Get Real is a joint project by

Get Real testing campaign: why new laboratory tests will do little to improve real-world fuel economy

March 2019

Get Real is a joint project of

Executive summary

The Get Real test programme

The biggest failure of Europe's actions to reduce CO_2 emissions from new cars has been the persistent inability to deliver emission reductions on the road. Whilst new car CO_2 emissions measured using the NEDC laboratory test procedure have fallen by 31% since 2000,[1] on the road the reduction is just 13%.[2] The gap between test and real-world performance has leapt from 8% in 2000 to 39% in 2017.[3] Meanwhile, the old NEDC test procedure was replaced with the new Worldwide Harmonised Light Vehicle Test Procedure (WLTP), which has been in force for all new cars sold in the EU since September 2018, with a transitional period until 2021 when both tests can be used.

In order to understand what effect the WLTP test will have on new cars' real-world CO_2 performance and fuel consumption, Transport & Environment (T&E) together with German NGO Deutsche Umwelthilfe (DUH) launched the 'Get Real' project[4] in 2016 to raise consumers' awareness about the gap between advertised and real-world fuel consumption of cars and to identify solutions to reduce the gap. As part of this project, T&E commissioned Emisia, an independent laboratory, to test three different WLTP-approved vehicles: a petrol Opel Adam I (with an indirect injection system), a petrol Ford Fiesta VII (with a direct injection system) and a diesel Honda Civic X. All three vehicles underwent the same tests: an NEDC and a WLTP laboratory test (with independent road load parameters) and two on-road tests compliant with the RDE regulation, but with two different driving styles: smooth and dynamic. The CO_2MPAS tool, an EU tool to derive NEDC values from WLTP test results, was used to obtain the NEDC-correlated CO_2 values from the WLTP tests performed.

What the tests show

This paper, published alongside a detailed test report, summarises the results of the independently performed tests. The most notable conclusions are:

- The CO_2 emissions gap between the independently performed WLTP and NEDC tests is small, only 2% on average, compared with a 19% difference from the official CO_2 values declared by car manufacturers.[5] This suggests the new WLTP test procedure is likely not sufficient to reduce or close the gap between official and real-world CO_2 emissions (which today is about 40%).
- The CO_2MPAS simulation tool used to turn WLTP values into the NEDC equivalent gives comparable results. The difference between the simulated NEDC-equivalent values and the independent NEDC tests on the three vehicles tested is around 1% on average, or as expected when the tool was designed. This suggests that the big discrepancies currently

[1] EEA, Monitoring CO_2 emissions from new passenger cars and vans in 2016, January 2018 & EEA, No improvements on average CO_2 emissions from new cars in 2017, April 2018
[2] Ibid. & The ICCT, From laboratory to road: A 2018 update, January 2019
[3] The ICCT, From laboratory to road: A 2018 update, January 2019
[4] Supported by the European Commission's Life+ programme
[5] Calculated from the official WLTP and NEDC CO_2 values in the Certificates of Conformity of the tested vehicles

claimed by carmakers are 1) either a result of them manipulating downwards NEDC-declared CO_2 values (as the test results in this paper show) or 2) manipulating upwards WLTP values to inflate the 2021 starting point for 2025/30 CO_2 reduction targets (as underlined in the European Commission's non-paper),[6] or both. However, what is clear is that the discrepancy cannot be blamed on the CO_2MPAS tool.

- The WLTP driving dynamics is more representative of real-world driving than the NEDC cycle. However, the WLTP laboratory cycle is still on the lower end of the driving dynamics range, when compared to an average PSA Group customer.[7] Besides, driving dynamics is not the only factor affecting real-world fuel consumption and cannot on its own be used to judge a test's representativeness. Overall, the WLTP test procedure is an improvement compared to the previous NEDC procedure, but it still does not close the large gap with real-world driving CO_2 emissions.

