term climate stabilization, the regulations could set more stringent CO_2 reduction targets, change the ZLEV targets to incorporate a two-way adjustment scenario, or change the ZLEV targets from rewards to enforceable requirements with a penalty mechanism.

The transition to WLTP introduces an element of uncertainty regarding the absolute CO_2 target levels for 2025/30. Depending on the development of the vehicle market between now and 2020, the proposed EC target values are likely to move further away from the CO_2 reduction range originally envisioned by the European Parliament. In addition, without regularly adjusting the slope for the vehicle mass vs. CO_2 relationship or shifting away entirely from a mass-based CO_2 target system, under the current EC proposal manufacturers would have an incentive to increase the mass of their vehicles to comply with the regulatory requirements. As an alternative approach, defining 2025 and 2030 CO_2 targets in absolute (g/km) terms, applying a technically sound NEDC-WLTP conversion factor, would provide more planning security and would eliminate potential for gaming.

ANNEX

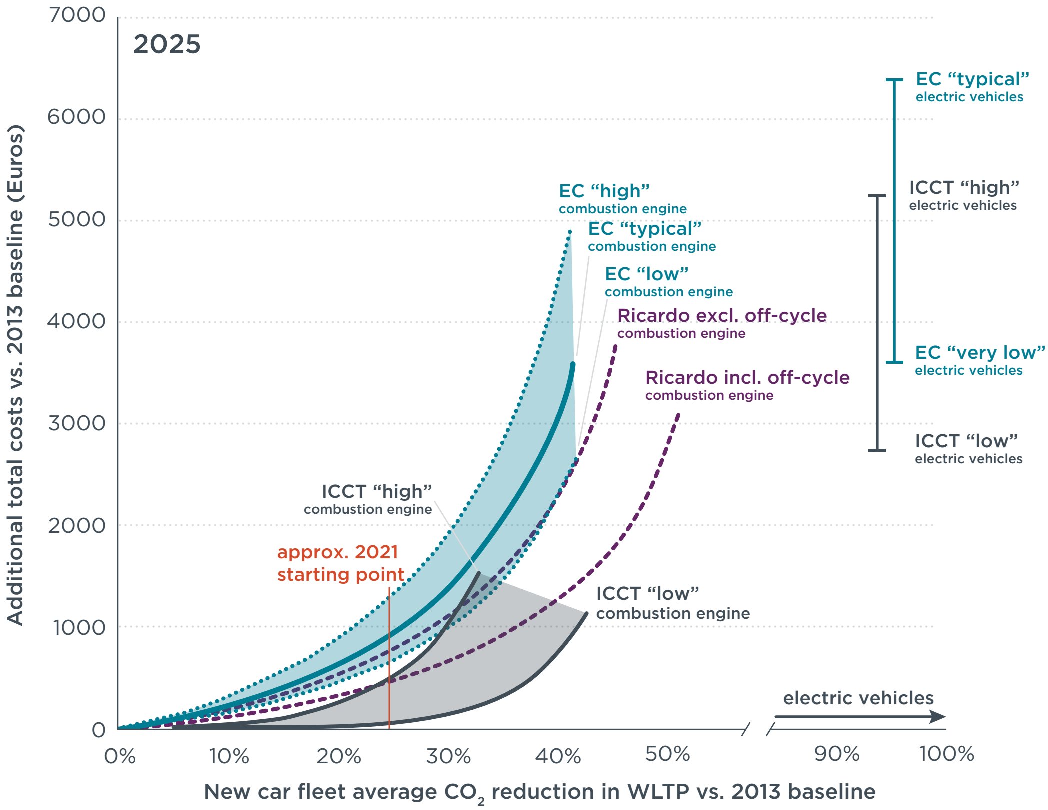

Figure 12. Additional costs (including direct and indirect manufacturing costs, excluding value added tax) of reducing the WLTP CO_2 emission level of the average new car in 2025 relative to a 2013 baseline.