

CO₂ emissions from new passenger cars in Europe: Car manufacturers' performance in 2023

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This briefing provides an overview of carbon dioxide (CO₂) emission levels of new passenger cars in the European Union (EU) in 2023 based on a preliminary dataset released by the European Environment Agency (EEA).¹ Analysis of the dataset shows that the 10.7 million new passenger cars sold in the European Economic Area in 2023 had average CO₂ emissions of 107 g/km, determined following the Worldwide harmonized Light vehicles Test Procedure (WLTP). This is approximately 1 g/km lower than average emissions in 2022. Based on our analysis, all manufacturers met their 2023 CO₂ targets.

As an update to the 2022 briefing, this paper details manufacturer performance in terms of CO₂ emissions reduction, fuel type and technology trends, and market share.² It focuses on differences among countries, as well as among the major car makers. It also discusses the use of flexible compliance mechanisms to meet CO₂ emission targets.

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 briefing may change. The preliminary data for 2023 should, however, provide relatively reliable results.³

BACKGROUND

The EEA recently released a preliminary dataset on the CO₂ emissions performance of new passenger cars in the European Union in 2023. Once validated, this dataset is used by the European Commission to monitor and evaluate if manufacturers are in compliance with mandatory CO₂ emission targets for passenger cars, as defined

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- 1 European Environment Agency, Monitoring of CO₂ emissions from passenger cars Regulation (EU) 2019/631 (Dataset, May 29, 2024), <https://www.eea.europa.eu/en/datahub/datahubitem-view/fa8b1229-3db6-495d-b18e-9c9b3267c02b>.
- 2 Jan Dornoff, Victor Valverde Morales, and Uwe Tietge, *CO₂ Emissions from New Passenger Cars in Europe: Car Manufacturers' Performance in 2022* (International Council on Clean Transportation, 2024), <https://theicct.org/publication/co2-emissions-new-pv-europe-car-manufacturers-performance-2022-feb24/>.
- 3 Historically, there has been little difference between the preliminary and final data. In 2022, the difference between preliminary and final average CO₂ emissions was approximately 0.2 g/km for WLTP values.

in 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 manufacturer CO₂ emission targets.

There are two issues related to the quality of the preliminary data. First, a small number of records, equivalent to 0.06% of 2023 passenger car registrations, appeared multiple times in the monitoring data. These duplicate records will be consolidated in the final dataset and were removed before aggregating the data for this briefing. Second, for 0.2% of the passenger cars in the EEA database, mostly vehicles registered in Germany, no CO₂ emission values were reported. These registration records are not considered in the analyses.

The 2023 data represents the third year that manufacturer CO₂ performance was determined using the WLTP instead of the New European Driving Cycle (NEDC). 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, where a higher mass leads to a higher CO₂ target, and the ratio of WLTP to NEDC CO₂ emissions in 2020. Each manufacturer is thus assigned a manufacturer-specific reference target for the years 2021–2024. The fleet-average of all manufacturer-specific reference CO₂ targets is 118.1 g/km.⁵

The passenger car fleet CO₂ targets for 2025–2029 and 2030–2034 are determined by applying the respective 15% and 55% reduction rates to the 2021 baseline of 109.8 g/km.⁶ Applying these reduction rates yields a 93.6 g/km target for 2025 and a 49.5 g/km target for 2030.⁷

Based on the preliminary EEA data, the sales-weighted fleet-average WLTP CO₂ emissions from new passenger cars in 2023 was 107 g/km, which is 1 g/km (1.5%) lower than in 2022.

Figure 1 plots the historical average CO₂ emission values relative to the targets. Up to and including 2020, NEDC CO₂ values are reported; after 2020, WLTP values are presented. Before standards were introduced, fleet CO₂ emissions, on average, declined by 1.9 g/km per year from 2000 to 2007. After the first CO₂ 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 CO₂ 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 CO₂ emissions increased

4 Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 Setting CO₂ 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>.

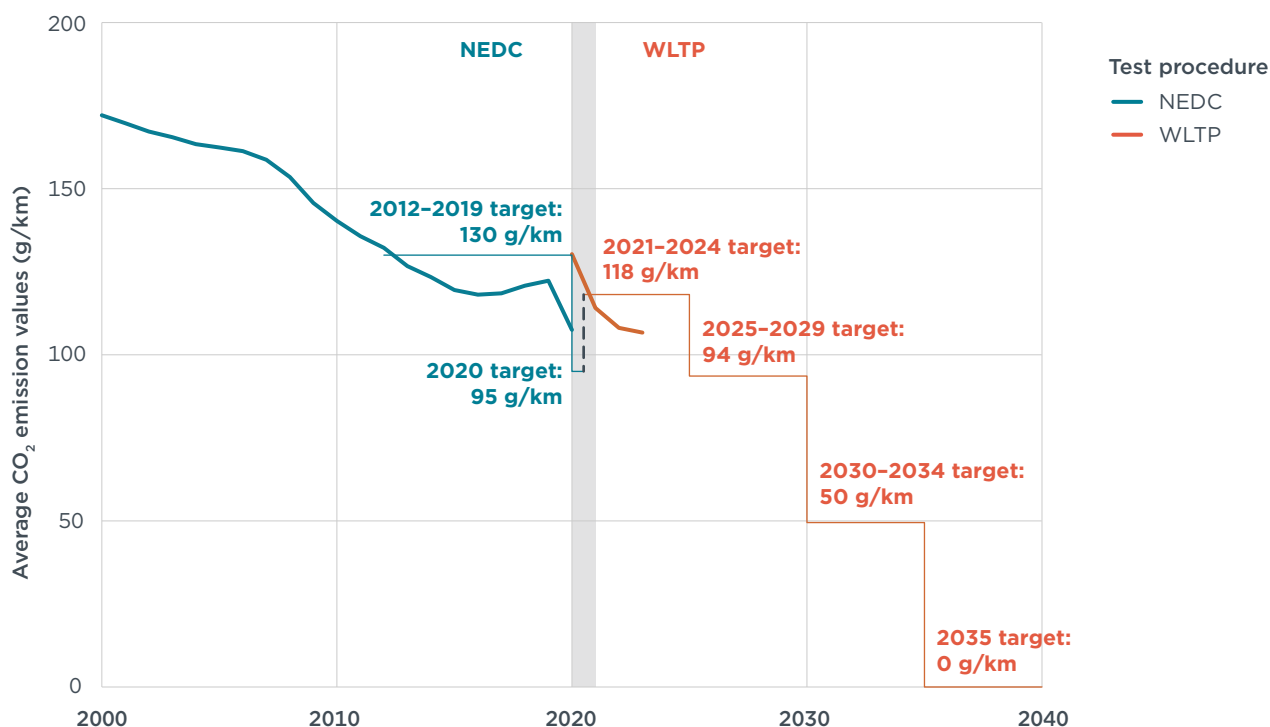
5 "Commission Implementing Decision (EU) 2023/1623 of 3 August 2023 Specifying the Values Relating to the Performance of Manufacturers and Pools of Manufacturers of New Passenger Cars and New Light Commercial Vehicles for the Calendar Year 2021 and the Values to Be Used for the Calculation of the Specific 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 CO₂ 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://eur-lex.europa.eu/eli/reg/2023/851/oj>; J. Suarez et al., *2025 and 2030 CO₂ Emission Targets for Light Duty Vehicles*, JRC Science For Policy Report (European Commission, Joint Research Centre, 2023), <https://data.europa.eu/doi/10.2760/901734>; Commission Implementing Decision (EU) 2023/1623 of 3 August 2023.

