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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

BRIEFING

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The role of standards in reducing CO_2 emissions of passenger cars in the EU

"We cannot allow Brussels to turn Germany into a country of compact car drivers!" Erwin Huber said angrily in February 2007.[1] The European Commission had just proposed a regulation that would force manufacturers to reduce the carbon dioxide (CO_2) emissions of new cars below a certain threshold. And Huber, at the time Bavarian Minister of State for Economics, Transport and Technology, was worried this new regulation would hurt the German car industry.

Today, more than ten years after Huber erupted about what the rule might do to German industry and German drivers, the average new car in the European Union emits considerably less than the 130 grams per kilometer limit it imposed, and car manufacturers are already well on their way to meeting the even more stringent 2021 target of 95 g/km. And Germans still drive big cars.[2]

So Huber's concerns were misplaced. But so it seems were the highest expectations of the regulation's proponents: CO_2 emissions from the transport sector in the EU have hardly decreased in recent years. Which raises the question: Are the European cars' CO_2 standards a success story? Or not?

In a word, yes. But their success has not been as great as it might have been had the European Commission's original strategy for reducing CO_2 emissions from the transportation sector been implemented more effectively. An examination of what that strategy was, and how and why its execution partially faltered, suggests some ways in which policy makers at the EU and member state level can work together to grapple with the challenge of meeting Europe's 2050 climate goals.

1 His original statement, in German, was: "[...] die Deutschen dürfen von Brüssel nicht zu einem Volk von Kleinwagenfahrern degradiert werden!". Hoeren, D., Koch, E. (2015, February 7). Klima-Katastrophe: So viel Dreck verschleudert Ihr Auto. BILD. Retrieved from http://www.bild.de/auto/2007/dreck-abgase-1370920.bild.html.

2 About 45% of new cars registered in Germany in 2016 belong to the medium segment or higher. For the EU average, about 30% of new cars are from these larger vehicle segments. All vehicle market data used in this document is based on Peter Mock (ed.), European Vehicle Market Statistics Pocketbook 2017/18 (ICCT: Berlin, 2017). http://eupocketbook.org.

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POLITICAL DECISIONS, 1998–2008

The origin of the EU vehicle CO_2 regulation is by now a well-known story. European car manufacturers promised to voluntarily reduce average CO_2 emissions of new cars to 140 g/km by 2008, starting in 1995, when average CO_2 emissions were 186 g/km. That worked out to an annual rate of reduction of 2.1%.[3] By 2005 it was clear that the manufacturers would not meet that voluntary commitment (Figure 1). In 2007 the European Commission announced the mandatory regulation that so exercised Erwin Huber, and it was formally adopted in 2009, after many rounds of technical discussions as well as some political horse trading. The CO_2 target, 130 g/km by 2015,[4] represented a lower annual rate of reduction than under the voluntary agreement: 1.7% per year. In 2013, EU policy makers set a new CO_2 target, 95 g/km by 2021.[5] That target entailed an annual CO_2 reduction rate after 2015 of 5.1%, much greater than both the manufacturers' early voluntary commitment and the first EU cars' CO_2 regulation.

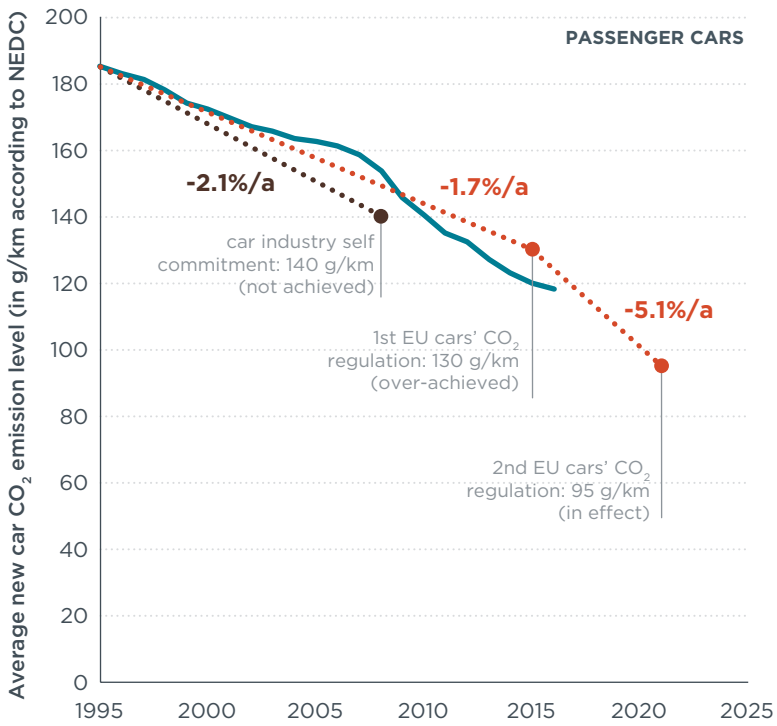

Figure 1. Average CO_2 emission level of new cars in the EU and target values set by car manufacturers (in brown) and the EU regulatory institutions (in red).

