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REPORT FROM THE COMMISSION

Commission report under Article 12(3) of Regulation (EU) 2019/631 on the evolution of the real-world CO2 emissions gap for passenger cars and light commercial vehicles and containing the anonymised and aggregated real-world datasets referred to in Article 12 of Commission Implementing Regulation (EU) 2021/392

{SWD(2024) 59 final}

1. INTRODUCTION

Road transport is responsible for about one fifth of the European Union's (EU) greenhouse gas emissions. Within road transport emissions, light-duty vehicles (passenger cars and light commercial vehicles) are responsible for around 70% of the total ([1]).

To reach climate neutrality in the EU by 2050, the European Green Deal ([2]) calls for a 90% reduction in greenhouse gas emissions from transport compared to 1990 levels. Regulation (EU) 2019/631 ([3]), which sets out the CO_2 emission performance standards for new light-duty vehicles, is one of the key policy instruments put in place to achieve this goal.

The official CO_2 emission values of vehicles, as determined during type-approval, are used to determine whether manufacturers comply with the targets under the Regulation. As such, the effectiveness of these targets in reducing CO_2 emissions, as well as the robustness of the CO_2 emission monitoring system, depend on how well those official test values represent the 'real-world' emissions of vehicles out on the road. This representativeness is important for the environmental integrity, transparency, and reliability of the monitoring system, and therefore also for consumers' trust.

Several measures have been put in place over recent years to make sure test values come as close to reality as possible. In 2017, the Worldwide harmonised Light vehicle Test Procedure (WLTP) ([4]) was introduced, which was designed to better represent real-world driving conditions. As part of the new procedures, new vehicles have to be equipped with on-board fuel consumption monitoring devices ('OBFCM devices'). This requirement applies for new M1 vehicles (cars) registered since 2021 and new N1 vehicles (vans) registered since 2022. In addition, Regulation (EU) 2019/631 introduced a requirement for national authorities to verify the correctness of the official WLTP CO_2 values through testing vehicles already in-service, i.e. used on the roads.

Regulation (EU) 2019/631 also tasked the Commission with monitoring the 'real-world' CO_2 emissions of vehicles on the road, using the data read out from the OBFCM devices, and comparing it with the corresponding official WLTP data ([5]).

([1]) https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

([2]) COM/2019/640 final, 11.12.2019

([3]) 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 Regulation (EC) No 443/2009 and (EU) No 510/2011 (OJ L 111, 25.4.2019, p. 13)

([4]) Commission Regulation (EU) 2017/1151 of 1 June 2017 supplementing Regulation (EC) No 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information, amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) No 1230/2012 and repealing Commission Regulation (EC) No 692/2008 (OJ L 175, 7.7.2017, p. 1)

([5]) The procedures for collecting and reporting this 'real-world' data and for comparing it with the corresponding WLTP data are set out in Commission Implementing Regulation (EU) 2021/392 (OJ L 77, 5.3.2021, p. 8)

This report is the first on the implementation of that 'real-world' CO_2 emission monitoring, focusing on data reported in 2022, for vehicles first registered in 2021. The official WLTP data used for the comparison was finalised and adopted in August 2023 ([6]).

This report includes an overview of the data received and processed by the Commission (Section 2), the main results of the analysis (Section 3), an assessment of how the real-world data may be used in the future (Section 4), and the conclusions that can be drawn at this stage (Section 5).

The Staff Working Document ([7]) accompanying this report sets out the methodology used for processing and analysing the real-world data and contains more detailed results. It also contains the first of the anonymised and aggregated annual datasets per manufacturer that form the basis for the Commission to monitor the gap between the WLTP and real-world values ([8]).

2. DATASET

2.1. Data sources and data processing

According to Implementing Regulation (EU) 2021/392, real-world data must be collected by both vehicle manufacturers and Member States and reported to the European Environment Agency (EEA). Manufacturers may rely on data transfer over-the-air directly from the vehicle or collect this data through their authorised dealers or repairers when vehicles are brought in for service or repairs. Member States have been required to collect the real-world data during roadworthiness tests since 20 May 2023.

This first report is based on the real-world data collected by vehicle manufacturers throughout 2021 on their cars and vans equipped with OBFCM devices. Real-world data was received for 988 231 vehicles out of a total of 9 821 479 vehicles first registered in 2021 in the EU, Iceland or Norway ([9]). This included 916 216 cars and 12 301 vans ([10]), which corresponds to 10.6% and 1.0%, respectively, of those vehicles first registered in 2021 ([11]).

Before being analysed, the data was processed and aggregated in several steps. Unrepresentative data, inconsistent data, outliers, and vehicles out-of-scope were removed.