7 Unlike the manufacturer-specific reference targets which apply in the 2021–2024 period, the 2021 WLTP fleet target of 109.8 g/km, used as the baseline for determining the 2025 and 2030 targets, is calculated using the ratio of measured WLTP and declared NEDC CO₂ emissions in 2020, instead of using the declared WLTP emission value.

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.⁸ Removing the phase-in provisions in 2021 required a further drop in fleet-average CO₂ emissions to meet the equivalent WLTP target. After this substantial reduction in 2021, manufacturers faced no pressure to further reduce CO₂ emissions until the next round of targets in 2025–2029, so 2022 and 2023 reductions occurred at a slower pace.

Figure 1
Historical average NEDC and WLTP CO₂ emission values and targets for new passenger cars without flexible compliance mechanisms



Note: 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.

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CO₂ EMISSIONS BY VEHICLE MANUFACTURER

Car manufacturers can pool together several brands, not necessarily from the same manufacturer, to meet CO₂ targets. Unless otherwise noted, we track manufacturer pools for this analysis. Through 2028, vehicle manufacturers with fewer than 300,000 registered passenger cars per calendar year can apply for a niche derogation to receive non-standard, manufacturer-specific reduction targets for 2021 onwards. This section,

⁸ Commission Implementing Decision (EU) 2022/2087 of 26 September 2022 confirming or amending the provisional calculation of the average specific emissions of CO₂ 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.

therefore, focuses on manufacturer pools with more than 300,000 passenger car registrations in 2023.⁹

Table 1 presents data for nine manufacturer pools representing approximately 94% of all new passenger car registrations in the European Economic Area in 2023. The table displays each manufacturer's market share, average CO₂ emissions, and CO₂ target. In addition, it includes eco-innovation credits, which reward innovative technologies that produce real-world CO₂ savings beyond what is measured over a standardized test cycle during type approval, adjusted by a factor of 1.5 in 2023. Eco-innovation credits are described in more detail in a subsequent section.

All manufacturer pools are expected to have met their 2023 CO₂ targets, even without using the flexible compliance mechanisms. Eco-innovation technologies lowered CO₂ emission levels by 0.4 to 2 g/km.

Table 1

Market share, CO₂ emissions, impact of flexible compliance mechanisms, and CO₂ emission targets in 2023 for the largest manufacturer pools in terms of registrations

Manufacturer pool	Market share	Average mass (kg)	CO ₂ values (g/km, WLTP)				
			2023 average	Eco-innovations	Adjusted 2023 average	Target	Distance to target
BMW	7%	1,813	104	-1.4	102	129	-26
Mercedes-Benz AG	6%	1,928	108	-0.4	108	128	-21
Stellantis	18%	1,343	105	-1.8	103	118	-15
Kia	4%	1,476	102	-0.7	101	113	-12
ALL POOLS	94%	1,510	111	-1.3	110	119	-9
Subaru-Suzuki-Toyota	9%	1,384	111	-0.9	110	118	-8
Ford	4%	1,579	118	-2.0	116	124	-8
Hyundai Motor Europe	4%	1,466	107	-0.8	106	113	-6
Volkswagen	27%	1,572	120	-1.3	119	122	-3
Renault-Nissan-Mitsubishi	14%	1,362	111	-1.7	109	111	-2

Note: Rows are sorted by the distance to 2023 target levels.

FUEL TYPE AND TECHNOLOGY TRENDS BY MEMBER STATE AND MANUFACTURER

Uptake of electrified powertrain vehicles increased from 2022 to 2023. The share of battery electric vehicles (BEVs) grew by 2.1 percentage points (from 13.4% to 15.5%), whereas the share of plug-in hybrid electric vehicles (PHEVs) decreased by 1.8 percentage points (from 9.6% to 7.8%). The share of full hybrid electric vehicles (HEVs) grew by 1.1 percentage points (from 8.3% to 9.4%), and the share of mild hybrid electric vehicles (MHEVs), that is internal combustion engine vehicles (ICEVs) using a low-voltage electric system, increased by 2.2 percentage points (from 14.7% to 16.9%). The diesel vehicle market share (including MHEVs) continued to fall, decreasing from 20%

⁹ In 2023, manufacturer pools (and their major brands) were: BMW (BMW, Mini); Ford (Ford); Hyundai Motor Europe (Hyundai); Kia (Kia); Mercedes-Benz AG (Mercedes-Benz, Smart); Renault-Nissan-Mitsubishi (Dacia, Mitsubishi, Nissan, Renault); Stellantis (Alfa Romeo, Citroën, DS Automobiles, Fiat, Jeep, Lancia, Opel, Peugeot, Vauxhall); Subaru-Suzuki-Toyota (Lexus, Subaru, Suzuki, Toyota); and Volkswagen (Audi, Cupra, Porsche, Seat, Škoda, VW). The pools KG Mobility Great Wall Motor and Mazda registered fewer than 300,000 passenger cars in 2023 and are not included in the results. The manufacturer Tesla registered more than 300,000 passenger cars in 2023 but has not joined a pool and, as an all-electric vehicle manufacturer, met its CO₂ target and is thus not included in the results.

in 2022 to 18% in 2023, while the share of petrol vehicles (including MHEVs) marginally increased from 46% in 2022 to 47% in 2023. Other powertrains, predominantly compressed natural gas and liquefied petroleum gas vehicles, accounted for 3.0% of the market, similar to the 2022 share of 2.9%.