But that story is only part of the full story, because the vehicle CO_2 standard was only part of the European Commission's plan. In 1995, the Commission envisioned a strategy to reduce CO_2 emissions from cars supported by three pillars: CO_2 performance standards for new cars, improved consumer information, and reforms to the system of vehicle taxes.[6]

In 1999, EU policy makers adopted a regulation requiring that new cars display a label in the showroom giving consumers the information they needed to choose a vehicle

3 For details, see "EU: Light-duty: GHG," TransportPolicy.net, accessed 26 June 2017, http://transportpolicy.net/index.php?title=EU:_Light-duty:_GHG#1998-2008:_Voluntary_Agreements.

4 Regulation (EC) No 443/2009.

5 Regulation (EC) No 333/2014; for a summary see Mock, P. (2014). *EU CO_2 standards for passenger cars and light-commercial vehicles*. Retrieved from the International Council on Clean Transportation, http://theicct.org/eu-co2-standards-passenger-cars-and-lcvs.

6 EC (1995). Communication from the Commission to the Council and the European Parliament. A Community strategy to reduce CO_2 emissions from passenger cars and improve fuel economy, COM(95) 689 final.

model with low emissions.[7] But the EU member states pressured the Commission to allow them great latitude in implementing the regulation. The result was an inconsistent and ultimately ineffective system. For example, the German labeling scheme awards a Porsche Cayenne (2,400 kg of weight, 193 kW of engine power, 179 g/km of CO_2) a green "B" rating[8]—the same "B" rating received by a smart fortwo (900 kg, 52 kW, 93 g/km). In practice, the information provided consumers was useless, and the second pillar of the European Commission's strategy collapsed.[9]

On taxes, the idea was simply that vehicles with low CO_2 emission levels would pay less, and vehicles with higher levels would pay more. Tax rates would thus amplify the effect of vehicle CO_2 labeling and provide an additional incentive for consumers to purchase those low-emission vehicles that manufacturers offered as a result of the vehicle CO_2 performance standards. But tax policy in the EU remains strictly the purview of member states, and they have blocked efforts to harmonize or modify the current system for taxing vehicle purchases, ownership, or use. Some EU member states, such as the Netherlands, have introduced vehicle taxation schemes that incentivize low-emission cars. In the Netherlands, the owner of a Porsche Panamera (3.0L engine displacement, 173 g/km of CO_2) pays about 15,000 Euros registration tax plus an annual ownership tax that varies depending on the province. The owner of a smart fortwo (1.0L, 93 g/km) pays a registration tax of about 1,500 Euros—about one-tenth of the Panamera's tax burden. In Germany, the annual ownership tax for the Panamera is about 200 Euros (there is no registration tax in Germany); for the fortwo it is about 20 Euros. Again the tax burden of the fortwo is one-tenth the Panamera's, but more important, both are too low to exert any significant influence on consumer behavior.

In short, the European Commission originally envisioned a package of policy measures to drive down CO_2 emissions of new cars. But the only policy measure actually implemented was the CO_2 performance standards. EU member states significantly weakened the second element, vehicle CO_2 labeling, and completely blocked any EU-wide measure on the third, vehicle CO_2 taxation. The EU's policy framework for reducing vehicle CO_2 emissions was left vulnerable to developments to come in the following years.

MARKET DEVELOPMENTS, 2009–2016

A comparison of the vehicle markets in Germany and the Netherlands illustrates the importance of vehicle CO_2 taxation measures. The structure of the vehicle fleets in both countries was very similar until about ten years ago. But in recent years they have diverged as the German and Dutch governments have taken different policy pathways.

In 2006 the Netherlands started paying low-CO_2 vehicles a registration tax bonus while charging high-CO_2 vehicles a registration tax penalty (malus). The owners of hybrid-electric cars could save up to 6,000 euros on the registration tax. Since then the Dutch government has refined its vehicle tax system and adjusted the thresholds. In 2009, owners of diesel cars emitting less than 95 g/km and gasoline cars below 110 g/km paid zero registration tax; by 2017, only zero-emission vehicles remained exempt from registration tax.

Germany, which levies no vehicle registration tax, began to base its annual vehicle ownership tax partly on CO_2 emissions in 2009 (the other basis being engine displacement). Under the German system, today vehicles with type-approval CO_2 emissions

7 Regulation (EC) No 94/1999.

8 All tax calculations in this document are based on the ACEA Tax Guides 2006-2017. Retrieved from European Automobile Manufacturers Association (ACEA)

9 Christiane Malina, "The Environmental Impact of Vehicle Circulation Tax Reform in Germany," CAWM Discussion Paper No. 86, University of Münster Centrum für angewandte Wirtschaftsforschung (CAWM), retrieved from https://www.wiwi.uni-muenster.de/cawm/sites/cawm/files/cawm/download/Diskussionspapiere/cawm_dp86.pdf

at or below 95 g/km are exempt from that portion of the annual tax. Above that threshold, petrol vehicles are taxed 2 euros per g/km of CO_2 and diesel cars are taxed 9.50 euros per g/km CO_2. For comparison, in the Netherlands every g/km of CO_2 above a threshold of 1 g/km is taxed at a rate that can rise to 475 Euros per g/km for high-emitting vehicles.