([6]) 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 (OJ L 111, 25.4.2019, p. 13.)

([7]) SWD(2024) 59

([8]) In accordance with Article 12 of Implementing Regulation (EU) 2021/392.

([9]) The total number of new cars and vans referred to do not include vehicles not in-scope for OBFCM (pure electric vehicles, fuel cell electric vehicles, natural gas vehicles), and E85 vehicles.

([10]) 59 714 vehicles could not be matched with the 2021 WLTP data.

([11]) Data shall be collected by manufacturers either over-the-air via direct data transfer from the vehicle, or, where data is not collected this way, data shall be collected each time the vehicle is brought in for service or repairs, unless the vehicle owner expressly refuses to make that data available. See also Section 3.2.1.

In particular, vehicles with a mileage below 500 km were filtered out, which removed 27% of cars in the dataset. Overall, 63% of the reported vehicles were retained in the final dataset. Further details on the process can be found in the accompanying Staff Working Document.

2.2. Final 2021 real-world dataset

The final dataset, which was used for the further calculations, is presented in *Table 1* below. It includes 617 194 cars (7.2% of cars first registered in 2021) and 6 667 vans (0.6% of vans first registered in 2021).

Overall, only a small number of manufacturers reported data from a significant share of their vehicles registered in 2021. Further efforts by manufacturers will be required to significantly improve the fleet coverage in the coming years. While for cars this dataset is sufficient to draw preliminary conclusions, there was an uneven distribution between data presented by manufacturers (see Section 3.2.1). For vans, the fleet coverage is very limited, which is explained by the fact that Class II and III vans (i.e. those weighing over 1 305 kg), which represent the vast majority of the fleet, are only required to have OBFCM devices as of 2022. As such, the real-world dataset for vans cannot be considered representative of the 2021 registrations, and this report's analysis focuses solely on cars.

Among cars, diesel and plug-in hybrid electric vehicles represent a higher share of the real-world dataset than of the overall 2021 registrations. Further calculations and gap analyses are therefore undertaken for each powertrain/fuel type.

Table 1: Final real-world dataset

Powertrain/fuel type	Number of vehicles reported	Number of vehicles after processing (% retained)	Total 2021 registrations by powertrain/fuel type	Share of 2021 registrations retained per powertrain/fuel type
Cars				
Petrol	391 329	274 451 (70.1%)	5 495 708	5.0%
Diesel	301 995	219 003 (72.5%)	2 229 388	9.8%
E85	2 084	0	6 026	0%
Other fuels	697	0	215 798	0%
Plug-in hybrid (petrol)	191 197	98 847 (51.7%)	848 251	11.7%
Plug-in hybrid (diesel)	28 914	24 893 (86.1%)	55 805	44.6%
TOTAL cars	***916 216***	***617 194 (67.4%)***	***8 629 152***	***7.2%***
Vans				

Petrol	1 891	988 (52.3%)	44 475	2.2%
Diesel	10 053	5 593 (55.6%)	1 139 405	0.5%
Other fuels	30	0	58 488	0%
Plug-in hybrid (petrol)	326	86 (25.8%)	1 501	5.7%
Plug-in hybrid (diesel)	1	0	4	0%
TOTAL vans	***12 301***	***6 667 (54.2%)***	***1 185 385***	***0.6 %***

2.3. Representativeness of the final 2021 real-world dataset

To assess whether the cars covered by the final 2021 real-world dataset are representative of the vehicles first registered in 2021 (per powertrain/fuel type), their average WLTP CO_2 emissions and mass are compared, as shown in *Table 2*.

This indicates that, on average, the petrol and diesel cars in the real-world dataset are around 7% heavier than the average new car registered in 2021, and their WLTP CO_2 emissions are around 6-8% higher. A similar trend is observed for petrol plug-in hybrid electric cars. This may bias results.

This is related to the fact that the 2021 real-world dataset is dominated by vehicles from a small number of manufacturers (see Section 3.2.1), many of which having over-the-air capabilities allowing data transmission directly to the manufacturers. In 2021, such vehicles were more prominently present in the heavier fleet segments.

Table 2: Representativeness of the real-world dataset compared to the vehicles first registered in 2021 (cars) ([12])

Powertrain/fuel type	**Average WLTP CO_2 emissions (g CO_2/km)**		**Average mass in running order (kg)**	
	real-world dataset	2021 first registrations	real-world dataset	2021 first registrations
Petrol	145.0	134.8	1 404	1 317
Diesel	153.0	144.7	1 747	1 627
Petrol + Diesel	148.5	137.7	1 554	1 407
Plug-in hybrid (petrol)	40.3	37.7	1 955	1 899
Plug-in hybrid (diesel)	37.2	37.2	2 281	2 291
Plug-in hybrid (all)	39.6	37.7	2 021	1 923

([12]) See note 9, page 2.