Table 2 presents the market share of the various fuel types and powertrain technologies by country in 2023.¹⁰ Norway continues to dominate the European BEV market in terms of market penetration, with more than 83% of new car registrations in 2023 being BEVs. In Iceland, another non-EU country, almost half of all new car registrations were BEVs. Of the EU Member States, Sweden saw the highest uptake of electric vehicles with 39% BEVs. Denmark, Finland, and the Netherlands had BEV market shares of around one third. Germany, the largest vehicle market in the EU, saw a marginal increase in the BEV registration share, from 17.7% in 2022 to 18.4% in 2023.

Shares of HEVs were particularly high in Poland and Lithuania, where almost one fifth of new car registrations were HEVs. More broadly, shares of HEVs exceeded 10% in half of the countries in the European Economic Area. Since noteworthy numbers of MHEVs were first registered in 2018, their market share has increased rapidly in most countries and constituted more than one quarter of diesel and petrol vehicles registered in 2023.

In 2023, PHEVs were most popular in Sweden, Belgium, and Finland, exceeding a market share of 20% in these three countries. Registration shares of PHEVs were higher than 10% in Portugal (13.5%), the Netherlands (12.7%), and Iceland (11.5%). In Germany, the PHEV market share decreased by more than half from 13.7% in 2022 to 6.2% in 2023.

At their peak in 2010–2015, diesel vehicles accounted for more than half of annual passenger car registrations in Europe but exceeded 25% in only two markets in 2023 (Austria and Czechia). Romania, Italy, and Portugal were the only markets with a share of compressed natural gas and liquefied petroleum gas vehicles above 5% in 2023.

¹⁰ 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 2023 by country**

Market	Diesel	Petrol	Mild hybrid electric	Hybrid electric	Plug-in hybrid electric	Battery electric	Other	EEA market share
Germany	24%	47%	19.9%	3.4%	6.2%	18.4%	0.5%	26.6%
France	11%	45%	10.0%	14.3%	9.2%	16.8%	3.8%	16.6%
Italy	23%	49%	25.9%	10.1%	4.4%	4.2%	9.1%	14.7%
Spain	17%	54%	17.6%	13.9%	6.5%	5.7%	2.7%	9.0%
Belgium	10%	42%	13.0%	7.6%	20.8%	19.3%	0.7%	4.5%
Poland	16%	56%	21.1%	19.5%	2.8%	3.6%	2.6%	4.5%
Netherlands	1%	44%	13.6%	10.8%	12.7%	30.8%	0.6%	3.5%
Sweden	8%	22%	11.2%	8.7%	21.0%	38.7%	1.4%	2.7%
Austria	26%	41%	15.2%	5.7%	7.0%	19.6%	0.0%	2.3%
Czechia	26%	60%	9.8%	6.4%	2.6%	3.0%	1.8%	2.1%
Portugal	14%	44%	9.1%	5.5%	13.5%	17.4%	5.6%	1.8%
Denmark	9%	41%	6.9%	4.7%	9.9%	36.1%	0.0%	1.6%
Romania	14%	50%	17.0%	9.7%	3.8%	10.6%	12.2%	1.3%
Greece	15%	61%	20.1%	10.5%	6.8%	4.7%	2.8%	1.3%
Norway	2%	1%	0.3%	6.0%	7.9%	82.5%	0.0%	1.2%
Ireland	25%	30%	7.0%	17.1%	9.6%	18.7%	0.0%	1.2%
Hungary	18%	57%	28.0%	13.6%	5.2%	5.4%	0.5%	1.0%
Slovakia	23%	59%	17.1%	10.3%	2.7%	3.1%	2.1%	0.9%
Finland	6%	23%	9.8%	15.7%	20.8%	33.8%	0.5%	0.8%
Croatia	25%	62%	17.5%	5.3%	2.2%	3.0%	2.9%	0.6%
Luxembourg	21%	43%	14.9%	4.4%	9.8%	22.5%	0.1%	0.5%
Slovenia	19%	64%	13.1%	6.1%	1.4%	9.0%	1.0%	0.4%
Lithuania	15%	52%	19.8%	19.3%	3.8%	7.5%	1.7%	0.3%
Estonia	18%	57%	23.2%	16.5%	2.4%	6.3%	0.3%	0.2%
Iceland	15%	14%	5.6%	9.2%	11.5%	49.8%	0.0%	0.2%
Latvia	20%	51%	6.6%	16.6%	1.9%	8.8%	2.0%	0.2%
Cyprus	6%	70%	23.2%	15.0%	3.5%	5.3%	0.0%	0.1%
EEA total	18%	47%	16.9%	9.4%	7.8%	15.5%	3.0%	

Notes: Countries are sorted by descending EEA 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 liquefied petroleum gas fueled vehicles.

Table 3 presents the market share by fuel type and powertrain technology in 2023 for manufacturer pools and selected brands. Most pools had a BEV share above 10% in 2023, led by BMW with almost 20%. Ford, Mazda, and Subaru-Suzuki-Toyota were the only pools with BEV registration shares below 5%. Subaru-Suzuki-Toyota stands out with almost two thirds of its registrations being HEVs. Among brands, Tesla and Smart registered 100% BEVs in 2023. The BEV share of MG reached about 51%, and Volvo, Mini, and Cupra each had a BEV share above 20%.

DS Automobiles (41%) and Volvo (35%) had the highest shares of PHEVs. The Mercedes-Benz AG pool stands out with the highest diesel share of 39%, including MHEVs, while all

other pools had diesel shares below 30%, resulting in an average share of 18%. Outside the Mercedes-Benz AG pool, diesel accounted for more than one third of the passenger car registrations of the brands Alfa Romeo (41%), Audi (34%), and BMW (34%).