The different approaches to vehicle tax policy have had perceptible effects. In 2001, 4% of new passenger cars sold in the EU were sport utility vehicles (SUVs). Today, one-quarter of customers opt for a vehicle from the SUV segment (Figure 2). The average SUV in Europe is about the same size as a lower-medium segment (C-segment) vehicle, such as a Golf, but is 14% heavier and emits 20% more CO_2, thereby driving up the new-vehicle fleet CO_2 average. Customers in the Netherlands are no exception when it comes to following vehicle manufacturers' marketing campaigns and nowadays are more inclined to choose a SUV than they were 15 years ago. And yet, SUVs in 2016 accounted for "only" 19% of the Dutch market, significantly below the total for the EU as a whole, due to the high tax penalties customers incur by purchasing a high-CO_2 emitting SUV.

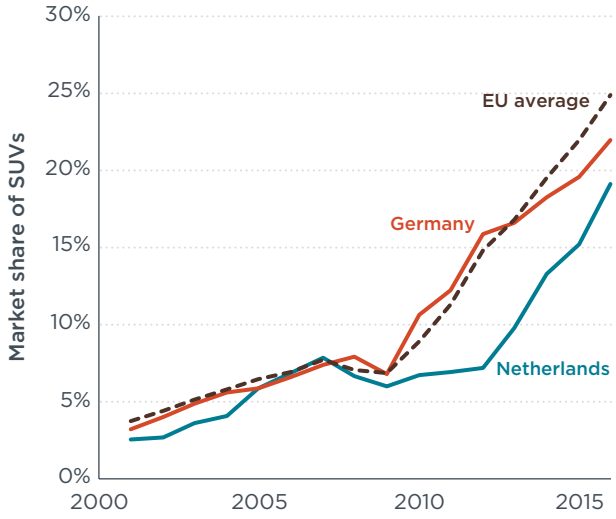

Figure 2. Share of Sport Utility Vehicles (SUV) as a percentage of all new passenger car sales in Germany, the Netherlands and the entire EU.

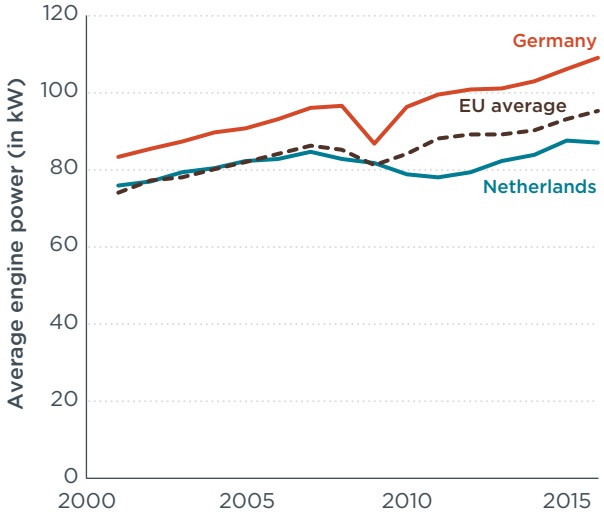

Figure 3. Average engine power of new passenger cars in Germany, the Netherlands and the entire EU.

Fleet CO_2 emission levels in the EU have risen in part through a rebound effect: new vehicles become more efficient, but part of the efficiency gain goes to making vehicles bigger, heavier, and more powerful. Customers throughout Europe have opted for higher vehicle performance in recent years. Average new-car engine power increased from 74 kilowatts (kW) in 2001 to 95 kW in 2016, an increase of 28% (Figure 3). The Netherlands, where the relatively high carbon emissions of bigger, more powerful engines are more heavily taxed, was more successful than other markets mitigating this rebound effect. Average new-vehicle engine power in the Netherlands increased only half as much between 2001 and 2016 as it did in Germany, rising 15% vs. 31%.

Tax incentives as well as penalties have shaped these vehicle markets. In early 2016, the German government announced that buyers of plug-in hybrid (PHEV) or battery electric (BEV) vehicles would receive up to 4,000 euros in rebates. Since then sales of electrified vehicles, including hybrid-electric vehicles (HEV), in Germany have accelerated, though they remain below the EU average market share (1.7% vs. 2.9%).[10] The Dutch government, in contrast, began offering consumer incentives for electrified vehicles ten years earlier, and

10 Tietge, U. (2016). *Diesels dip, electric vehicles rise in Germany*. Retrieved from the International Council on Clean Transportation, http://www.theicct.org/blogs/staff/diesels-dip-electric-vehicles-rise-in-germany

today the market share for electrified vehicles in the Netherlands is the second-highest share in Europe (8.8%) (Figure 4). Only in Norway do electrified vehicles sell better (40%).

