BRIEFING

FEBRUARY 2024

CO_2 emissions from new passenger cars in Europe: Car manufacturers' performance in 2022

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This briefing paper provides an overview of CO_2 emission levels of new passenger cars in the European Union (EU) in 2022 based on a preliminary dataset released by the European Environment Agency (EEA).[1] The dataset shows that the 9.48 million new passenger cars sold in the European Economic Area in 2022 had average CO_2 emissions of 108 g/km determined following the Worldwide Harmonized Light Vehicles Test Procedure (WLTP), which is approximately 6 g/km lower than average emissions in 2021. For the first time, annual registration of battery electric vehicles exceeded one million in 2022. Based on our analysis, all manufacturers met their 2022 CO_2 targets.

As an update to 2021's briefing, this paper details manufacturer performance in terms of CO_2 emissions reduction, fuel type and technology trends, and market share.[2] The paper focuses on differences between countries, as well as between the major car makers. It also discusses flexible compliance mechanisms.

The preliminary EEA dataset used in this briefing has yet to be validated. Once the final dataset is published, the specific values used in this report may change. The preliminary data for 2022 should, however, provide relatively reliable results.[3]

BACKGROUND

The EEA recently released a preliminary dataset on the CO_2 emissions performance of new passenger cars in the EU in 2022. This dataset is used by the European Commission to monitor and evaluate if manufacturers are in compliance with mandatory CO_2 emission targets for passenger cars, as defined in

1 European Environment Agency, "Monitoring of CO_2 Emissions from Passenger Cars – Regulation (EU) 2019/631," Data, June 9, 2022, https://www.eea.europa.eu/data-and-maps/data/co2-cars-emission-20.

2 Uwe Tietge, Jan Dornoff, Peter Mock, and Sonsoles Díaz, *CO_2 Emissions from New Passenger Cars in Europe: Car Manufacturers' Performance in 2021*, (Washington, DC: ICCT, 2022), https://theicct.org/publication/co2-new-passenger-cars-europe-aug22/.

3 Historically, there has been little difference between preliminary and final data. In 2021, the difference between preliminary and final average CO_2 emissions was less than 1 g/km for WLTP values.

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Regulation (EU) 2019/631.[4] Countries in the European Economic Area, comprised of EU Member States plus Iceland and Norway, are required to submit detailed information on each new car registered in a calendar year to the EEA. Vehicles registered in all countries in the European Economic Area count toward the CO_2 emission targets.

There were two issues related to the quality of the preliminary data. First, a small number of records, equivalent to 0.002% of 2022 passenger car registrations, appeared multiple times in the monitoring data. These duplicate records will be consolidated in the final dataset; we removed them before aggregating the data for this briefing. Second, for 0.15% of the passenger cars in the EEA database, mostly vehicles registered in Germany and Poland, no CO_2 emission values were reported. These registration records were not taken into account in the analyses.

For the second year, manufacturer CO_2 performance for 2022 will be determined using the WLTP instead of the New European Driving Cycle (NEDC). Accordingly, the 2020 fleet-wide target of 95 g/km over the NEDC was converted to WLTP targets for the period 2021–2024. The conversion was performed for each manufacturer individually based on its average vehicle mass in 2020 and the *ratio of declared WLTP and NEDC* CO_2 emissions in 2020. Thereby, each manufacturer is assigned a *manufacturer-specific reference target* for the years 2021–2024. The fleet-average of all manufacturer-specific reference CO_2 targets is 118.1 g/km.[5]

From 2025 onwards, the manufacturer-specific reference targets will be replaced by fleet-wide targets. The passenger car fleet CO_2 targets for 2025–2029 and for 2030–2034 are determined by applying the respective 15% and 55% reduction rates to the *2021 WLTP fleet target***,** as defined in Regulation (EU) 2023/851.[6] Unlike the manufacturer-specific reference targets which apply in the 2021–2024 period, the 2021 WLTP fleet target is calculated using the *ratio of measured WLTP and declared NEDC* CO_2 emissions in 2020, *instead of using the declared WLTP emission value*. Together with the vehicle mass and the number of registered vehicles in 2021, the 95 g/km NEDC target is converted to the equivalent 2021 WLTP fleet target of 109.8 g/km.[7] Applying the reduction rates, the target for 2025 is 93.6 g/km and the 2030 target is 49.5 g/km.[8]

Based on the preliminary EEA data, the sales-weighted fleet average WLTP CO_2 emissions from new passenger cars in 2022 was 108 g/km, which is 6 g/km (5.1%) lower than in 2021.

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4 European Union, "Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 Setting CO_2 Emission Performance Standards for New Passenger Cars and for New Light Commercial Vehicles, and Repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (Text with EEA Relevance.)," Pub. L. No. 32019R0631, 111 OJ L 13 (2019), http://data.europa.eu/eli/reg/2019/631/oj/eng.

5 European Commission, "Commission Implementing Decision (EU) 2023/1623 of 3 August 2023 Specifying the Values Relating to the Performance of Manufacturers and Pools of Manufacturers of New Passenger Cars and New Light Commercial Vehicles for the Calendar Year 2021 and the Values to Be Used for the Calculation of the Specific Emission Targets from 2025 Onwards, Pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council and Correcting Implementing Decision (EU) 2022/2087 (Notified under Document C(2023) 5068)," Pub. L. No. OJ L 200, 5 (2023), http://data.europa.eu/eli/dec_impl/2023/1623/oj.

6 Regulation (EU) 2023/851 of the European Parliament and of the Council of 19 April 2023 amending Regulation (EU) 2019/631 as regards strengthening the CO_2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition (Text with EEA relevance) PE/66/2022/REV/1 OJ L 110, 25.4.2023, p. 5–20.

7 Jamie Suarez Corujo, Dimitrios Komnos, Markos Ktistakis, Georgios Fontaras, "2025 and 2030 CO_2 emission targets for Light Duty Vehicles," (Joint Research Centre, 2023), doi:10.2760/901734.

8 European Commission, Commission Implementing Decision (EU) 2023/1623 of 3 August 2023 specifying the values relating to the performance of manufacturers and pools of manufacturers of new passenger cars and new light commercial vehicles for the calendar year 2021 and the values to be used for the calculation of the specific emission targets from 2025 onwards, pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council and correcting Implementing Decision (EU) 2022/2087 (notified under document C(2023) 5068).

Figure 1 plots the historical average CO_2 emission values relative to the targets. Up to and including 2020, NEDC CO_2 values are reported; after 2020, WLTP values are presented. Before standards were introduced, fleet CO_2 emissions, on average, declined by 1.9 g/km per year from 2000 to 2007. After the first CO_2 standards were agreed upon in 2008, manufacturers outperformed the annual reduction rates required to meet the 2015 target of 130 g/km; instead of the required 3.6 g/km annual reduction, average CO_2 emissions declined by 4.9 g/km per year. After 2015 targets were met, and in the absence of more stringent targets before 2020, average CO_2 emissions increased by 0.7 g/km per year. The 2020 target of 95 g/km over the NEDC included a phase-in provision and flexible compliance mechanisms, but still led to a steep decline of 14 g/km from 2019 to 2020. By using flexible compliance mechanisms, all manufacturers met their 2020 targets.[9] Removing the phase-in provisions in 2021 required a further drop in fleet average CO_2 emissions to meet the equivalent WLTP target. The 6 g/km CO_2 reduction from 2021 to 2022 was about half of the reduction from 2020 to 2021. If the reduction continues at the rate of 5.1% per year, CO_2 emissions will not fall below the 2025-2029 target of 94 g/km before 2025.