3. RESULTS

The average real-world and WLTP CO_2 emissions and fuel consumption, as well as the gap between those real-world and WLTP values are calculated at fleet level and for each manufacturer separately.

The calculation methodology and results are presented in more detail in the Staff Working Document, which also contains the data at country-level, and information regarding the electric energy consumption of the plug-in hybrid electric vehicles.

3.1. Fleet-wide assessment of the average CO_2 emissions, fuel consumption and real-world gap

Table 3 summarises the main findings for cars. It shows, for each of the powertrain/fuel type groups, the average real-world fuel consumption and CO_2 emissions, as well as the corresponding WLTP values, and the relative gap between those average real-world and WLTP values. For the gap, both the arithmetic average and the km-weighted average are presented, as the latter should provide a better indication of the total additional fuel consumption and CO_2 emissions due to the real-world gap.

Table 3: Average real-world and WLTP fuel consumption, CO_2 emissions, and gap between real-world and WLTP values (cars)

	Average fuel consumption (l/100 km)		**Average CO_2 emissions (g/km)**		**Gap (%) ([13])**	
Powertrain/fuel type	real-world	WLTP	real-world	WLTP	average	km-weighted average
Petrol	7.89	6.38	179.8	145.3	23.7	20.4
Diesel	6.88	5.82	181.0	153.2	18.1	16.7
Petrol + Diesel	7.44	6.13	180.3	148.8	21.2	18.1
Plug-in hybrid (petrol)	5.97	1.76	135.9	40.2	238	251
Plug-in hybrid (diesel)	5.83	1.41	153.3	37.2	312	318
Plug-in hybrid (all)	5.94	1.69	139.4	39.6	252	267

In their first year of use, the average real-world gap for new vehicles registered in 2021 was 23.7% (34.6 g CO_2/km) for petrol cars and 18.1% (27.8 g CO_2/km) for diesel cars, giving a combined average gap of 21.2% (31.6 g CO_2/km). The km-weighted average gaps are somewhat lower: 20.4% (30.4 g CO_2/km) for petrol cars and 16.7% (25.3 g CO_2/km) for diesel cars.

This observed gap for 2021 registrations indicates that the switch from the old NEDC (New European Driving Cycle) to the new WLTP testing procedure has about halved the gap between the real-world emissions and those measured through laboratory testing. By 2017,

([13]) The gap is expressed here as a % deviation of real-world CO_2 emissions from the WLTP CO_2 value, where a positive deviation indicates that the former are larger. It is the same for both CO_2 emissions and fuel consumption, except for the cases combining petrol and diesel values, where the CO_2 gap is shown.

the gap between real-world CO_2 emissions and CO_2 emissions measured under the NEDC procedure had grown to around 40% ([14]). This rising gap motivated the switch from NEDC to WLTP, and the requirement to fit vehicles with OBFCM devices.

For the Impact Assessments ([15]) underpinning the revision of the CO_2 emission performance standards for cars and vans, the Commission assumed that the WLTP CO_2 emissions of combustion engine cars were on average 21% higher than those calculated with the NEDC, which was later confirmed by a JRC study ([16]). This ratio implies an emissions gap of about 16% between the real-world emissions and the WLTP ones. For the year 2021, the gap observed is compatible with the 2021 gap assumed for the Impact Assessments. Such a gap was anticipated, as there are different factors affecting real-world emissions which cannot all be fully replicated in a laboratory test.

The observed gap also means that the real-world fuel consumption experienced by drivers remains on average 1-1.5 l/100km higher than what is indicated on the official documents.

An analysis by mass showed that while lighter petrol and diesel vehicles have a real-world gap between 20-40 g CO_2/km, for heavy vehicles, such as SUVs and luxury vehicles, the gap is 1.5-2.5 times greater, which adds to their already higher WLTP CO_2 emissions.