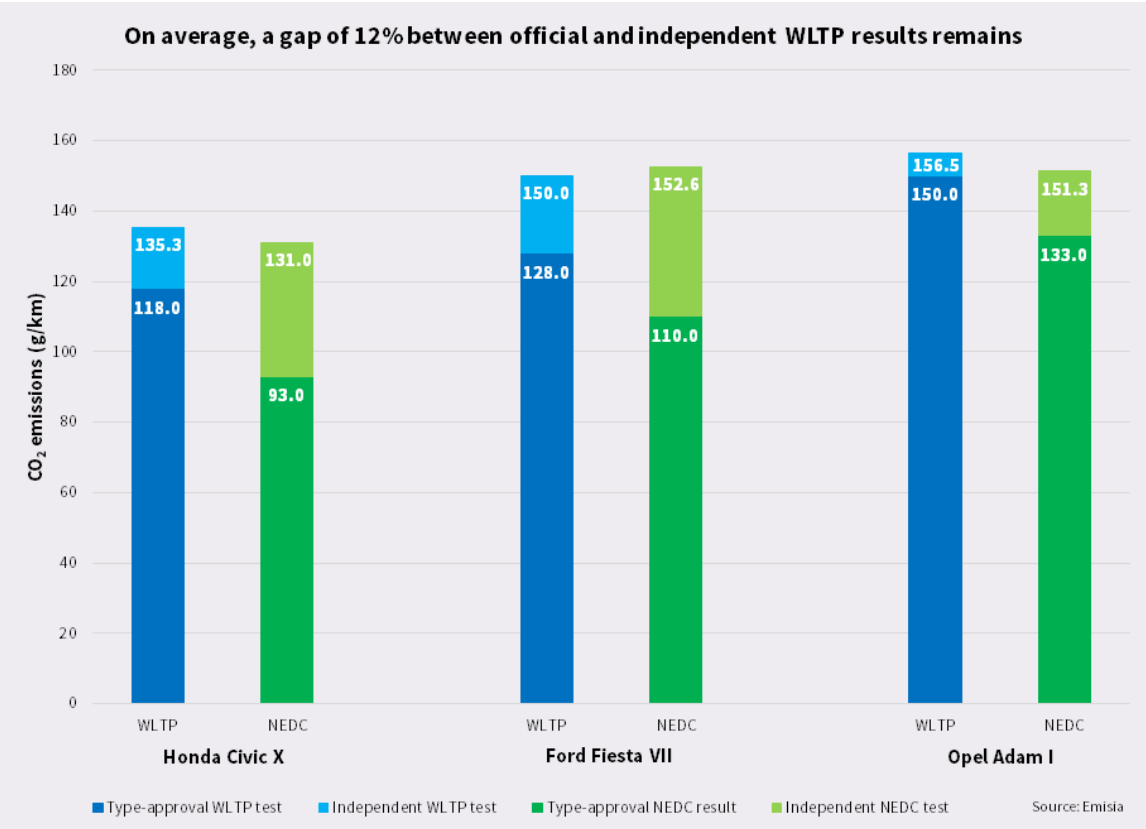

Figure 1

The persistent lack of transparency in EU emissions testing

According to the three vehicles we tested, there appears to remain an important gap between the official and independent test results. However, it is not possible to fully analyse and explain the reasons for the gap due to a lack of transparency on key testing parameters:

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[6] T&E, Ending the cheating and collusion: Using real-world CO_2 measurements within the post-2020 CO_2 standards, August 2018

[7] PSA Group, T&E, France Nature Environnement (FNE) & Bureau Veritas, Real-world fuel economy measurements: technical insights from 400 tests of Peugeot, Citroen and DS cars, September 2017