The manufacturer pool Renault-Nissan-Mitsubishi had by far the highest share of compressed natural gas and liquefied petroleum gas vehicles at 17.5% compared to a fleet average of about 3%. This was primarily driven by the brand Dacia, which had a market share of such vehicles of more than 38%.

Table 3
Market share of fuels/technologies for new passenger cars in 2023 for manufacturer pools

Manufacturer pool	Diesel	Petrol	Mild hybrid electric	Hybrid electric	Plug-in hybrid electric	Battery electric	Other	EEA market share
Volkswagen	26%	55%	11.0%	0.0%	5.7%	12.9%	0.3%	25.9%
Volkswagen	26%	56%	3.8%	0.0%	3.2%	14.6%	0.2%	10.8%
Škoda	31%	55%	4.3%	0.0%	2.6%	11.1%	0.4%	5.5%
Audi	34%	43%	37.3%	0.0%	10.0%	13.2%	0.1%	5.4%
SEAT	15%	82%	2.7%	0.0%	2.6%	0.0%	0.9%	1.9%
Cupra	7%	55%	9.3%	0.0%	17.8%	20.4%	0.0%	1.6%
Porsche	0%	64%	0.0%	0.0%	18.7%	17.0%	0.0%	0.7%
Stellantis	19%	61%	15.9%	0.0%	6.9%	11.8%	0.7%	17.6%
Peugeot	24%	56%	0.7%	0.1%	8.1%	11.9%	0.0%	5.3%
Fiat	15%	66%	59.4%	0.0%	0.0%	17.2%	2.1%	3.4%
Opel/Vauxhall	13%	67%	0.0%	0.0%	4.7%	15.1%	0.0%	3.3%
Citroën	22%	65%	0.3%	0.0%	5.6%	7.2%	0.0%	3.2%
Jeep	18%	53%	20.5%	0.0%	20.0%	9.5%	0.0%	1.1%
Alfa Romeo	41%	46%	32.6%	0.0%	12.7%	0.0%	0.0%	0.4%
DS Automobiles	30%	23%	0.0%	0.0%	40.6%	6.8%	0.0%	0.4%
Lancia	0%	89%	88.7%	0.0%	0.0%	0.0%	11.3%	0.4%
Renault-Nissan-Mitsubishi	8%	45%	11.1%	18.2%	1.3%	10.7%	17.5%	13.0%
Renault	10%	45%	14.0%	25.7%	1.3%	11.1%	6.9%	5.9%
Dacia	9%	39%	0.0%	1.9%	0.0%	11.4%	38.5%	4.8%
Nissan	1%	49%	30.7%	39.0%	0.0%	10.2%	0.4%	1.9%
Mitsubishi	0%	70%	10.1%	6.4%	23.1%	0.0%	0.0%	0.4%
Subaru-Suzuki-Toyota	2%	30%	15.3%	61.8%	3.2%	2.2%	0.3%	8.6%
Toyota	3%	18%	0.0%	74.5%	2.2%	2.5%	0.1%	6.6%
Suzuki	0%	87%	85.2%	11.8%	1.5%	0.0%	0.0%	1.5%
Lexus	0%	4%	0.0%	65.5%	27.0%	3.9%	0.0%	0.4%
BMW	28%	37%	26.5%	0.0%	15.3%	19.6%	0.0%	6.8%
BMW	34%	30%	32.6%	0.0%	16.9%	18.9%	0.0%	5.6%
Mercedes-Benz AG	39%	24%	29.0%	0.0%	19.2%	17.8%	0.0%	5.9%
Mercedes-Benz	41%	25%	30.3%	0.0%	20.0%	14.0%	0.0%	5.6%
Smart	0%	0%	0.0%	0.0%	0.0%	99.9%	0.0%	0.3%
Kia	7%	57%	19.6%	9.5%	10.7%	13.3%	2.3%	4.2%
Kia	7%	57%	19.6%	9.5%	10.7%	13.3%	2.3%	4.2%
Hyundai	5%	58%	18.0%	16.3%	5.1%	15.0%	1.0%	4.1%
Hyundai	5%	58%	18.1%	16.3%	5.1%	14.9%	1.0%	4.1%
Ford	19%	57%	44.3%	7.8%	11.0%	4.4%	1.5%	3.8%
Ford	19%	57%	44.3%	7.8%	11.0%	4.4%	1.5%	3.8%
Mazda	9%	68%	51.7%	6.4%	11.9%	4.9%	0.0%	1.4%
Mazda	9%	68%	51.7%	6.4%	11.9%	4.9%	0.0%	1.4%
Other brands								
Tesla	0%	0%	0.0%	0.0%	0.0%	100.0%	0.0%	2.9%
Volvo	19%	20%	35.9%	0.0%	34.9%	26.1%	0.0%	2.1%
MG	0%	44%	0.0%	0.0%	4.9%	51.4%	0.0%	1.4%
EEA total	18%	47%	16.9%	9.4%	7.8%	15.5%	3.0%	

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 liquefied petroleum gas fueled vehicles.