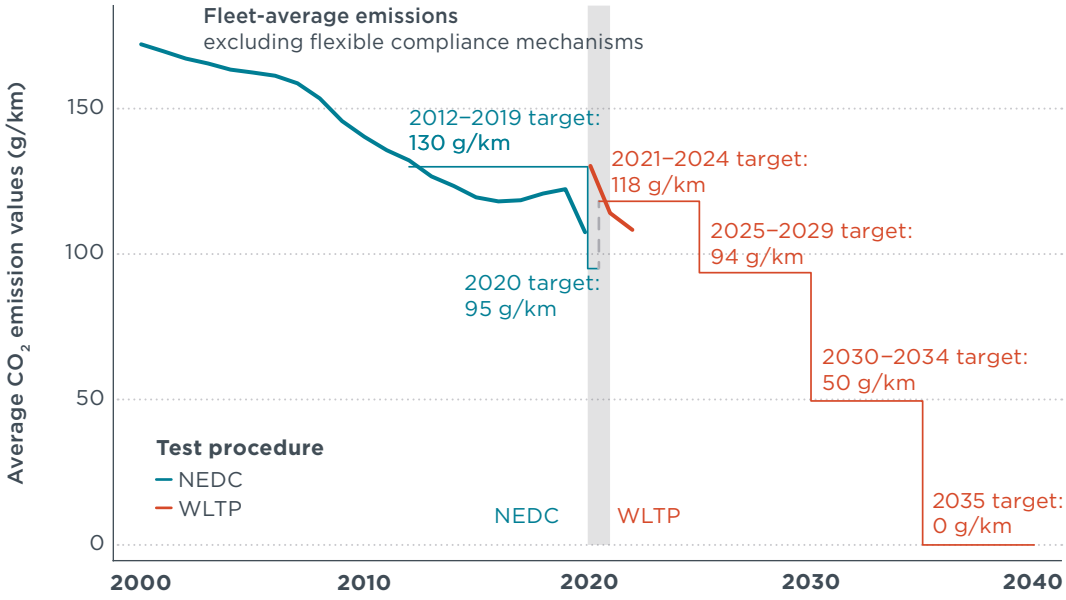

Figure 1. Historical average NEDC and WLTP CO_2 emission values and targets of new passenger cars without flexible compliance mechanisms. The 2021–2024 line corresponds to the WLTP specific emissions reference target for 2021, calculated as the average of the WLTP specific emissions reference targets of all manufacturers.

CO_2 EMISSIONS BY VEHICLE MANUFACTURER

Car manufacturers can pool together several brands, not necessarily from the same manufacturer, to meet CO_2 targets. Unless otherwise noted, we track manufacturer pools for this analysis.[10] Through 2028, vehicle manufacturers with fewer than 300,000

9 Commission Implementing Decision (EU) 2022/2087 of 26 September 2022 confirming or amending the provisional calculation of the average specific emissions of CO_2 and the specific emissions targets for manufacturers of passenger cars and light commercial vehicles for the calendar year 2020 and informing manufacturers of the values to be used for the calculation of the specific emissions targets and derogation targets for the calendar years 2021 to 2024 pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council (notified under document C(2022) 6754) (Text with EEA relevance) C/2022/6754. OJ L 280, 28.10.2022, p. 49–93.

10 In 2022, manufacturer pools (and their major brands) were: BMW (BMW, Mini); Ford (Ford); Hyundai (Hyundai); Kia (Kia); Mazda-Subaru-Suzuki-Toyota (Lexus, Mazda, Subaru, Suzuki, Toyota); Mercedes-Benz (Mercedes-Benz, Smart); Renault-Nissan-Mitsubishi (Dacia, Mitsubishi, Nissan, Renault); Stellantis (Alfa Romeo, Citroën, DS Automobiles, Fiat, Jeep, Lancia, Opel, Peugeot, Vauxhall); Tesla-Honda-JLR (Honda, Land Rover, Tesla); and VW (Audi, Cupra, Porsche, Seat, Škoda, VW).

registered passenger cars per calendar year can apply for a niche derogation to receive non-standard, manufacturer-specific reduction targets for 2021 onwards. Because this niche derogation could apply to Volvo and MG in 2022, these manufacturers are omitted from the analysis.

Table 1 presents data for the 10 manufacturer pools representing approximately 94% of all new passenger car registrations in the European Economic Area in 2022. In addition to displaying each manufacturer's market share, average CO_2 emissions, and CO_2 target, Table 1 accounts for the impact of flexible compliance mechanisms, namely:

- Mass-adjusted manufacturer targets;
- Super-credits for vehicles with NEDC CO_2 emissions below 50 g/km, which are counted 1.33 times in 2022 in the calculation of average emissions; and
- Eco-innovation credits, which reward innovative technologies that produce real-world CO_2 savings beyond what is measured over a standardized test cycle during type approval, adjusted by a factor of 1.7 in 2022.

These mechanisms are described in more detail in a subsequent section.

All manufacturer pools are expected to have met their 2022 CO_2 targets, even without using the flexible compliance mechanisms for this purpose. Nine out of ten pools had already exhausted their super-credits in 2020 and 2021, which are capped at 7.5 g/km for the period 2020–2022. Only the Mazda-Subaru-Suzuki-Toyota pool was still entitled to a super-credit related reduction of about 5 g/km; however, the number of eligible vehicles registered in 2022 only generated super-credits of 0.9 g/km. Eco-innovation technologies lowered CO_2 emission levels by 0.4 to 2.2 g/km.

Table 1. Market shares, average vehicle mass, and CO_2 emissions, impact of flexible compliance mechanisms, and CO_2 emission targets for 2022 of the 10 largest manufacturer pools in terms of 2022 registration numbers.

Manufacturer pool	Market share	Average mass (kg)	CO_2 values (g/km, WLTP)					
			2022 average	Super-credits	Eco-innovations	Adj. 2022 average	2022 target	Distance to target
Tesla-Honda-JLR	3%	1,954	50	0	-0.4	50	136	-86
BMW	7%	1,779	107	0	-1.6	105	128	-22
Mercedes-Benz	6%	1,879	113	0	-0.7	112	127	-14
Stellantis	20%	1,346	106	0	-1.8	104	118	-14
Kia	5%	1,469	101	0	-0.6	101	113	-12
ALL POOLS	**94%**	**1,518**	**110**	**-0.1**	**-1.4**	**108**	**119**	**-11**
Ford	4%	1,568	116	0	-2.2	114	124	-10
Hyundai Motor Europe	5%	1,468	103	0	-0.8	102	112	-9
Renault-Nissan-Mitsubishi	13%	1,346	107	0	-1.9	106	109	-4
Volkswagen	25%	1,575	120	0	-1.5	119	122	-4
Mazda-Subaru-Suzuki-Toyota	8%	1,429	117	-0.9	-1.0	115	118	-3

Note: Rows are sorted by the distance to 2022 target levels.