The importance of vehicle CO_2 taxation measures is most clearly visible when comparing the change in new-car CO_2 emission levels over time (Figure 5). In 2001, the typical European vehicle emitted 167 g/km of CO_2. The average vehicles in Germany and the Netherlands emitted even more than that: 179 g/km and 172 g/km. Beginning in that year, CO_2 emissions in Germany decreased at about the EU average rate, to a level of 125 g/km in 2016 (-30%). In the Netherlands, in contrast, the rate of reduction was much greater, and CO_2 emissions fell to 108 g/km (-37%). Between 2009 and 2013 the Netherlands car fleet was transformed from one of the worst in the EU in terms of CO_2 emissions to one of the best. Where Germany largely relied on CO_2 performance standards alone to drive down emissions, the Netherlands made use of tax policies to complement and leverage the effect of standards—the original European Commission strategy, never implemented in practice.

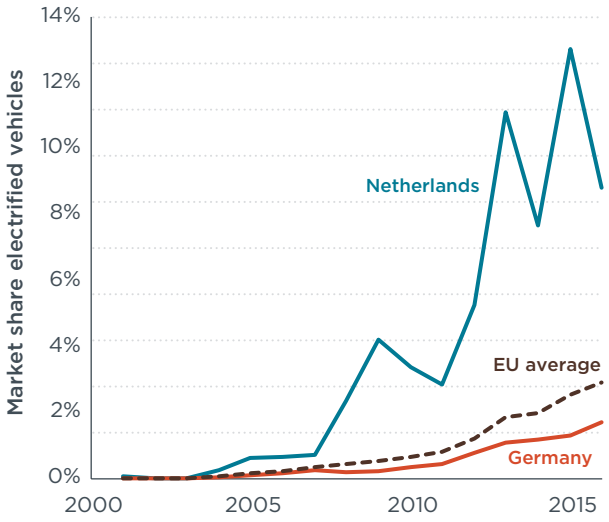

Figure 4. Share of electrified vehicles (HEV, PHEV, BEV) as a percentage of all new passenger car sales in Germany, the Netherlands and the entire EU.

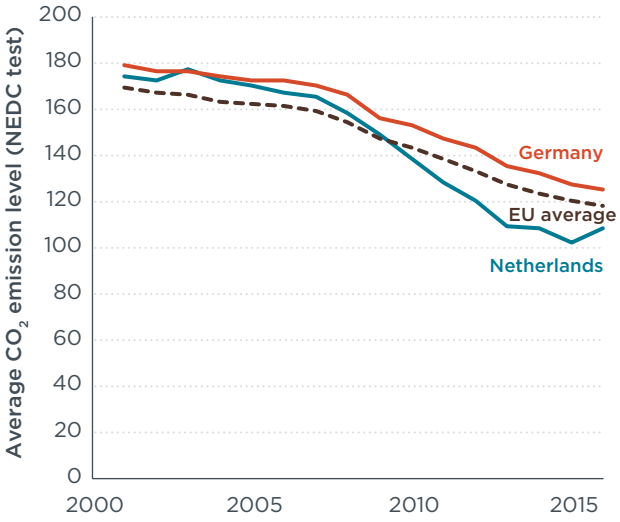

Figure 5. Average CO_2 emission level of new passenger cars in Germany, the Netherlands and the entire EU (according to New European Driving Cycle – NEDC test).

If the experience of Germany and the Netherlands tends to confirm the practical effectiveness of incorporating tax policy into the overall approach to increasing vehicle efficiency, another market development, in this case Europe-wide, spotlights a key aspect of the performance standards side of the policy strategy. In 2016, the real-world CO_2 emissions of a typical new car were more than 40% higher than advertised by the manufacturer and certified through the type-approval process.[11] In 2001 the gap was much lower, about 9%. It has widened as car makers have systematically exploited loopholes in the vehicle testing regulations. One could say that vehicle manufacturers decided to deliver only as much climate protection as they were absolutely required to deliver, not as much as was technically and economically possible, and to that end they have gamed the CO_2 performance standards' system. But policy makers have become aware of the problem,[12] and since September 2017 an improved test procedure is in place for new-car type approval.[13] Nevertheless, there is a risk that manufacturers may identify loopholes in the

11 Uwe Tietge et al. *From laboratory to road: A 2017 update* (2017) Retrieved from the International Council on Clean Transportation, http://www.theicct.org/publications/laboratory-road-2017-update.

12 SAM (2016). *Closing the gap between light-duty vehicle real-world CO_2 emissions and laboratory testing*. Scientific Advice Mechanism (SAM), High Level Group of Scientific Advisors to the European Commission, Scientific Option No. 1/2016, retrieved from https://ec.europa.eu/research/sam/pdf/sam_co2_emissions_report.pdf#view=fit&pagemode=none

13 The Worldwide Harmonized Light Vehicles Test Procedure (WLTP)

new test procedure, as well.[14] Improved enforcement must therefore be added as another key pillar in a comprehensive strategy to bring down vehicle CO_2 emissions in Europe.

AN AGENDA FOR PROGRESS, 2020-2030

In real-world driving, CO_2 emission levels of new cars have decreased by about 7% since the EU adopted performance standards in 2008–2009. This equals a reduction of about 1% per year and is much less than the 3.8% annual reduction represented in official vehicle test procedure values. At the same time, it is a greater reduction rate than was achieved before the introduction of performance standards. Between 2001 and 2008 the real-world CO_2 improvement of new cars in the EU was zero.