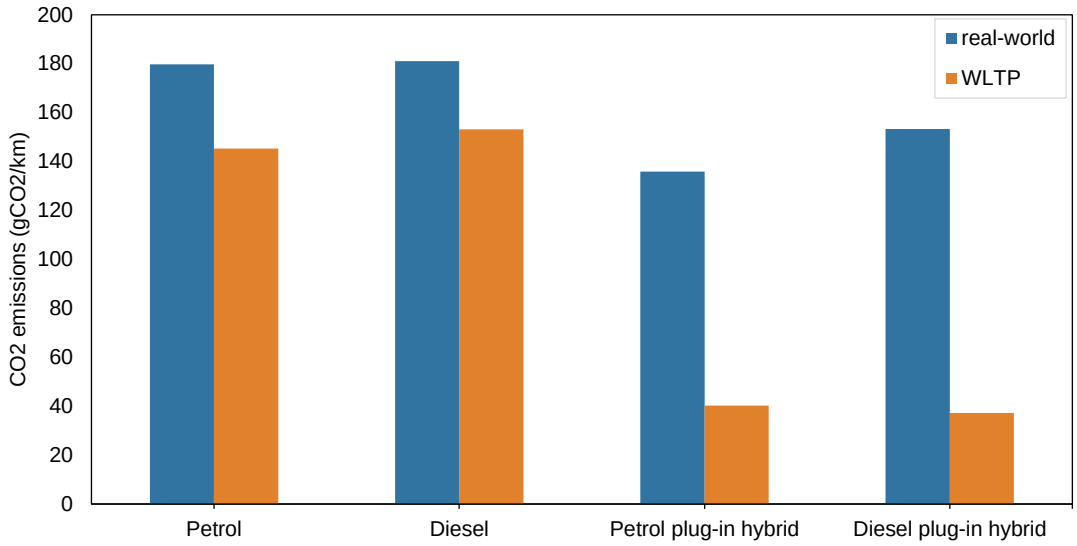
For the new plug-in hybrid electric cars registered in 2021, the average real-world CO_2 emissions (139.5 g CO_2/km) were only 23% lower than for conventional cars (180.3 g CO_2/km), and 3.5 times (100 g CO_2/km) higher than what the WLTP test indicated (39.5 g CO_2/km) – see *Figure 1*. For those vehicles, the calculation of their WLTP fuel consumption and CO_2 emissions takes into account a utility factor, which is the expected share of distance driven in electric mode. On the road, the CO_2 emissions of those vehicles will depend to a great extent on the real share of distance driven fully electrically, which in turn depends on the actual recharging and use patterns, and specific vehicle technologies. The large discrepancy found for these vehicles between the real-world and the WLTP values shows that they are charged and driven in electric mode much less than how they were expected to be used and that assumptions used for calculating the WLTP test result do not hold in real-world conditions.

([14]) Pavlovic, J., Clairotte, M., Anagnostopoulos, K., Arcidiacono, V., Fontaras, G. and Ciuffo, B., Characterisation of real-world CO_2 variability and implications for future policy instruments, EUR 28734 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-72096-3, doi:10.2760/839690, JRC107796.

([15]) SWD(2017)650 final and SWD(2021)613 final.

([16]) Chatzipanagi, A., Pavlovic, J., Ktistakis, M., Komnos, D. and Fontaras, G., Evolution of European light-duty vehicle CO2 emissions based on recent certification datasets, Transportation Research Part D-Transport and Environment, ISSN 1361-9209, 107, 2022, p. 103287, JRC127295.

Figure 1: Average real-world and WLTP CO_2 emissions (cars)