FUEL TYPE AND TECHNOLOGY TRENDS BY MEMBER STATE AND MANUFACTURER

Uptake of electrified powertrain vehicles increased from 2021 to 2022, as shown in Table 2. The share of battery electric vehicles (BEVs) grew by 33% (from 10.1% to 13.4%), whereas the share of plug-in hybrid electric vehicles (PHEVs) had only a marginal increase of 3% (from 9.2% to 9.5%). The share of full hybrid electric vehicles (HEVs) grew by 26% (from 6.6% to 8.3%), and the share of mild hybrid electric vehicles (MHEVs), that is internal combustion engine vehicles (ICEVs) using a low-voltage electric system, increased slightly (from 13.7% to 14.7%). Diesel vehicle market share (including MHEVs) continued to fall, decreasing from 23% in 2021 to 20% in 2022, as did the share of petrol vehicles (including MHEVs), which decreased from 48% in 2021 to 46% in 2022. Other powertrains, predominantly compressed natural gas (CNG) and liquified petroleum (LPG) gas vehicles, accounted for 2.9% of the market, similar to the 2021 share of 2.7%.

Table 2 also presents the market share by country in 2022 of the various fuel types and powertrain technologies.[11] Norway continues to dominate the European BEV market in terms of market share, with more than 79% of new car registrations in 2022 being BEVs. Iceland also recorded high BEV market shares of more than 33% in 2022. Of the EU Member States, Sweden saw the highest uptake of electric vehicles with 33% BEVs. Denmark and the Netherlands had BEV market shares higher than 20% in 2022. Germany, the largest vehicle market in the EU, saw a 30% increase in BEV registration share, from 13.6% in 2021 to 17.7% in 2022.

Shares of HEVs were particularly high in Finland and Lithuania at 18.1% in 2022, increasing from 14.8% and 13.4%, respectively, in 2021. Shares of HEVs exceeded 10% in 12 countries. Since noteworthy numbers of MHEVs were first registered in 2018, their market share has increased rapidly in most countries and constituted substantial share of diesel and petrol vehicles registered in 2022.

In 2022, PHEVs were most popular in Iceland, with a market share of 24.6%, and in Sweden, at 23%. PHEV registration shares were higher than 10% in Finland (19.8%), Denmark (17.7%), Belgium (15.9%), Germany (13.7%), the Netherlands (11.1%), and Portugal (10.1%). In Germany the PHEV market share increased by 10% from 12.4% in 2021 to 13.7% in 2022.

At their peak in 2010 to 2015, diesel vehicles accounted for more than 50% of annual passenger car registrations in Europe, but exceeded 25% in only four markets in 2022 (Austria, Luxembourg, Ireland, and Croatia). Italy was the only major market with a considerable share of CNG and LPG vehicles in 2022.

11 Because they do not include details on electric powertrains, this briefing supplements EEA data with proprietary data content supplied by Dataforce (https://www.dataforce.de/en/).

Table 2. Market share of fuels and technologies for new passenger cars in 2022 by country.

Market	Diesel	Petrol	Mild hybrid electric	Hybrid electric	Plug-in hybrid electric	Battery electric	Other	EEA market share
Germany	24%	41%	14.6%	2.9%	13.7%	17.7%	0.7%	28.0%
France	17%	46%	9.9%	11.9%	8.3%	13.3%	3.9%	16.2%
Italy	24%	48%	24.6%	9.3%	5.1%	3.7%	9.7%	14.0%
Spain	22%	54%	16.1%	12.8%	5.8%	3.8%	1.8%	8.8%
Poland	16%	60%	15.1%	15.5%	2.5%	2.7%	2.9%	4.4%
Belgium	18%	48%	14.1%	7.4%	15.9%	10.1%	0.8%	3.9%
Netherlands	2%	52%	13.8%	11.2%	11.1%	23.5%	0.8%	3.3%
Sweden	12%	22%	11.7%	8.9%	23.0%	33.0%	1.3%	3.1%
Austria	30%	44%	13.6%	5.0%	6.0%	15.5%	0.0%	2.3%
Czechia	25%	63%	7.9%	4.9%	1.9%	2.1%	2.5%	2.0%
Norway	3%	3%	0.6%	5.8%	9.2%	79.3%	0.0%	1.8%
Portugal	21%	49%	10.0%	5.2%	10.1%	11.3%	3.5%	1.6%
Denmark	11%	45%	8.6%	6.0%	17.7%	20.6%	0.0%	1.6%
Romania	15%	53%	14.1%	9.5%	3.0%	9.0%	10.5%[a]	1.4%
Hungary	18%	62%	27.6%	10.8%	4.0%	4.2%	0.8%	1.2%
Ireland	28%	32%	6.4%	16.6%	8.4%	14.9%	0.7%	1.1%
Greece	17%	60%	17.0%	10.6%	5.4%	2.7%	3.5%	1.1%
Finland	9%	35%	13.4%	18.1%	19.8%	17.8%	0.7%	0.9%
Slovakia	20%	65%	13.3%	8.6%	2.0%	2.0%	2.1%	0.9%
Croatia	26%	59%	13.6%	4.9%	2.5%	3.2%	3.9%	0.5%
Slovenia	21%	66%	11.7%	5.4%	1.5%	5.1%	1.5%	0.5%
Luxembourg	28%	43%	15.1%	3.9%	9.2%	15.2%	0.1%	0.4%
Lithuania	14%	58%	17.6%	18.1%	2.6%	5.3%	1.5%	0.3%
Iceland	16%	17%	6.6%	9.0%	24.6%	33.2%	0.0%	0.2%
Estonia	21%	57%	16.9%	16.3%	1.9%	3.4%	1.4%	0.2%
Latvia	21%	55%	5.8%	13.8%	1.8%	6.4%	2.0%	0.2%
Cyprus	8%	71%	19.2%	12.8%	1.7%	3.4%	0.0%	0.1%
EEA total	**20%**	**46%**	**14.7%**	**8.3%**	**9.5%**	**13.4%**	**2.9%**	**–**

Notes: Countries are sorted by descending market share. No data is available for Bulgaria or Malta. "Diesel" and "Petrol" columns include mild hybrid-electric vehicles. The "Other" column primarily covers compressed natural gas and liquified petroleum gas fuels.
[a] Value accounts for vehicles with no information on powertrain type.

Table 3 presents the market share by fuel type and powertrain technology in 2022 for manufacturer pools and selected brands. The columns Diesel and Petrol comprise both conventional ICEVs as well as MHEVs.

Among pools, the Tesla-Honda-Jaguar-Land Rover pool had the highest BEV share with 65.8%. Most pools (Hyundai, BMW, Mercedes-Benz, Renault-Nissan-Mitsubishi, Kia, Volkswagen and Stellantis) have a BEV share between 10% and 15%. Ford and Mazda-Subaru-Suzuki-Toyota had a BEV registration share below 5%. The latter pool stands out with more than 50% of its registrations being HEVs. Among brands, Tesla, Polestar, and Smart registered 100% BEVs in 2022. The BEV share of MG reached about 53%, and Mini, Cupra, Volvo, and Porsche each had a BEV share of about 20%.

Mitsubishi (51%), Jeep (45%), Volvo (37%), and DS Automobiles (35%) had the highest share of PHEVs. The Mercedes-Benz pool stands out with the highest diesel share of 40%, including MHEVs, while the other pools have diesel shares at or below 30%, resulting in an average diesel share of 20%. Outside those pools, diesel accounted for slightly less than half of the passenger car registrations of Alfa Romeo (48%) and Land Rover (46%).