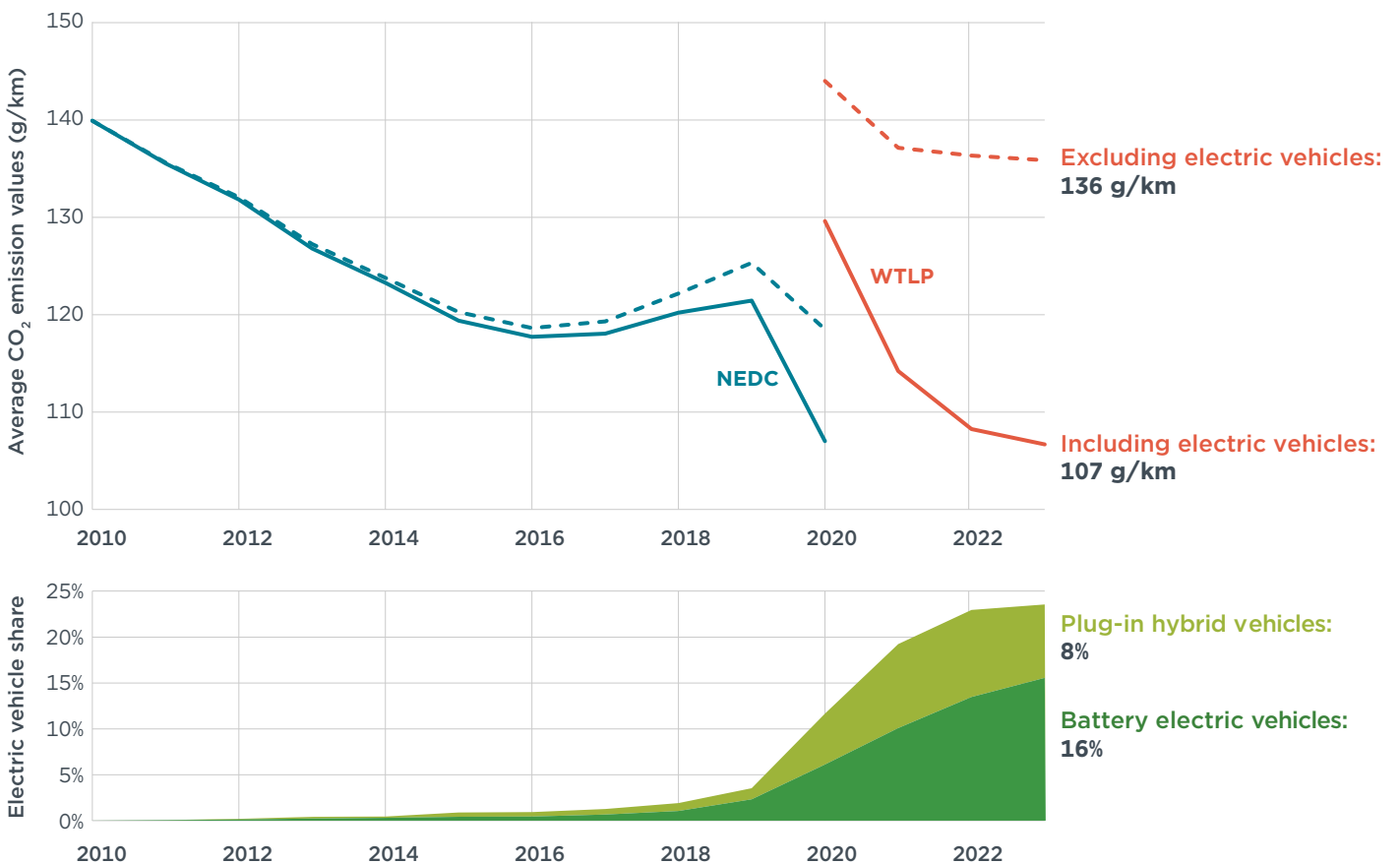
FLEXIBLE COMPLIANCE MECHANISMS

Several flexible compliance mechanisms were included in the EU CO₂ standards to reduce compliance costs, foster innovation, and accommodate changes in the vehicle market. Mass-based CO₂ targets are one of the principal mechanisms to account for varying consumer preferences. Other compliance mechanisms include incentives for innovative technologies, manufacturer pooling, and derogations for small manufacturers.

Sales of BEVs and PHEVs also reduce a manufacturer's fleet-average CO₂ emissions. Figure 2 plots the historical fleet-average CO₂ emissions when excluding BEVs and PHEVs in comparison with the emissions when including all vehicles. Up to and including 2020, NEDC CO₂ values are plotted, and WLTP values are presented from 2020 onward. The figure shows that the WLTP CO₂ emissions of combustion engine vehicles, including hybrid vehicles, have only declined by 1 g/km since 2021 and remain at about 136 g/km. Fleet-average CO₂ reductions from 2021 to 2023 are almost entirely due to the growing share of BEVs and PHEVs, which lowered 2023 fleet-average type-approval CO₂ emissions by 29 g/km to 107 g/km.

Figure 2

Top panel: Historical average CO₂ emissions excluding and including battery electric and plug-in hybrid vehicles Bottom panel: Share of battery electric and plug-in hybrid vehicles



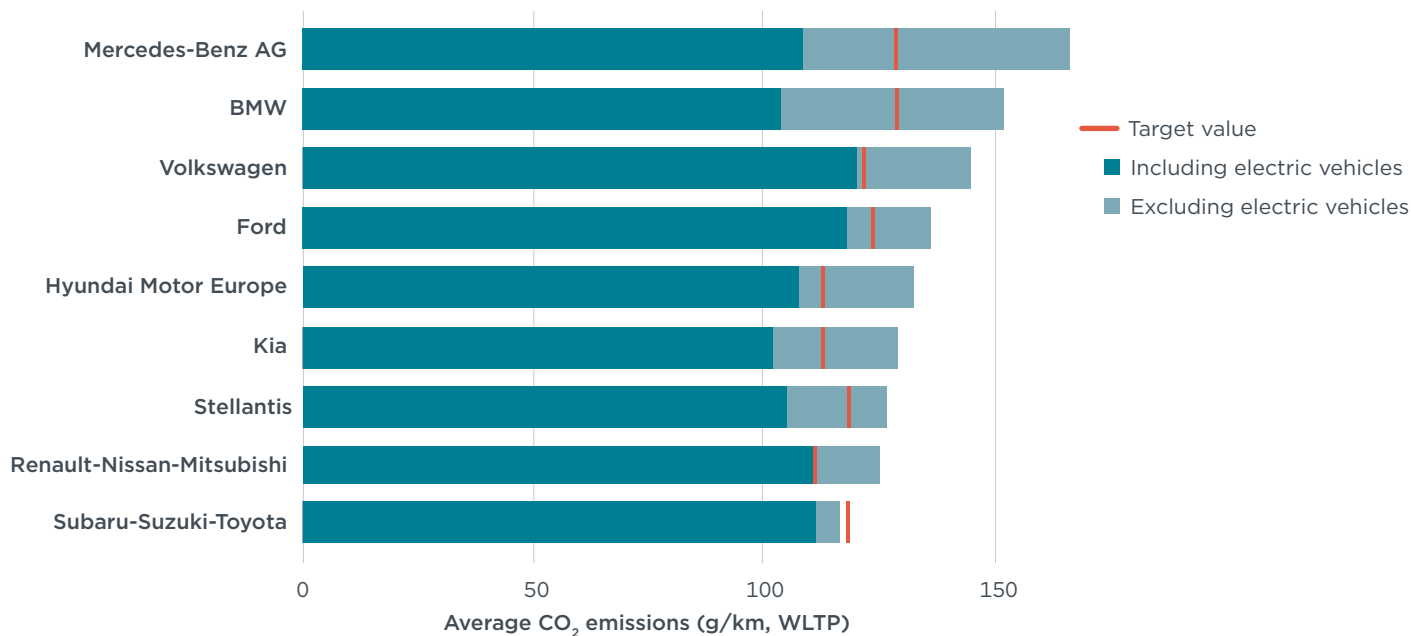
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As shown in Figure 3, eight of the nine major manufacturer pools made use of BEVs and PHEVs to meet their 2023 targets, though to different extents. Without electric vehicles, the Mercedes-Benz AG pool would have missed its target by 37 g/km and BMW and Volkswagen by 23 g/km. Including electric vehicles, BMW and Mercedes-Benz AG overachieved their targets by the widest margin (25 g/km and 20 g/km,