3.2. Manufacturer-level assessment

3.2.1. Coverage

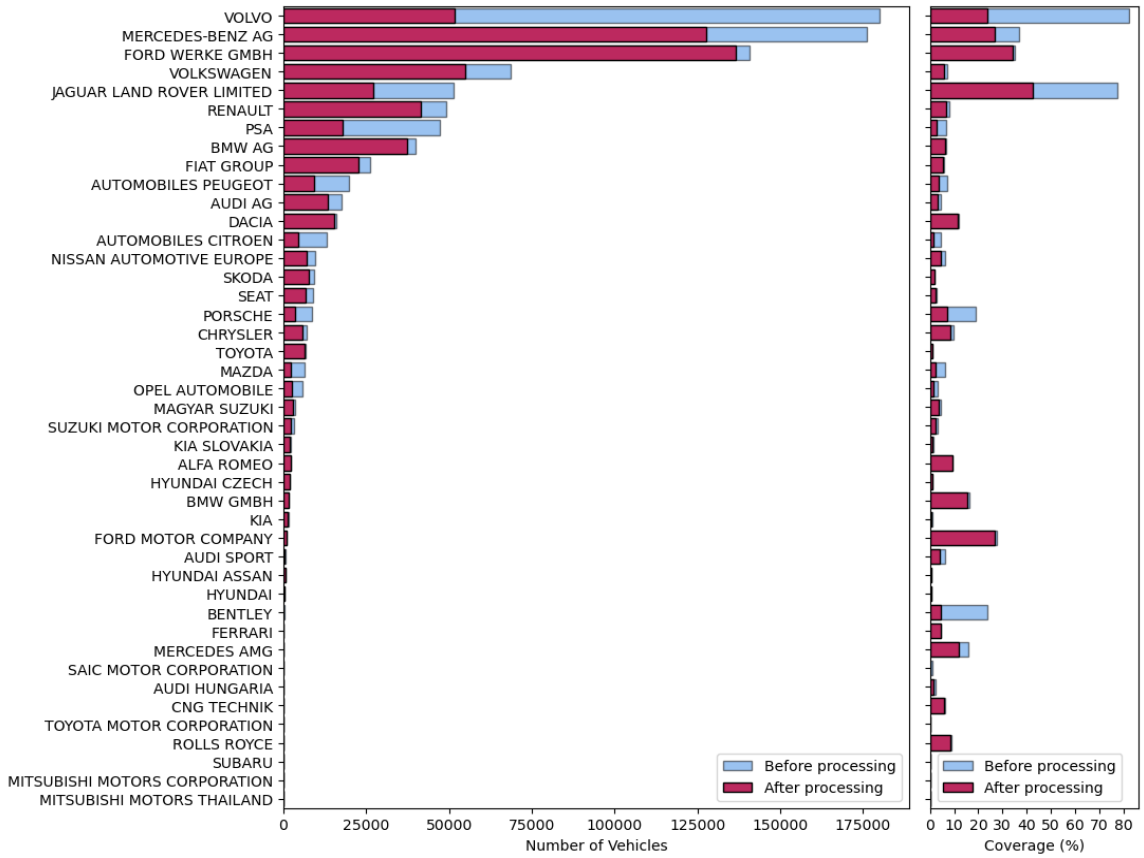
Figure 2 provides an overview of the number of vehicles reported per manufacturer in the real-world dataset, both before and after processing, and the extent to which this covers their vehicles first registered in 2021.

This illustrates the very significant variability amongst manufacturers. This can be explained by the different degree to which the available data collection options were used, with only a few manufacturers making comprehensive use of over-the-air data transmission. Other manufacturers only collected data from the limited number of vehicles that were brought in for service or repairs in the first year after their registration. In accordance with Regulation (EU) 2021/392, manufacturers will be required to provide reasons for the missing vehicle data as part of their reporting for the following year.

After data processing, the coverage of the 2021 fleet was rather poor in this first reporting year, except for Jaguar Land Rover (43%), Ford Werke GmbH (34%), Mercedes-Benz AG (27%), Ford Motor Company (27%) and Volvo (24%). Most of the other manufacturers reported data for less than 5% of their vehicles first registered in 2021. For certain manufacturers with a high initial coverage before data processing, the low-mileage filter reduced a significant number of vehicles. This was the case for Volvo and Jaguar Land Rover, which had the highest initial coverage, but 70% and 31% of their respective reported vehicles had driven less than 500 km.

The final dataset is dominated by very few manufacturers, in particular Ford Werke GmbH (22%) and Mercedes-Benz AG (21%). Together with Volkswagen (9%), Volvo (8%), Renault (7%), and BMW AG (6%), they represent 73% of the final dataset for cars. The plug-in hybrid dataset consists primarily of Mercedes-Benz AG (39%), Volvo (19%), and Ford Werke GmbH (16%) vehicles.

Figure 2: Number of cars per manufacturer, before and after data processing: total number (left) and percentage of the manufacturer's total 2021 new registrations (right) ([17])



3.2.2. Average CO_2 emissions, fuel consumption and real-world gap

For each manufacturer, the average real-world fuel consumption and CO_2 emissions as well as the gap with the WLTP average values have been calculated.

In this section, the results are presented only for those manufacturers with over 500 vehicles reported (for the powertrain/fuel type concerned). The Staff Working Document provides additional details.

The results for different manufacturers may depend on various factors, which will require further analysis, also based on subsequent datasets.

As shown in *Figure 3*, the average real-world gap for petrol cars differs quite significantly across manufacturers, ranging from 10% to 32%, with an average of 23.7%.

([17]) In all Figures within Section 3.2, manufacturers are shown in decreasing order of their number of vehicles in the final dataset.