The manufacturer pool Renault-Nissan-Mitsubishi had by far the highest share of compressed natural gas (CNG) and liquified petroleum gas (LPG) vehicles at almost 16% compared to a fleet average of about 3%. This was driven by the brand Dacia, which had a market share of such vehicles of over 35%.

Table 3. Market share of fuels/technologies for new passenger cars in 2022 for manufacturer pools.

Manufacturer pool	Diesel	Petrol	Mild hybrid electric	Hybrid electric	Plug-in hybrid electric	Battery electric	Other	EEA market share
Volkswagen	27%	53%	9.7%	0.0%	7.0%	12.2%	0.7%	25.0%
Volkswagen	27%	55%	2.3%	0.0%	4.8%	13.4%	0.5%	11.0%
Audi	38%	37%	37.9%	0.0%	11.3%	13.8%	0.2%	5.1%
Škoda	30%	57%	2.7%	0.0%	3.1%	9.3%	1.2%	5.0%
Seat	18%	78%	4.9%	0.0%	1.4%	0.0%	3.0%	1.9%
Cupra	8%	46%	0.7%	0.0%	24.5%	21.5%	0.0%	1.3%
Porsche	0%	60%	0.0%	0.0%	20.1%	20.1%	0.0%	0.7%
Stellantis	26%	55%	13.9%	0.0%	7.5%	10.7%	1.0%	19.4%
Peugeot	33%	47%	0.0%	0.0%	7.9%	11.8%	0.0%	6.0%
Fiat	17%	63%	54.3%	0.0%	0.0%	16.4%	3.4%	3.9%
Citroën	33%	56%	0.0%	0.0%	5.5%	5.7%	0.0%	3.7%
Opel/Vauxhall	18%	64%	0.0%	0.0%	4.0%	14.0%	0.0%	3.6%
Jeep	22%	32%	9.1%	0.0%	45.3%	0.0%	0.0%	1.0%
DS Automobiles	29%	29%	0.0%	0.0%	35.3%	6.5%	0.0%	0.5%
Lancia	0%	87%	86.8%	0.0%	0.0%	0.0%	13.1%	0.4%
Alfa Romeo	46%	53%	33.2%	0.0%	0.6%	0.0%	0.0%	0.3%
Renault-Nissan-Mitsubishi	10%	48%	11.0%	9.5%	3.6%	13.2%	15.7%	12.6%
Renault	12%	45%	12.0%	19.2%	2.8%	16.0%	5.7%	5.7%
Dacia	12%	42%	0.0%	0.0%	0.0%	10.9%	35.4%	4.6%
Nissan	1%	77%	41.9%	6.3%	0.0%	14.6%	1.3%	1.7%
Mitsubishi	0%	49%	0.0%	0.0%	51.1%	0.0%	0.1%	0.6%
Mazda-Subaru-Suzuki-Toyota	3%	36%	16.0%	55.8%	3.9%	1.2%	0.2%	9.6%
Toyota	4%	20%	0.0%	72.7%	2.6%	0.6%	0.1%	6.9%
Suzuki	0%	88%	84.2%	9.5%	2.1%	0.0%	0.0%	1.2%
Mazda	4%	75%	43.1%	5.6%	10.0%	4.6%	0.0%	1.2%
Lexus	0%	8%	0.0%	69.7%	19.0%	3.7%	0.0%	0.3%
BMW	30%	35%	23.6%	0.0%	18.9%	15.3%	0.0%	6.8%
BMW	36%	29%	29.2%	0.0%	21.1%	13.7%	0.0%	5.5%
Mini	5%	63%	0.0%	0.0%	9.8%	22.1%	0.0%	1.3%
Mercedes-Benz	40%	24%	15.4%	0.2%	22.2%	14.3%	0.0%	6.0%
Mercedes-Benz	41%	25%	16.0%	0.2%	23.0%	11.2%	0.0%	5.8%
Smart	0%	0%	0.0%	0.0%	0.0%	99.9%	0.0%	0.2%
Kia	5%	58%	17.3%	8.2%	13.7%	12.9%	2.3%	4.6%
Kia	5%	58%	17.3%	8.2%	13.7%	12.9%	2.3%	4.6%
Hyundai	6%	56%	16.6%	13.9%	7.7%	16.0%	0.9%	4.5%
Hyundai	5%	56%	16.6%	13.9%	7.7%	15.9%	0.9%	4.5%
Ford	23%	51%	34.3%	6.5%	11.9%	4.9%	3.2%	4.4%
Ford	23%	51%	34.3%	6.5%	11.9%	4.9%	3.2%	4.4%
Tesla-Honda-JLR	9%	6%	11.2%	13.9%	5.5%	65.8%	0.0%	2.8%
Tesla	0%	0%	0.0%	0.0%	0.0%	100.0%	0.0%	1.8%
Land Rover	48%	23%	59.5%	0.0%	28.8%	0.0%	0.0%	0.4%
Honda	0%	5%	0.6%	91.0%	0.0%	3.7%	0.0%	0.4%
Other brands								
Volvo	20%	23%	33.8%	0.0%	37.2%	20.4%	0.0%	2.2%
MG	0%	24%	0.0%	0.0%	23.0%	52.6%	0.0%	0.7%
Polestar	0%	0%	0.0%	0.0%	0.3%	99.7%	0.0%	0.3%
EEA total	**20%**	**46%**	**14.7%**	**8.3%**	**9.5%**	**13.4%**	**2.9%**	

Notes: Brand shares may not add up to manufacturer pool totals because only brands with at least 0.2% market share are displayed in the table. Manufacturer pools are sorted by descending market share. "Diesel" and "Petrol" columns include mild hybrid electric vehicles. The "Other" column primarily covers compressed natural gas and liquified petroleum gas fuels.

FLEXIBLE COMPLIANCE MECHANISMS

Several flexible compliance mechanisms were included in the EU CO_2 standards to reduce compliance costs, foster innovation, and accommodate changes in the vehicle market. Mass-based CO_2 targets are one of the principal mechanisms to account for varying consumer preferences. Other compliance mechanisms include incentives for electric vehicles and innovative technologies, manufacturer pooling, derogations for small manufacturers, and phase-in provisions for CO_2 targets.

In the 2015 and 2020/21 CO_2 standards, super-credits were included to incentivize sales of low-emission vehicles that emit less than 50 g CO_2/km over the NEDC. Super-credit multipliers increase the weighting of low-emission vehicles in the calculation of manufacturers' CO_2 emission averages. In the 2015 CO_2 standard, each low-emission vehicle counted as 3.5 cars in 2013, 2.5 cars in 2014, and 1.5 cars in 2015. In the 2020/21 standard, each low-emission car counts as 2 cars in 2020, 1.67 cars in 2021, and 1.33 cars in 2022. The combined impact of super-credits for the years 2020–2022 is capped at 7.5 g/km per manufacturer pool.[12]

Figure 2 plots the historical fleet average, NEDC-equivalent CO_2 emission performance when excluding BEVs and PHEVs in comparison with the emissions when including all vehicles and when including the effect of super-credits. The data shows that the CO_2 emissions of combustion engine vehicles, including hybrid vehicles, have not declined since 2021 and remain at about 113 g/km. Fleet average CO_2 reductions from 2021 to 2022 are almost entirely due to the growing share of BEVs and PHEVs, which lowered the fleet average type-approval CO_2 emissions by 23 g/km to 90 g/km in 2022. With eight out of ten manufacturer pools having exhausted their 7.5 g/km super-credit allowance in 2020, super-credits reduced fleet-average CO_2 emissions by almost 7 g/km (NEDC) in 2020 but by less than 1 g/km (WLTP) in 2021 and 2022.