respectively) while Renault-Nissan-Mitsubishi and Volkswagen came closest missing their targets (within 0 g/km and 2 g/km, respectively). Subaru-Suzuki-Toyota had the lowest share of electric vehicle registrations (6.7%) and was the only pool to meet their target when excluding BEVs and PHEVs, instead largely relying on sales of hybrid electric vehicles.

Figure 3

Manufacturer pool average CO₂ emissions, including and excluding electric vehicles, compared with their respective 2023 targets

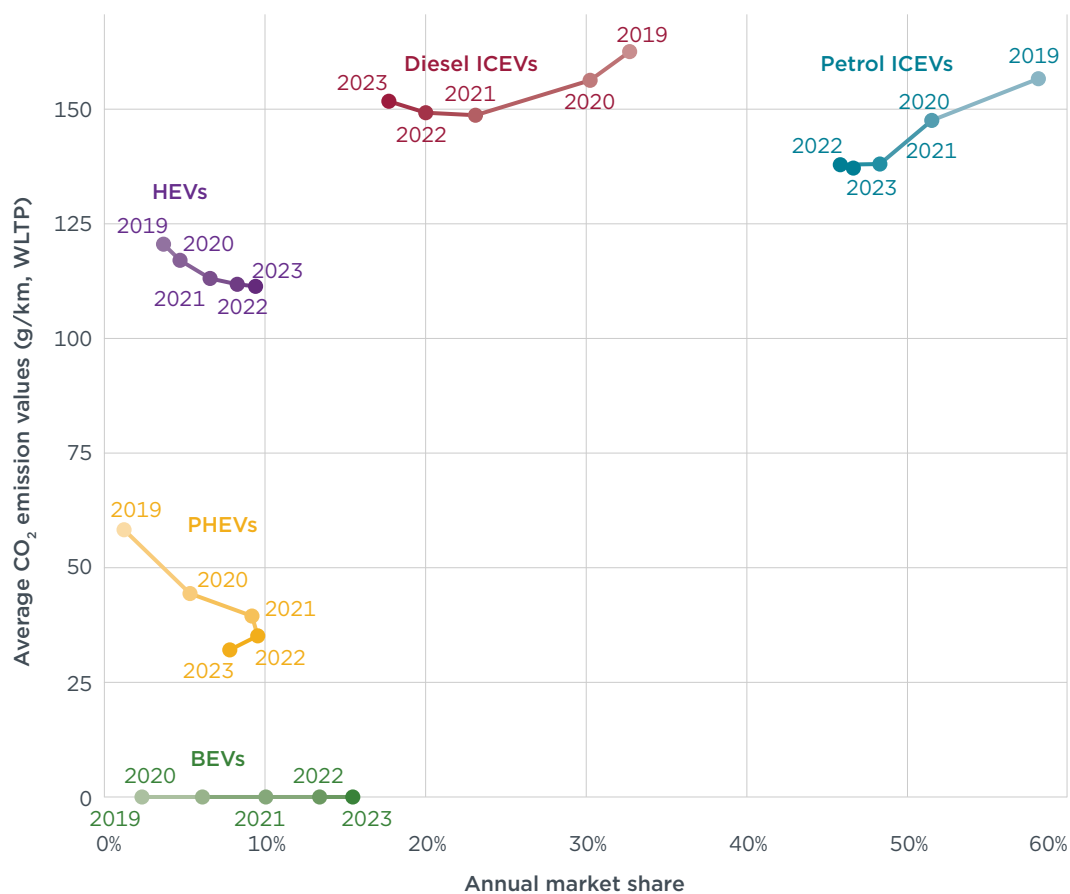


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Figure 4 shows the market shares and average CO₂ emissions of different fuel and powertrain technologies over time. Vehicles of all powertrains and fuel combinations saw declining CO₂ emissions in 2019-2021. For ICEVs and HEVs, CO₂ emissions stabilized or slightly increased in 2022-2023 compared to 2021. The market shares of both diesel and petrol ICEVs have decreased by more than 10 percentage points since 2019. Growth of the PHEV market share slowed substantially in 2022 and reversed in 2023, whereas the BEV share continued its rapid increase. Overall, Figures 2-4 illustrate that CO₂ emission reductions since 2021 were mostly achieved by selling BEVs and, to a lesser extent, PHEVs while efficiency improvements in ICEVs stalled.

Figure 4

Annual average CO₂ emissions and market share per fuel and powertrain technology, 2019–2023



Note: Diesel and petrol ICEVs include mild hybrid electric vehicles.