Figure 3: Average real-world CO_2 emissions and fuel consumption (left) and gap (right) per manufacturer (petrol cars)

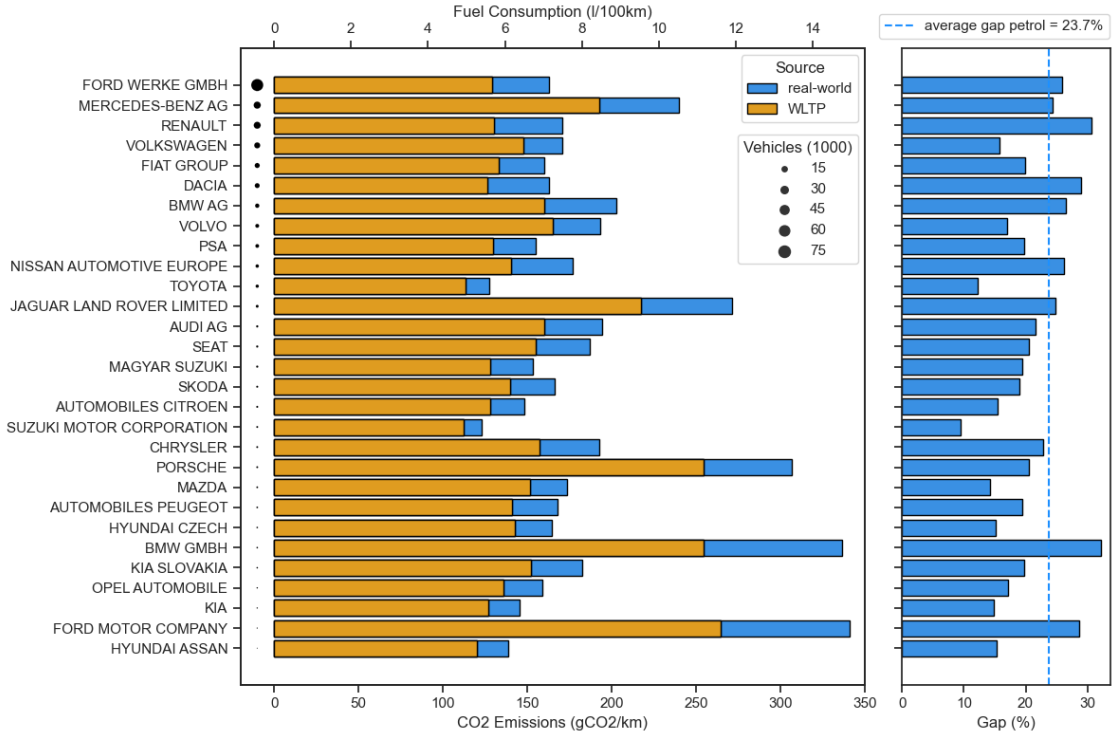
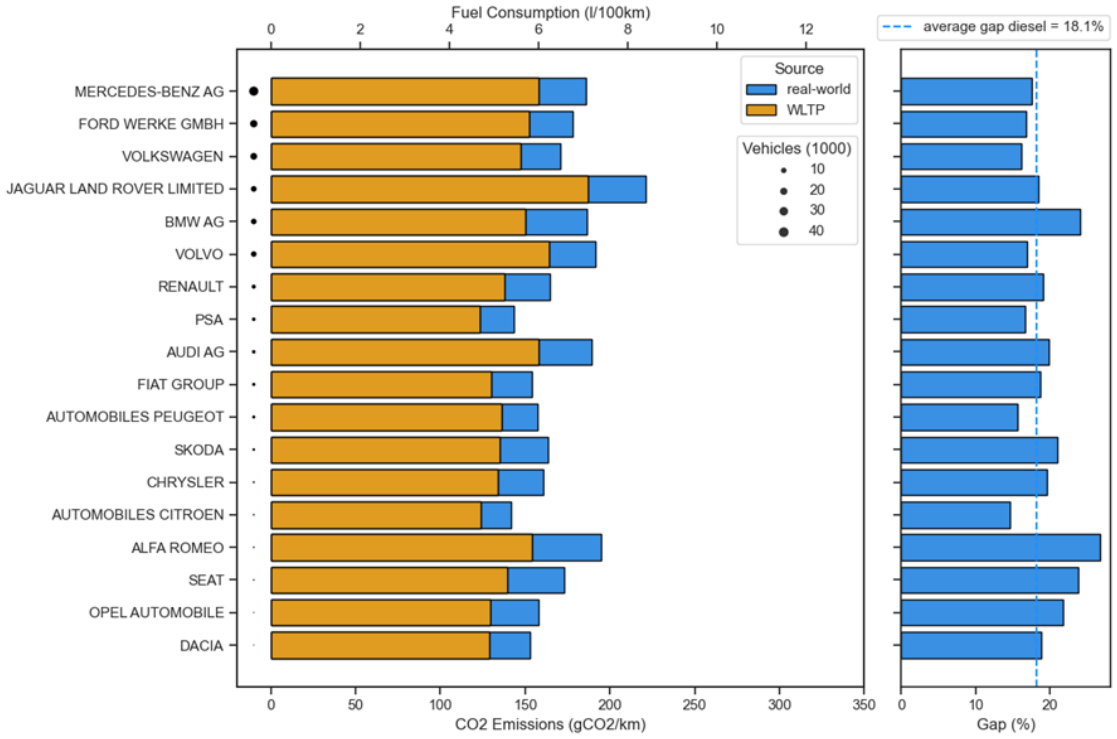