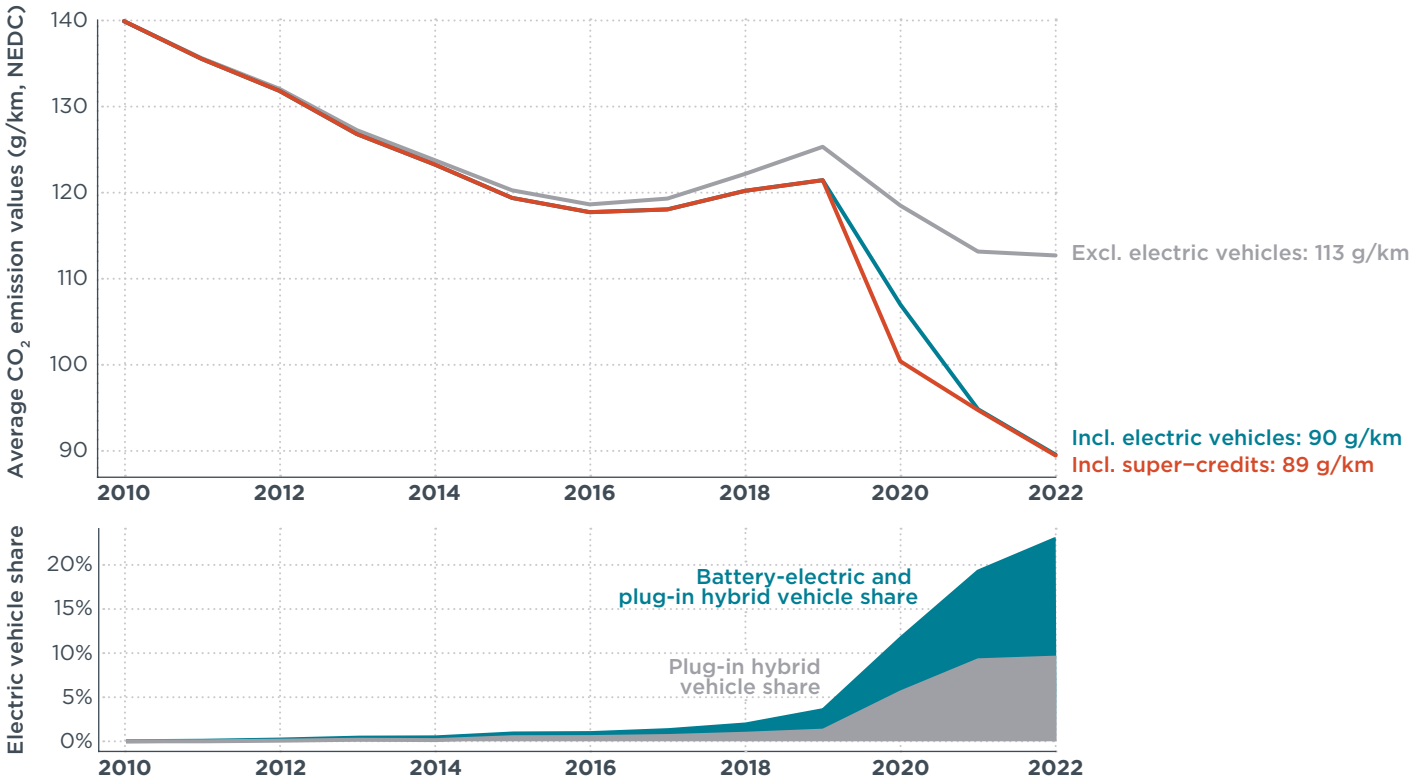

Figure 2. Top panel: Historical average CO_2 emissions (g/km, NEDC) excluding and including battery electric and plug-in hybrid vehicles. Bottom panel: Share of battery electric and plug-in hybrid vehicles.

12 Peter Mock, *CO_2 Emission Standards for Passenger Cars and Light-Commercial Vehicles in the European Union*, (Washington, DC: ICCT, 2019), https://theicct.org/publication/co2-emission-standards-for-passenger-cars-and-light-commercial-vehicles-in-the-european-union/.

As shown in Figure 3, all manufacturers made use of battery electric and plug-in hybrid vehicles to meet their 2022 targets, though to different extents. Without electric vehicles, the Mercedes-Benz pool would have missed its target by 41 g/km, the Tesla-Honda-JLR pool by 31 g/km, BMW by 24 g/km, and Volkswagen by 23 g/km. Three manufacturer pools registered just enough electric vehicles to bring their average CO_2 emissions below the target: Mazda-Subaru-Suzuki-Toyota, Renault-Nissan-Mitsubishi, and Volkswagen. At the other end of the scale, the large number of electric vehicles in the Tesla-Honda-JLR pool reduced its fleet average emissions by 116 g/km, making the pool overachieve its target by 85 g/km. Electric vehicles lowered BMW's CO_2 emissions to 21 g/km below the target, and Kia, Stellantis, and Mercedes-Benz had fleet average emissions 12–14 g/km below their respective targets due to the registration of electric vehicles.