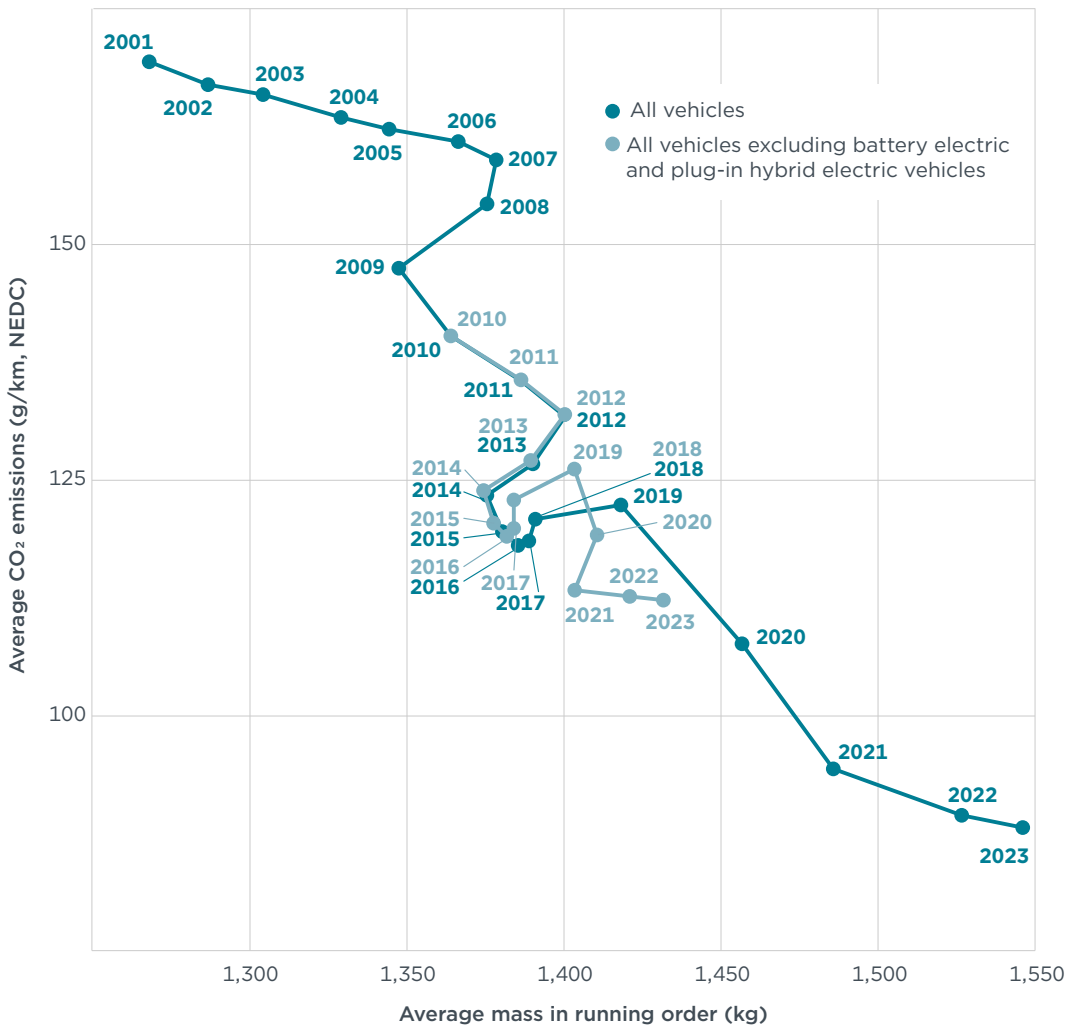
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In the EU CO₂ standards, manufacturer CO₂ targets increase with vehicle mass to account for varying consumer preferences. This mechanism was introduced at a time when virtually all vehicles were ICEVs, meaning that heavier vehicles would generally emit more CO₂ than lighter vehicles. Electric vehicles (BEVs and PHEVs), however, have zero to low tailpipe CO₂ emissions over the WLTP and are substantially heavier than ICEVs (34% heavier in 2023), thus decoupling CO₂ emissions from mass.

Figure 5 plots the annual average NEDC-equivalent CO₂ emissions over average vehicle mass, both including and excluding electric vehicles. The average CO₂ emissions of ICEVs remained fairly constant from 2021 to 2023, despite a slight increase in average mass of about 28 kg. When taking electric vehicles into account, the average mass continued its rapid growth that began in 2019, increasing by 19 kg, from 1,528 kg in 2022 to 1,546 kg in 2023. Fleet-average CO₂ emissions have declined in parallel, reducing by about 1 g/km, from 89 g/km in 2022 to 88 g/km in 2023 g/km NEDC-equivalent.

Figure 5

Annual average CO₂ emissions and average mass in running order, including and excluding battery electric and plug-in hybrid vehicles



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Coupled with the fact that new passenger cars have become heavier over time, the way the CO₂ emission standards account for vehicle mass inflates CO₂ targets. While 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. The fleet-average reference target for the 2021–2024 period is thus inflated by 3.1 g/km, or 2.7%, from 115 g/km to 118.1 g/km.¹¹

For the calculation of 2023 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

¹¹ Commission Implementing Decision (EU) 2022/2087 of 26 September 2022 Confirming or Amending the Provisional Calculation of the Average Specific Emissions of CO₂ 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>.

average vehicle mass in the years 2017, 2018, and 2019, which was 1,398.5 kg.¹² However, due to the 2023 fleet-average mass being 1,546 kg, and thereby 147 kg heavier than the reference value, the fleet-average 2023 WLTP CO₂ target calculates to 120 g/km. This means the fleet-average target in 2023 is approximately 4% 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 CO₂ reduction intended by the regulation.

Eco-innovation credits incentivize the development and adoption of new fuel efficiency technologies that produce real-world CO₂ savings beyond what is measured over a standardized test cycle during vehicle type approval. Because CO₂ savings from eco-innovations count toward manufacturers' annual CO₂ performance, automakers have an incentive to deploy cost-effective eco-innovation technologies.¹³ In 2021, 2022, and 2023, eco-innovation credits are multiplied by 1.9, 1.7, and 1.5, respectively, in the calculation of manufacturers' CO₂ savings from eco-innovation technologies.¹⁴ The total impact of eco-innovation technologies on the CO₂ emission targets is limited to 7 g/km per manufacturer pool per year.

The share of new passenger cars equipped with eco-innovation technologies decreased from 65% in 2022 to 54% in 2023. Figure 6 plots the average CO₂ emission reduction through eco-innovation technologies per manufacturer pool in 2023, with and without applying the 1.5 multiplier. Market-wide average CO₂ reductions from eco-innovation technologies were 1.2 g/km in 2023, down from 1.7 g/km in 2022. Three manufacturer pools, Ford, Stellantis, and Renault-Nissan-Mitsubishi, had eco-innovation technologies installed in more than two thirds of passenger cars registered in 2023. These three pools, in addition to BMW and Volkswagen, benefited from above-average eco-innovation savings. The Mercedes-Benz AG pool made the least use of this mechanism, claiming a reduction of 0.4 g/km, roughly one fifth of the reduction claimed by the Ford pool of 2 g/km.