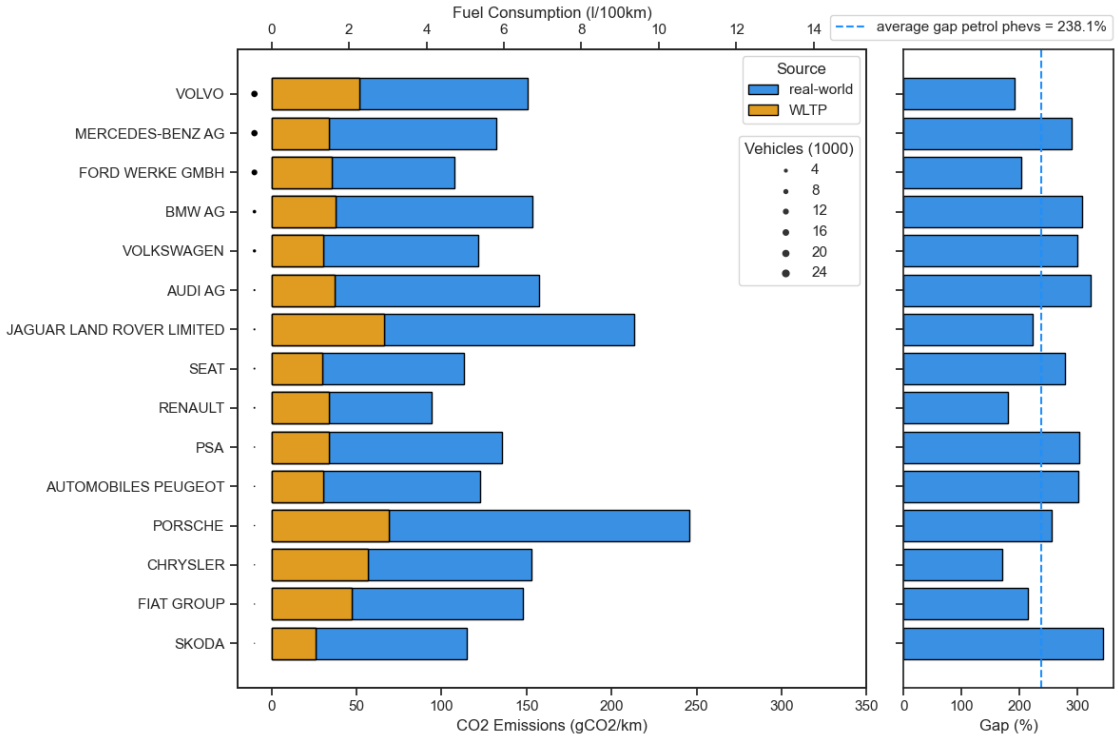
Figure 4 shows that for diesel cars there is less variation across manufacturers in the real-world gap, which ranges from 15% to 27%, with an average of 18.1%.

Figure 4: Average real-world CO_2 emissions and fuel consumption (left) and gap (right) per manufacturer (diesel cars)



For petrol plug-in hybrid vehicles, as shown in *Figure 5*, the average gap per manufacturer ranges from 170% to 345%, with an average of 238%.

Figure 5: Average real-world CO_2 emissions and fuel consumption (left) and gap (right) per manufacturer (petrol plug-in hybrid electric cars)



4. ASSESSING THE FUTURE USE OF THE REAL-WORLD DATA

This section of the report constitutes the Commission's assessment under Article 12(3) of Regulation (EU) 2019/631 of how the real-world data may be used to ensure that the WLTP CO_2 emissions and fuel or energy consumption values remain representative of the real-world performance over time for each manufacturer.

At this stage, the following further uses of the real-world data should be considered.

4.1. Ensuring that the WLTP values remain representative of the real-world emissions

The main objective of the real-world data monitoring is to track the evolution of the real-world gap to ensure that the WLTP CO_2 emission values remain representative of the real-world vehicle emissions over time. If the gap does grow over time, this trend should be identified as soon as possible and measures should be taken to ensure that the growing discrepancy is either fixed or adequately accounted for. This could be done, for example, through adjusting the WLTP, correcting the WLTP monitoring data, or setting targets based on real-world emissions.