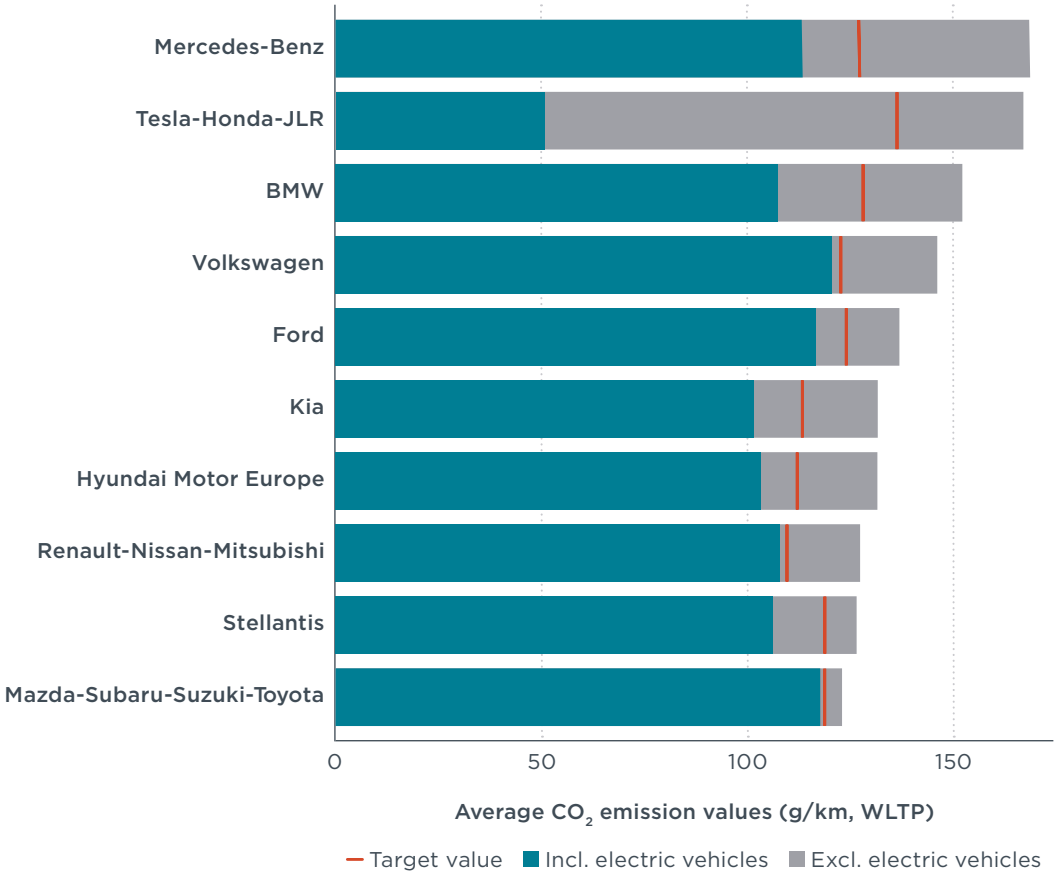

Figure 3: Manufacturer pool average CO_2 emissions when including and excluding electric vehicles, that is battery electric and plug-in hybrid vehicles, compared to their respective 2022 targets.

Figure 4 shows the development of the market shares and average NEDC-equivalent CO_2 emissions of different fuel and powertrain technologies. Vehicles of all powertrains and fuel combinations saw declining CO_2 emissions in the years 2019–2021. For ICEVs and HEVs, the CO_2 emissions stabilized in 2022 at the 2021 level or saw a slight increase compared to 2021. The market shares of diesel and petrol ICEVs have reduced substantially since 2019. Growth of the diesel MHEV share stalled in 2022, and the petrol MHEV share grew at a much lower rate between 2021 and 2022 compared to previous years. The PHEV share growth also slowed substantially in the last year, whereas the BEV share continued its rapid increase.

MHEVs and ICEVs using LPG and CNG (labelled as 'other ICEVs), had the largest efficiency improvements over the 2019–2022 period. However, in each year, the average CO_2 emissions of the diesel MHEV fleet were higher than the emissions

of the conventional diesel ICEVs. This could, at least in part, be due to mild hybrid technologies predominantly being installed in larger vehicle models.

Despite the trend of stabilizing or even increasing CO_2 emissions for most technologies, the increasing market share of battery electric, hybrid, and plug-in hybrid vehicles led to the observed decline in fleet-average CO_2 emissions from 115 g/km in 2021 to 108 g/km in 2022, as measured via the WLTP.

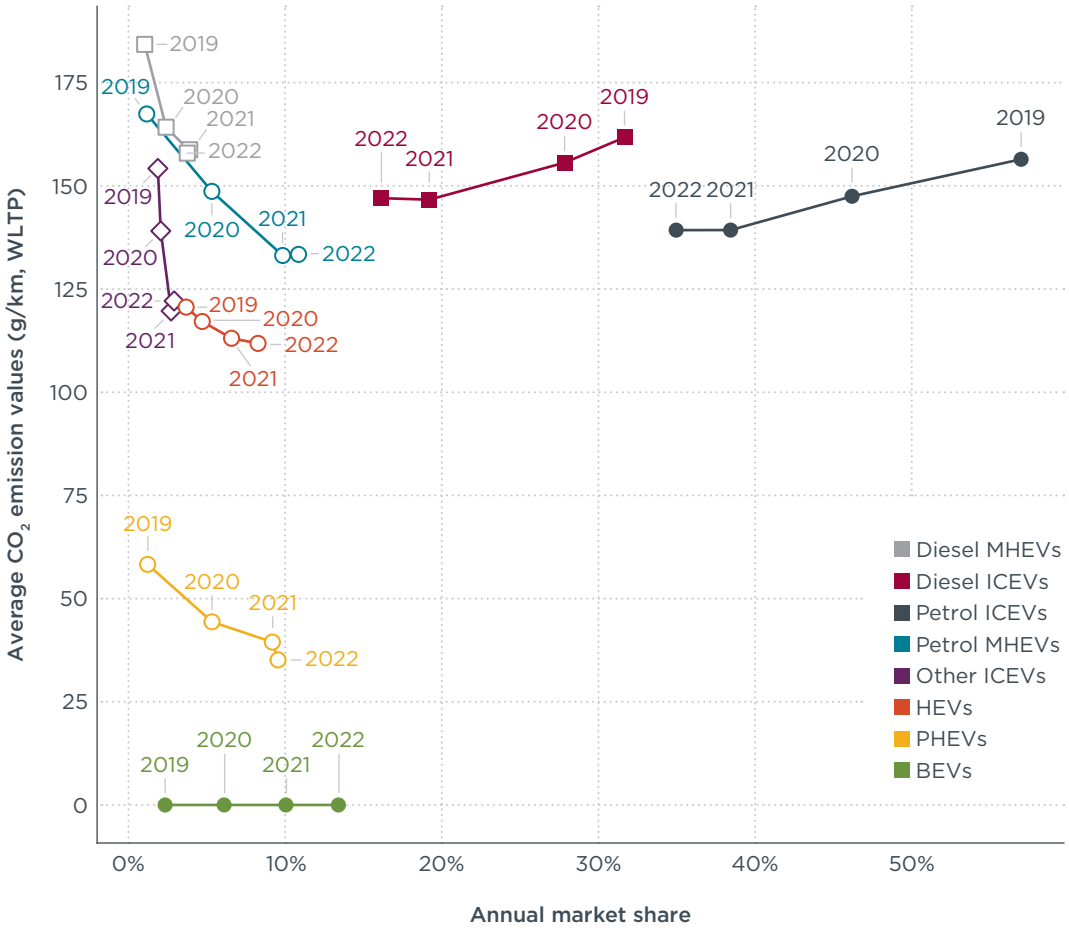

Figure 4. Annual average CO_2 emissions and market share per fuel/powertrain technology between 2019 and 2022. Diesel and petrol ICEVs are conventional, non-hybridized vehicles, that is excluding mild hybrid electric vehicles. "Other ICEVs" primarily covers vehicles running on compressed natural gas and liquified petroleum gas fuels.

In the EU CO_2 standards, manufacturer CO_2 targets are adjusted by vehicle mass to account for varying consumer preferences. Figure 5 plots the annual average NEDC-equivalent CO_2 emissions over average vehicle mass, both including and excluding electric vehicles (BEVs and PHEVs). The average CO_2 emissions of ICEVs (excluding electric vehicles) remained constant from 2021 to 2022, despite a slight increase in average mass of about 9 kg. When taking electric vehicles into account, the average mass continued its fast growth that started in 2019, increasing by 39 kg from 1490 kg in 2021 to 1528 kg in 2022. Fleet average CO_2 emissions have dropped in parallel since 2020, reducing by about 5 g/km from 95 g/km in 2021 to 90 g/km in 2022 g/km NEDC-equivalent.