Compared to a baseline scenario without mandatory CO_2 standards, the current EU policy has helped to reduce the average new car real-world CO_2 level by 18% since 2001, from about 200 g/km to 165 g/km (Figure 6). Had there been effective enforcement of the standards, real-world CO_2 emission levels would have decreased at the same rate as official type-approval figures suggest, and an average new car today would emit 127 g/km of CO_2 under real-world driving conditions, rather than the 165 g/km that we observe instead (a 33% reduction, nearly double the 18% that has been achieved). If, in addition, other EU member states had used public policies to promote electrification of the new vehicles' fleet to a similar degree as the Netherlands did, the average new car today would emit as little as 117 g/km of CO_2 in real-world terms, which would be 42% less than the baseline scenario. These estimations highlight both the importance of CO_2 performance standards and the leveraging effects of supplemental policies.

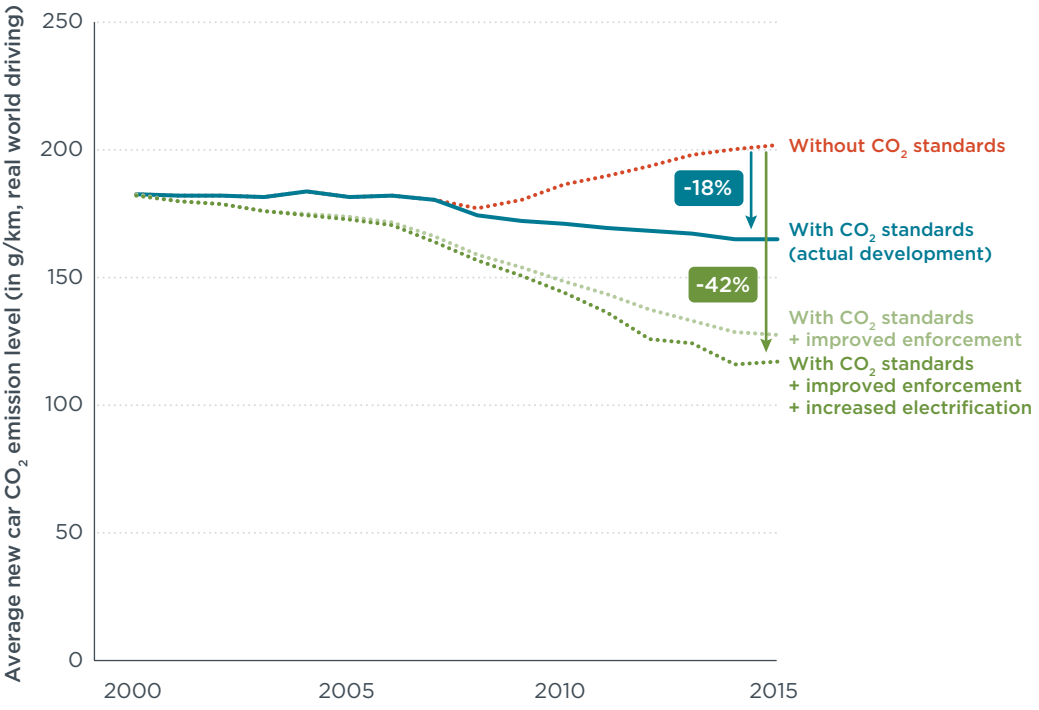

Figure 6. Average CO_2 emission level of new passenger cars in the EU under real-world driving conditions (blue). Hypothetical development if assuming no performance standards (red), performance standards in combination with improved enforcement (light green) and in combination with improved enforcement and increased electrification (dark green).[15]

14 A. Stewart, A. Hope-Morley, P. Mock, and U. Tietge, *Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans*. Report for the United Kingdom Committee on Climate Change, (2015). Retrieved from https://www.theccc.org.uk/publication/impact-of-real-world-driving-emissions/

15 The red scenario assumes a 1.3% (pre-standards) annual reduction rate. In the blue scenario the real-world gap increases to a level of 42%. The light green scenario assumes a constant real-world gap of 9% and a 3.8% (post-standards) annual reduction rate. The dark green scenario assumes a market share of electrified vehicles as in the Netherlands for all EU member states.

A similar pattern is visible when comparing emissions trends in different economic sectors. From 1990 to 2012, total greenhouse gas (GHG) emissions from the EU-28 decreased more than 1,000 million tons, with Germany and the United Kingdom accounting for nearly half of these reductions. CO_2 reductions in the United Kingdom were primarily attributable to shifting the energy mix, from oil and coal to natural gas, and in Germany to increased efficiency in power and heating plants and to reunification.[16] Only in the transport sector are GHG emissions today higher than 1990 levels. Transport GHG emissions increased steadily between 1990 and 2007 and then fell due to a combination of efficiency policies and economic downturn (Figure 7). In the absence of CO_2 performance standards for new vehicles, annual emissions from the transport sector would be about 40 million tons higher than they are. But in combination with better enforcement and supportive vehicle tax measures, the transport sector's emissions could be about 75 million tons lower, and closer to the EU's GHG reduction corridor for 2050.