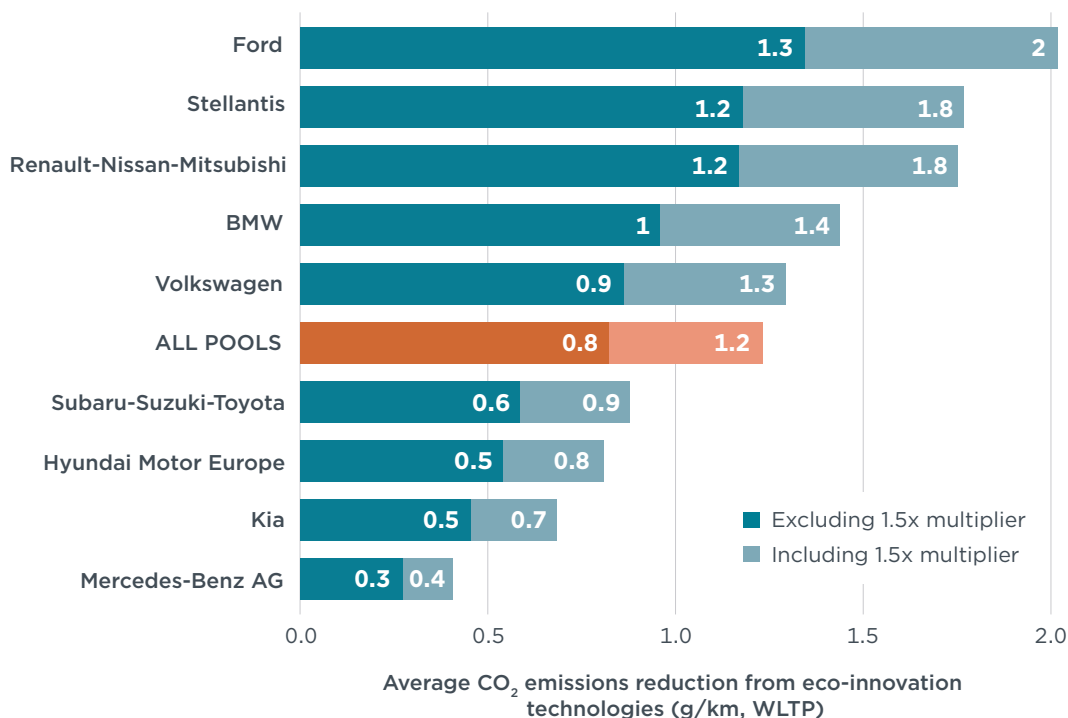
12 Commission Delegated Regulation (EU) 2021/1961 of 5 August 2021 Amending Annex I to Regulation (EU) 2019/631 of the European Parliament and of the Council in Order to Take into Account the Evolution of the Mass of New Passenger Cars Registered in 2017, 2018 and 2019 (Text with EEA Relevance), Pub.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

13 Uwe Tietge, Peter Mock, and Jan Dornoff, *Overview and Evaluation of Eco-Innovations in European Passenger Car CO₂ Standards* (International Council on Clean Transportation, 2018), <https://theicct.org/publication/overview-and-evaluation-of-eco-innovations-in-european-passenger-car-co2-standards/>.

14 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.

Figure 6

Average CO₂ emissions reduction in 2023 per manufacturer pool from eco-innovation technologies, including and excluding the 2023 multiplier of 1.5



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OUTLOOK

Based on the preliminary EEA dataset, all manufacturer pools met their 2023 CO₂ targets. Manufacturers mostly relied on increasing the share of battery electric and plug-in hybrid electric vehicles to meet their targets. CO₂ emissions of combustion engine vehicles largely remained unchanged over the past 2 years and the impact of eco-innovation technologies remained low.

At the fleet-average level, CO₂ emission reductions stalled between 2022 and 2023, likely because of the flat CO₂ targets from 2021 to 2024. This pattern of stalling CO₂ reductions in the absence of continuous targets was also observed from 2012 to 2019 and was followed by a steep decline in CO₂ emissions to meet the 2020 target.

Regulation (EU) 2023/851 adjusted the 2030 CO₂ reduction target from the passenger car fleet to -55% compared to 2021 levels and introduced a -100% target for 2035.¹⁵ 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 low or zero CO₂ emission vehicle technologies to the late 2020s. The 2023 slowdown in CO₂ emission reductions, electric vehicle uptake, and efficiency improvements of non-electric vehicles seems to validate this possibility. In addition, with the fleet-average mass increasing at a much higher rate than assumed by the regulation, CO₂ targets are inflated, thus undermining the reduction efforts. Nevertheless, the phase-out of new combustion engine vehicles by 2035 will be an

¹⁵ 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 CO₂ emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition. <https://eur-lex.europa.eu/eli/reg/2023/851/oj>.

important step toward reaching the EU's climate protection targets and would send a strong signal to the rest of the world that the EU leads by example.

While the EU CO₂ emission standards focus on official type-approval emissions, it is important to ensure that real-world emissions decrease at the same rate. Real-world emissions are, however, substantially higher than the official values presented in this briefing. The gap between real-world and NEDC CO₂ emission values of internal combustion engine and hybrid electric cars widened over time and reached approximately 33% in 2018.¹⁶ With the introduction of the WLTP, the gap between real-world and official figures narrowed to approximately 8% in the same year. There are, however, signs that the WLTP gap is growing, reaching about 14% in 2022. Since 2021, on-board fuel consumption meters that monitor real-world fuel consumption are mandatory in European new passenger cars and most vans. The European Commission is tasked to analyze this data and, on this basis, enact policies to prevent a widening of the gap between type-approval and real-world emission values in the future.¹⁷

16 Jan Dornoff, Victor Valverde Morales, and Uwe Tietge, *On the Way to 'Real-World' CO₂ Values? The European Passenger Car Market after 5 years of WLTP* (International Council on Clean Transportation, 2024), [https://theicct.org/publication/real-world-CO₂-emission-values-vehicles-Europe-jan24](https://theicct.org/publication/real-world-CO2-emission-values-vehicles-Europe-jan24).

17 Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 Setting CO₂ 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>.



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