Using mass as reference parameter inflates the fleet average CO_2 targets. Whereas a fleet average mass of 1,379.9 kg was assumed when calculating the 2020 manufacturer targets, the actual average mass of vehicles registered in 2020 reached 1,455.7 kg.

Thereby, the fleet average reference target for the 2021–2024 period is inflated by 3.1 g/km, or 2.7%, from 115 g/km to 118.1 g/km.[13]

For the calculation of 2022 manufacturer targets, the reference target of 118.1 g/km is adjusted by the difference in manufacturer average mass compared to the assumed fleet average mass used as the reference. This reference mass is calculated as the average vehicle mass in the years 2017, 2018, and 2019, which is 1398.5 kg.[14] However, due to the 2022 fleet average mass being 1528 kg, and thereby 130 kg higher than the reference value, the fleet-average 2022 WLTP CO_2 target calculates to 120 g/km. This means the fleet-average target in 2022 is 4.2% higher than the 115 g/km that would result from converting the 95 g/km 2020 NEDC target to WLTP in 2021, substantially undermining the CO_2 reduction intended by the regulation.

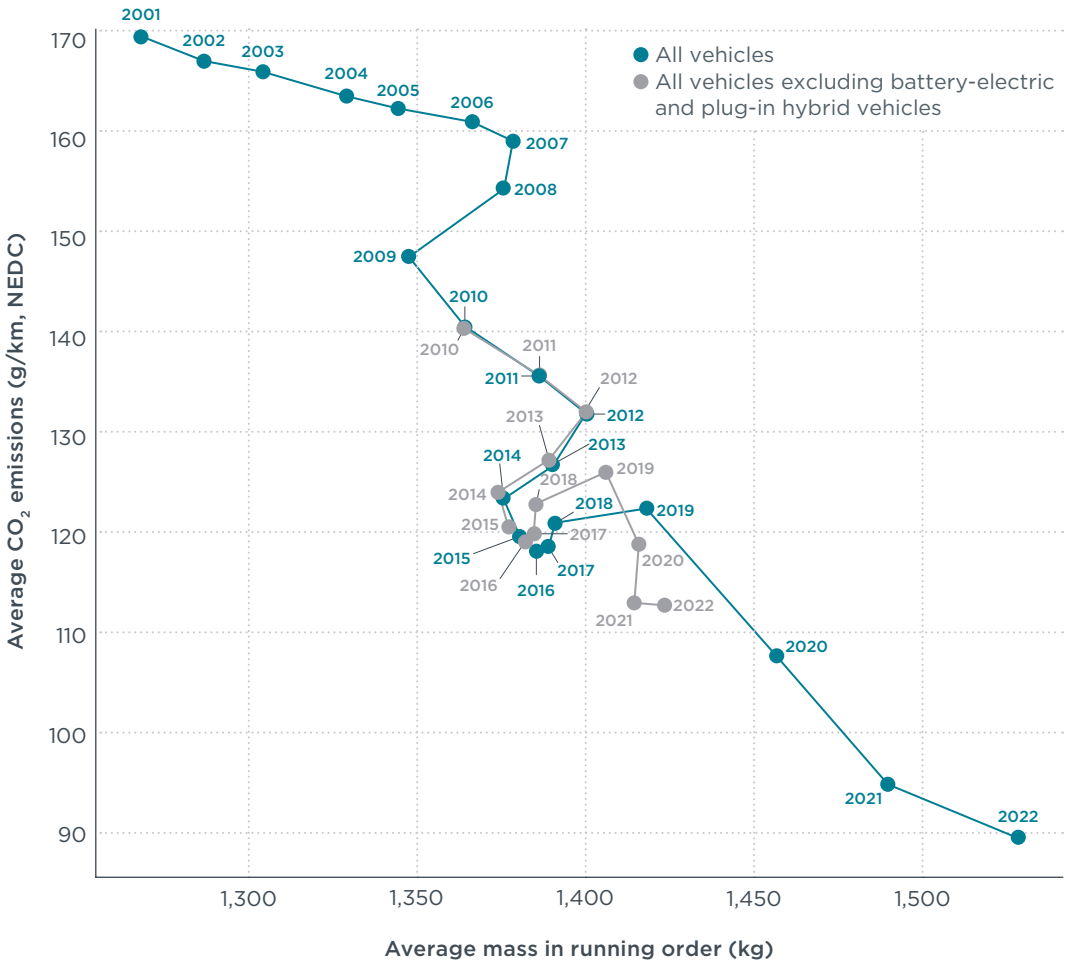

Figure 5. Annual average CO_2 emissions (g/km, NEDC) over average mass in running order (kg), including and excluding battery electric and plug-in hybrid vehicles.

13 European Commission, "Commission Implementing Decision (EU) 2022/2087 of 26 September 2022 Confirming or Amending the Provisional Calculation of the Average Specific Emissions of CO_2 and the Specific Emissions Targets for Manufacturers of Passenger Cars and Light Commercial Vehicles for the Calendar Year 2020 and Informing Manufacturers of the Values to Be Used for the Calculation of the Specific Emissions Targets and Derogation Targets for the Calendar Years 2021 to 2024 Pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council," Pub. L. No. (EU) 2022/2087, OJ L280 (2022), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02022D2087-20230810&qid=1702892035354.

14 European Commission, "Commission Delegated Regulation (EU) 2021/1961 of 5 August 2021 Amending Annex I to Regulation (EU) 2019/631 of the European Parliament and of the Council in Order to Take into Account the Evolution of the Mass of New Passenger Cars Registered in 2017, 2018 and 2019 (Text with EEA Relevance)," Pub. L. No. (EU) 2021/1961, OJ L 400 (2021), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1961.

Eco-innovation credits incentivize the development and adoption of new fuel efficiency technologies that produce real-world CO_2 savings beyond what is measured over a standardized test cycle during vehicle type approval. Because CO_2 savings from eco-innovations count toward manufacturers' annual CO_2 performance, automakers have an incentive to deploy cost-effective eco-innovation technologies.[15] In 2021, 2022, and 2023, eco-innovation credits are multiplied by 1.9, 1.7, and 1.5, respectively, in the calculation of manufacturers' CO_2 savings from eco-innovation technologies.[16] The total impact of eco-innovation technologies on the CO_2 emission targets is limited to 7 g/km per manufacturer pool per year.

The share of new passenger cars with eco-innovation technologies installed has increased from 43% in 2020 and 2021 to 53% in 2022. Figure 6 plots the average CO_2 emission reduction through eco-innovation technologies per manufacturer pool in 2022, with and without applying the 1.7 multiplier. Market-wide average CO_2 reductions from eco-innovation technologies were 1.4 g/km in 2022, up from 1.3 g/km in 2020. Three manufacturer pools, Renault-Nissan-Mitsubishi, Ford, and Stellantis, had eco-innovation technologies installed in more than 65% of passenger cars registered in 2022. These three pools, in addition to BMW and Volkswagen, yielded above average eco-innovation savings. The Tesla-Honda-JLR pool made the least use of this mechanism, claiming a reduction of 0.4 g/km, or 18% of the reductions claimed by the Ford pool of 2.2 g/km.