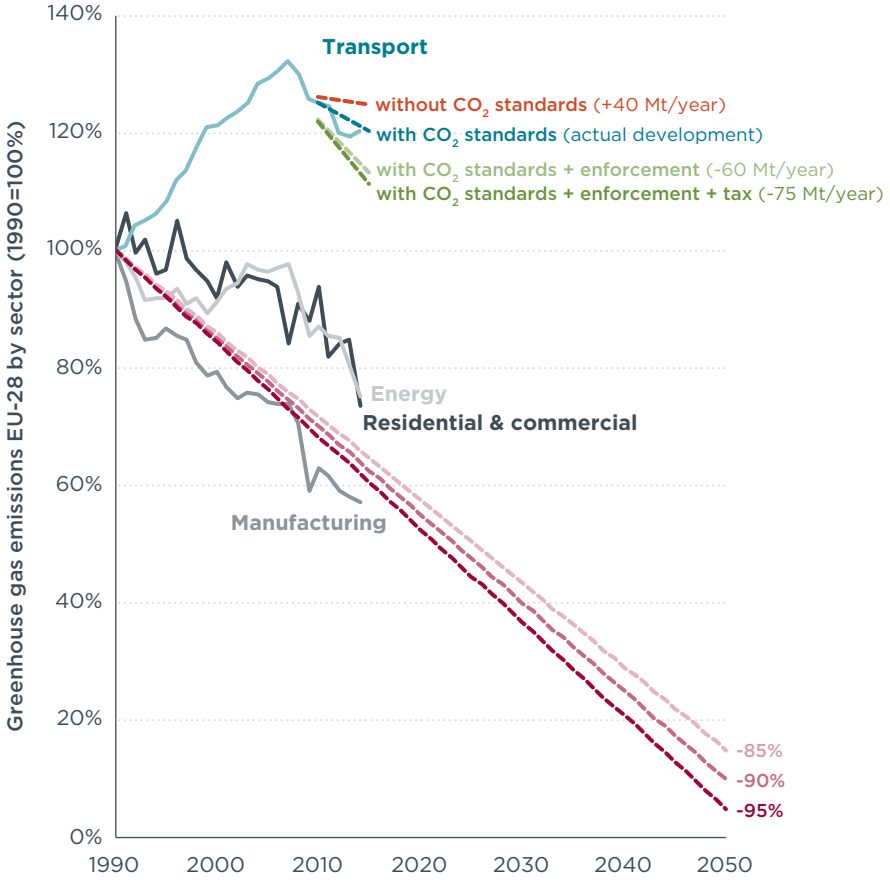

Figure 7. Greenhouse gas emissions in the EU by sector. For the transport sector, actual development (blue), hypothetical development if assuming no performance standards (red), performance standards in combination with improved enforcement (light green) and in combination with improved enforcement and advanced vehicle tax (dark green).[17] Dashed red lines indicate a range of potential reduction targets for 2050.

The importance of continuing to develop the CO_2 performance standards for new vehicles in the EU is, thus, quite clear. In concrete terms, for passenger cars average

16 European Environmental Agency, Why did GHG emissions decrease in the EU between 1990 and 2012? (2014). Retrieved from https://www.eea.europa.eu/publications/ghg-trends-and-projections-2012

17 Sources: European Environmental Agency, *Statistical Pocketbook 2016*, June 2016, retrieved from https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2016_en. ICCT Global Transportation Roadmap Model (http://www.theicct.org/global-transportation-roadmap-model). Ton-kilometers driven by road freight vehicles decreased by 10% between 2007 and 2014 while the share of biofuels (which are counted as having zero emissions in the official statistics) increased. These two factors explain the majority of the decreasing emission level for the transport sector from 2007 to 2014.

new-car CO_2 emission levels should fall by about 58% between 2021 and 2030 (a rate of about 9% per year) (Figure 8). Only then, at a New European Driving Cycle (NEDC) level of about 70 g/km by 2025 and 40 g/km by 2030, would the pace of new-car efficiency improvements be in line with the EU's overall 30% reduction target for the transport sector by 2030.