At this point, however, it is too early to identify trends in the gap size as data is only available for one year. For the following years, it will be necessary to obtain a better and more representative coverage of the vehicle fleet to track the real-world data and achieve an adequate analysis of this gap over time.

4.2. Revision of the utility factor for plug-in hybrid electric vehicles

The analysis of the real-world data confirms that the real-world gap for plug-in hybrids is significantly higher than for conventional vehicles. A major reason for such a discrepancy is the mismatch between the utility factor used during type-approval and the actual vehicle charging and driving patterns.

To tackle this, Commission Regulation (EU) 2023/443 has already introduced changes to the calculation of the utility factor to bring it closer to real-world conditions. These changes will apply in two consecutive steps, from 2025 and 2027 onwards. Furthermore, by the end of 2024 and based on the real-world data collected by then, the Commission will review the factor for the second stage.

4.3. Using real-world data to support the in-service verification of CO_2 emissions

As regards in-service verification, Article 13(2) of Regulation (EU) 2019/631 proposes making use of the data from OBFCM devices. Delegated Regulation (EU) 2023/2867 setting out the guiding principles for this in-service verification of CO_2 emissions and Implementing Regulation (EU) 2023/2866 specifying the verification procedures have recently been adopted. These set out that real-world data can be used as part of the risk assessment to support identifying for which vehicle families it makes most sense to verify their WLTP CO_2 emissions.

5. CONCLUSIONS

The representativeness of the CO_2 emission values from vehicles is key for the environmental integrity, transparency, reliability of the monitoring system, and therefore also for consumers' trust.

This first report, focusing on data for vehicles first registered in 2021, initiates a process of monitoring and reporting on the implementation of real-world CO_2 emissions. In the first year, real-world data was collected from 988 124 vehicles, covering 10.6% of the cars and 1.0% of the vans first registered in 2021. Following data processing, an analysis was performed on a final dataset consisting of 617 194 cars (67% of reported) and 6 667 vans (54% of reported).

The data collected in this first year presents a number of limitations in terms of coverage, representativeness and quality. By definition, vehicles reported in the first year had been on the road for less than one year. Thereby, except for manufacturers making extensive use of over-the-air transmission, data was only collected from the limited number of vehicles brought in for service or repairs. For cars, the final dataset covers 7.2% of the new cars first registered in the EU in 2021, but mainly consists of vehicles from only four manufacturers. It also has a relatively higher share of heavier and diesel vehicles. For vans, very limited real-world data was reported in 2021, as the vast majority of them were only required to record such data as of 2022. Therefore, no representative analysis for vans was possible for this year.

Overall, for most manufacturers, the fleet coverage was below expectations and further steps should be taken to significantly improve this in the coming years, both for cars and vans. In accordance with Regulation (EU) 2021/392, manufacturers will be

required to provide valid reasons for any missing vehicle data as part of their reporting for the following years.

The average gap observed between the real-world and the WLTP CO_2 emissions and fuel consumption of new cars registered in 2021 was 23.7% (34.6 g CO_2/km) for petrol cars and 18.1% (27.8 g CO_2/km) for diesel cars. This confirms that switching from the NEDC to the WLTP for determining the official CO_2 emission and fuel consumption values has roughly halved the real-world gap for conventional vehicles. For the year 2021, the gap observed is compatible with the assumptions for the 2021 gap made in the Impact Assessments underpinning the revision of the CO_2 standards.

Nevertheless, the real-world fuel consumption experienced by drivers is still around one fifth higher than what the official type-approval documents show, and it is important that the public is made aware of this.

This gap appears to be particularly wide for heavier vehicles, such as SUVs and luxury vehicles, whose emissions are already significantly greater than other cars. This larger gap could exacerbate the impacts of wider observed fleet trends, where average vehicle sizes and weights have been increasing, reducing the effects of fuel efficiency improvements. The link between the gap and vehicle mass will need to be monitored closely in the coming years.

For new plug-in hybrid electric vehicles registered in 2021, the real-world CO_2 emissions were on average 3.5 times (100 g CO_2/km) higher than the WLTP ones, which confirms that these vehicles are currently not realising their potential, in particular as they are not being charged and driven fully electrically as frequently as assumed. To better reflect the real-world situation, the Commission has already introduced changes to the calculation of the utility factor used for the official test procedure, which will apply as of 2025, and may need to be further adjusted based on real-world data.

While this first data is not yet broad or representative enough to draw firm conclusions, it does provide valuable preliminary insights for car emissions, in how the official and real-world CO_2 emissions compare across vehicle types and manufacturers.