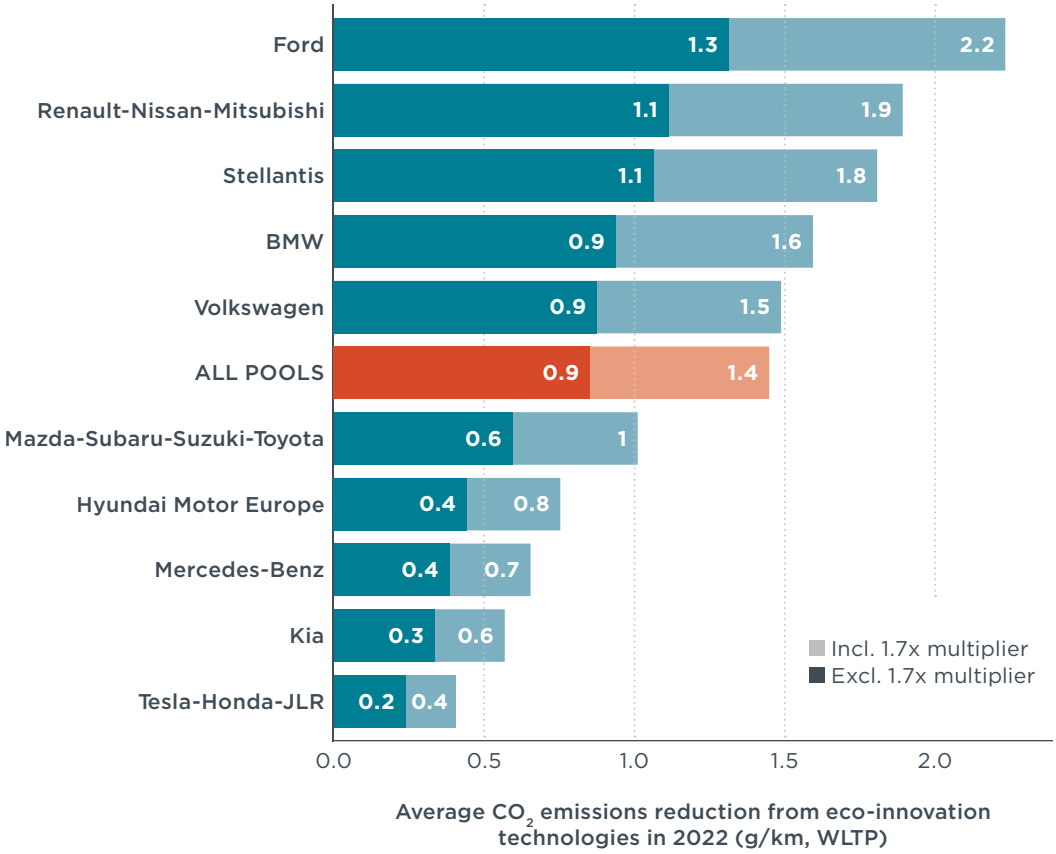

Figure 6. Average CO_2 emission reduction (g/km, WLTP) in 2022 per manufacturer pool from eco-innovation technologies, including and excluding the 2022 multiplier of 1.7.

15 Uwe Tietge, Peter Mock, and Jan Dornoff, *Overview and Evaluation of Eco-Innovations in European Passenger Car CO_2 Standards*, (Washington, DC: ICCT, 2018), https://theicct.org/publication/overview-and-evaluation-of-eco-innovations-in-european-passenger-car-co2-standards/.

16 European Commission, "Commission Implementing Regulation (EU) 2017/1153 of 2 June 2017 Setting out a Methodology for Determining the Correlation Parameters Necessary for Reflecting the Change in the Regulatory Test Procedure and Amending Regulation (EU) No 1014/2010," Pub. L. No. OJ L 175, 02.06.2017, p.679, 29 (2017), http://data.europa.eu/eli/reg_impl/2017/1153/oj.

OUTLOOK

Based on the preliminary EEA dataset, all manufacturer pools met their 2022 CO_2 targets. Despite the CO_2 targets remaining constant in the period 2021–2024, the fleet average CO_2 emissions continued to decrease from 2021 to 2022. This is mainly driven by the increasing share of electric vehicles, whereas the emissions of combustion engine vehicles, mild hybrid vehicles, and full hybrid vehicles largely remained at the same level.

In 2022, reliance on flexible compliance mechanisms to meet CO_2 targets was primarily limited to the deployment of eco-innovations, as all but one pool had exhausted their super-credits cap for 2020–2022 in 2020. Instead, manufacturers relied mostly on increasing the share of battery electric and plug-in hybrid electric vehicles to meet their targets.

EU regulation (EU) 2023/851 adjusted the 2030 CO_2 reduction target from the passenger car fleet to −55% compared to 2021 levels and introduced a −100% target for 2035.[17] In order to meet these targets, manufacturers will have to continue to electrify their fleets in the coming years. However, with the 2025 target remaining at −15% and in the absence of interim targets, there remains a risk that automakers will postpone the introduction of innovative vehicle technologies to the late 2020s. Initial indicators that this postponement may be materializing can be observed in the data, with the market uptake of electric vehicles slowing down and the CO_2 emissions of non-electric vehicles stalling at high levels. At the same time, with the fleet average mass increasing at much higher rate than assumed by the regulation, CO_2 targets are inflated which undermines the reduction targets. Still, the phase-out of new combustion engine vehicles for 2035 will be an important step towards reaching the EU's climate protection targets and sends a strong signal to the rest of the world that the EU is leading by example.

While the focus of the EU CO_2 emission standards is on official type-approval emissions, it is important to ensure that real-world emissions decrease over time at least at the same rate. Real-world emissions are substantially higher than the official values presented in this briefing. The gap between the real-world and NEDC CO_2 emission values of European internal combustion engine and hybrid electric cars widened over time and reached approximately 33% in 2018. With the introduction of WLTP, the gap between real-world and official figures narrowed to approximately 8% in the same year. However, a recent ICCT analysis indicates a growing gap for WLTP type-approved vehicles, reaching about 14% in 2022.[18] Since 2021, on-board fuel consumption meters are mandatory in European new passenger cars and most vans to monitor their real-world fuel consumption. The European Commission is tasked to analyze this data and, on this basis, to enact policies to prevent a widening of the gap between type-approval and real-world emission values in the future.[19] For meaningful monitoring of real-world emission levels, detailed fuel and energy consumption data should become publicly available.

17 European Union, "Regulation (EU) 2023/851 of the European Parliament and of the Council of 19 April 2023 Amending Regulation (EU) 2019/631 as Regards Strengthening the CO_2 Emission Performance Standards for New Passenger Cars and New Light Commercial Vehicles in Line with the Union's Increased Climate Ambition," Pub. L. No. (EU) 2023/851, OJ L 110/5 (2023), https://doi.org/10.5040/9781782258674.

18 Jan Dornoff, Victor Valverde Morales, and Uwe Tietge, *On the way to 'real-world' CO_2 values? The European passenger car market after 5 years of WLTP*, (Washington, DC: ICCT, 2024), https://theicct.org/publication/real-world-CO2-emission-values-vehicles-Europe-jan24.

19 European Commission, "Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 Setting CO_2 Emission Performance Standards for New Passenger Cars and for New Light Commercial Vehicles, and Repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (Text with EEA Relevance.)," Pub. L. No. 32019R0631, 111 OJ L 13 (2019), http://data.europa.eu/eli/reg/2019/631/oj/eng.