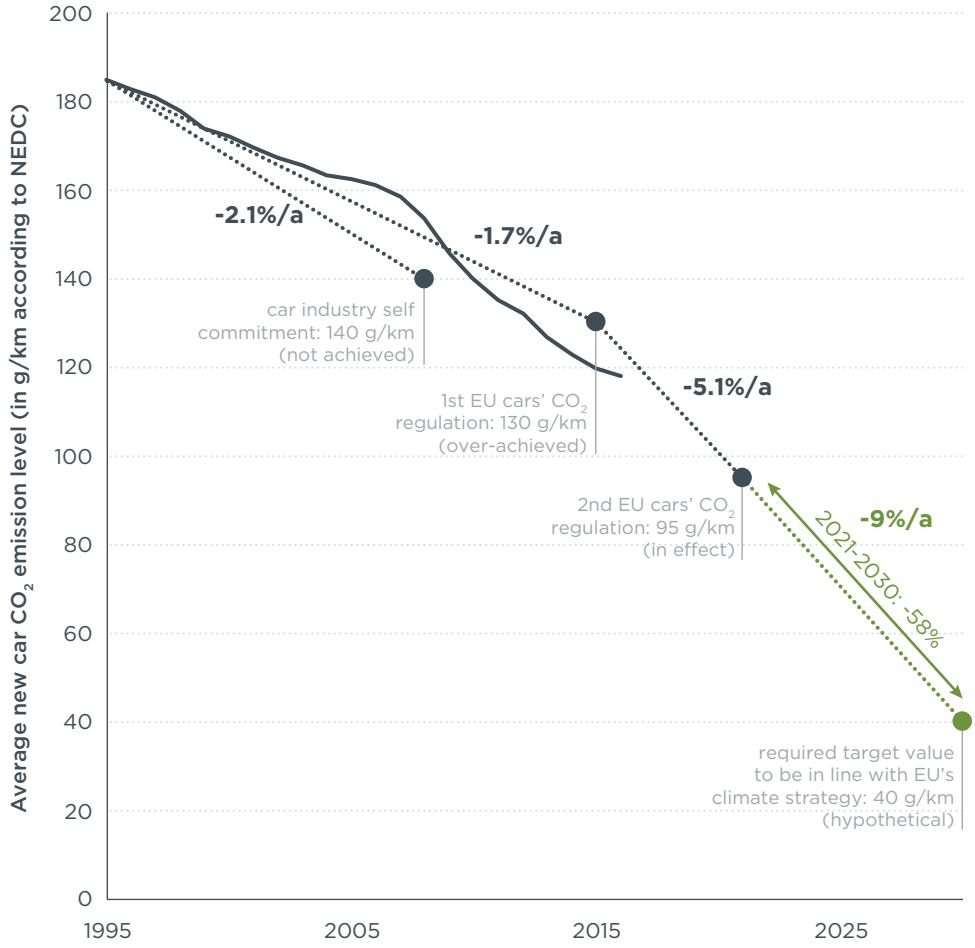

Figure 8. Historic development of average CO_2 emission (target) levels and required further development in 2021–2030 time period to be in line with the EU's climate strategy.[18]

Vehicle manufacturers could achieve a new-car CO_2 level of 70 g/km (NEDC) by 2025 largely through further improvements of combustion-engine technologies, at modest increased cost which would be offset by fuel-cost savings within the first years of ownership of the vehicle. More cost-efficient, though, would be to rely less on combustion engines and accelerate the increase in market share of electric vehicles. This would reduce the costs of meeting a 70 g/km (NEDC) CO_2 emissions target for passenger cars by about €350 per vehicle in 2025. The electric-vehicles market share required would be about 17%, which is at the lower end of what vehicle manufacturers such as BMW, Daimler, and Volkswagen envision in recent announcements.[19] In a lower-bound scenario that approach would result in overall compliance cost for reaching a 70 g/km CO_2 target of about €650 by 2025 (Figure 9).

18 ICCT internal calculations using the ICCT Global Transportation Roadmap Model (http://www.theicct.org/global-transportation-roadmap-model).

19 BMW and Daimler announced 15%–25% of their sales by 2025 would be electric cars, and Volkswagen announced that 20%–25% of its 2025 sales would be electric cars. International Energy Agency, *Global EV Outlook 2017*, https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf. Fred Lambert, "Tesla has freed the electric car from its granola image', says Daimler CEO," *Electrek* (March 24, 2017), https://electrek.co/2017/03/24/tesla-electric-car-granola-image-daimler-ceo/.

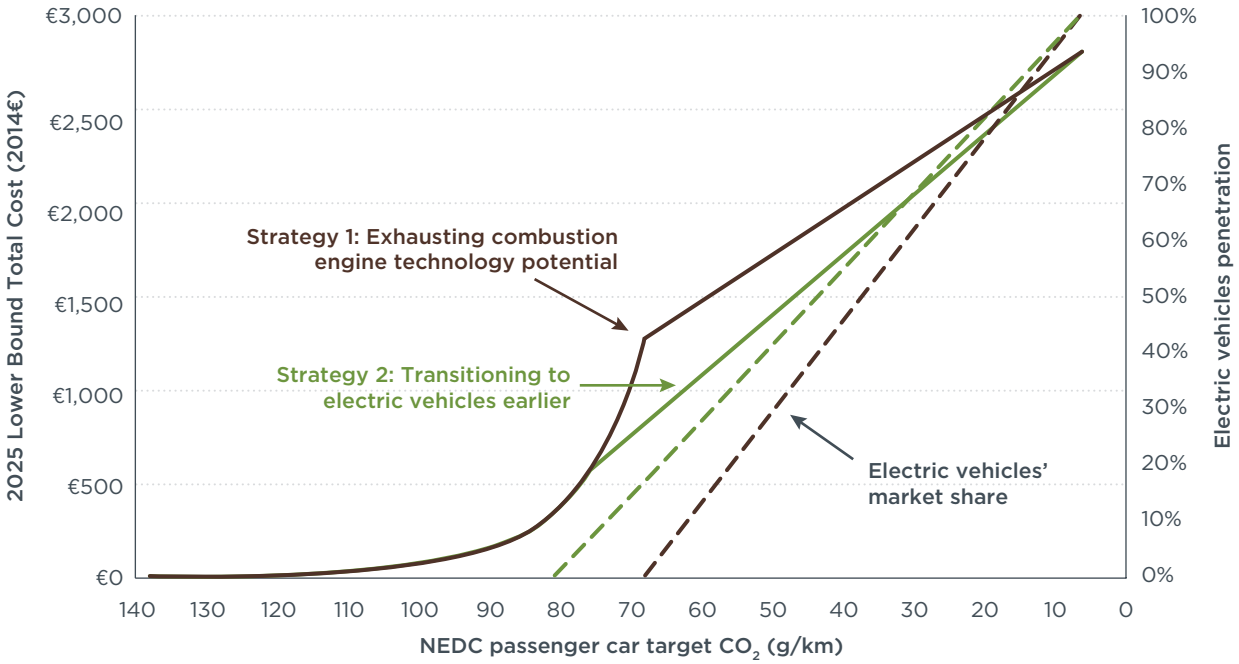

Figure 9. Total incremental cost (including indirect costs but excluding taxes) of reducing CO_2 emissions of the average passenger car in the EU by 2025 in a lower-bound scenario, comparing full deployment of combustion engine technologies before transitioning to electric vehicles to a least-cost strategy of transitioning to electric vehicles earlier[20].

But as the European experience clearly confirms, new-car[21] CO_2 performance standards cannot stand alone; they must be complemented by other measures to form a comprehensive and effective package. The European Commission originally envisioned a package of complementary policies, headlined by mandatory performance standards, to drive down CO_2 emissions from vehicles. The logic of that approach remains compelling, and the experience of the past years adds empirical support. Now, a dramatically changing technological context, especially with respect to developments in electrified vehicles and information technologies (as those affect mobility options) highlights a number of possible components of a multifaceted strategy for the 2020–2030 time period:

- **Improved enforcement**: On-road emissions' testing should be extended to CO_2. Measured on-road CO_2 values should be communicated to consumers and systematically monitored. A not-to-exceed threshold for the real-world CO_2 gap should be added to the CO_2 performance standards.
- **Supportive vehicle taxes**: Vehicle CO_2 standards serve to push manufacturers to develop and offer new technologies. The lower these target values, the more important it becomes to incentivize consumers to pull technologies into the market. EU member state taxation systems should function to increase demand in low-emission vehicles.
- **Electric-vehicle mandates and infrastructure investments**: The pace of CO_2 reduction for new cars must accelerate in order to come into line with the EU's climate targets. Electric vehicles will have to play a key role in these efforts. At the EU and member state level, mandates should be implemented to further incentivize manufacturers to build and market electric vehicles and to provide the planning security necessary to foster investments in electric vehicle charging infrastructure.

20 Peter Mock, *2020–2030 CO_2 standards for new cars and light-commercial vehicles in the European Union* (ICCT, 2016), retrieved from http://www.theicct.org/2020-2030-co2-standards-cars-lcvs-eu-briefing-nov2016

21 CO_2 performance standards for light-commercial vehicles (vans) are not separately discussed in this paper but, together with passenger cars, are considered part of the light-duty vehicles' regulation.

- **Improved consumer information**: The EU's vehicle labeling Directive should be revised in order to better inform consumers about available low-emission vehicles. Examples for improving the practical usefulness of the vehicle CO_2 labels include providing information on real-world CO_2 values and expected annual fuel costs for each individual vehicle model.
- **Intelligent road tolls**: A refined road-toll system, with charges linked to a vehicle's emission level and traffic situation, can help to control rebound effects and provide a further incentive for consumers to opt for low-emission vehicles. EU member states should consider complementing or replacing the current system of fuel and energy taxes with an emissions' based road toll scheme that allows for a more targeted pricing of different vehicle and usage types.

CONCLUSIONS

Vehicle CO_2 performance standards for cars, vans, and trucks—effectively enforced—are at the core of any serious effort to realize lower-carbon transport. However, the recently proposed 2025 and 2030 standards for cars and vans are based on annual CO_2 reduction rates that 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.[22] To be in line with the EU's climate goals for 2030, the level of ambition of the proposed 2025/30 CO_2 standards must increase and must be complemented by a similar CO_2 regulation for heavy-duty trucks, as well as by measures to limit the gap between official and real-world CO_2 emission levels.

In addition to these EU-wide measures, the EU member states will have to leverage the effects of the new-vehicle CO_2 performance standards by implementing supporting policy measures at the national level, such as emissions-based vehicle taxes, mandates for electric vehicles, and emissions-based road pricing. In that sense, the agenda for progress in the road transport sector is not so different from the original European Commission strategy from 1995, except in that it will actually have to rest on more than three pillars—and this time it must be implemented in practice.

22 Jan Dornoff, Joshua Miller, Peter Mock, Uwe Tietge, *The European Commission regulatory proposal for post-2020 CO_2 targets for cars and vans: A summary and evaluation* (ICCT, 2018), retrieved from https://www.theicct.org/publications/ec-proposal-post-2020-co2-targets-briefing-20180109