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- Once a laboratory test is performed, several regulatory corrections need to be performed before the official value, used for type-approval, is derived. However, the information on which corrections were performed or what factors were used is currently not accessible to third parties.
- No information is currently available from carmakers or authorities on whether a vehicle is part of a CO_2 interpolation family, which has an impact on how the CO_2 emissions of a given vehicle are determined. Furthermore, it is not transparent which vehicle models and what test values (e.g. vehicle mass or road load parameters) were used to determine the CO_2 emissions for a vehicle within an interpolation family.
- The same lack of data transparency applies to the NEDC-correlated CO_2 values. Currently, it is unclear whether the official results come from the NEDC declared value confirmed via the CO_2MPAS tool, or from a separate NEDC double test that carmakers are still allowed to perform. In reality, it is likely that almost all NEDC values are the result of double testing. This allows carmakers to achieve low NEDC results to meet the 95g target and at the same time inflate the 2021 WLTP baseline for the 2025/30 targets.

The European Commission has recently finalised the new WLTP and RDE provisions to provide more information to accredited testers and make it easier to conduct independent compliance tests. However, parameters such as vehicle mass and road loads on NEDC, especially in the case of double testing, or some aerodynamics parameters necessary to compute WLTP interpolation lines remain unknown; therefore major gaps in understanding persist.

Explaining the gap between laboratory and the road

The most likely reason for the continued difference between independent measurements and official results is 'road load optimisation'. The so-called 'road load' captures the aerodynamic and rolling resistance impact on a vehicle and is one of the most important factors in determining the CO_2 performance of cars. The importance of road load optimisation, and possibly manipulation, has long been recognised as a major shortcoming of the EU CO_2 testing framework.[8] This optimisation is estimated to account for one fourth of the overall CO_2 gap between official tests and real-world driving.[9] The European Commission's Joint Research Centre (JRC) estimates that road load determination accounts for up to a third of the gap in CO_2 emissions between NEDC and WLTP.[10] Our testing programme shows that the biggest road load gap is observed for the Honda Civic X and the Opel Adam I, with the energy demand over the WLTP cycle underestimated by 10% when the type-approval road load parameters are compared to the independently measured values. The gap for the Ford Fiesta VII is 7%. A simulation of the emissions impact of the type-approval road load performed by T&E suggests that CO_2 emissions are reduced by 7% on both the Honda Civic X and

[8] T&E, Mind the Gap 2016 - Report, December 2016
[9] The ICCT and Element Energy, Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans, for the UK Committee on Climate Change, September 2015
[10] J. Pavlovic, B. Ciuffo, G. Fontaras, V. Valverde & A. Marotta, How much difference in type-approval CO_2 emissions from passenger cars in Europe can be expected from changing to the new test procedure (NEDC vs. WLTP)?, Transportation Research Part A: Policy and Practice, Volume 111, pp.136-147, May 2018

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the Opel Adam I, while the reduction is 4% on the Ford Fiesta VII, compared to independent road load data. This shows that for all tested vehicles, road load optimisation is one of the likely ways carmakers continue to manipulate CO_2 tests. It is also likely that there are other test optimisations that we are not currently aware of.

Policy recommendations

The Get Real project's testing activities demonstrate that it remains difficult for third parties to fully reproduce CO_2 tests and explain the differences in CO_2 performance, thus making robust and independent compliance monitoring impossible. Furthermore, the results also show that despite the introduction of the WLTP test procedure that closes some of the loopholes, carmakers can continue to exploit test flexibilities and manipulate lab tests, thus failing to produce representative real-world CO_2 values. Going forward, a number of policy recommendations is suggested:

- All relevant data should be made available to independent testers and third parties: both carmakers and type-approval authorities should disclose the correction factors and other test parameters, such as road load, needed for third parties to fully compare independent tests with official type-approval results. E.g. the recently agreed monitoring and reporting regulation for trucks requires a lot of transparency on key input parameters, so there is no reason why the same should not apply to passenger cars and vans.
- Since WLTP will not close the CO_2 gap fully between laboratory test and on-road performance, the about to be reviewed EU Car Labelling Directive should provide real-world information on fuel consumption, electric range and CO_2 emissions to drivers and consumers EU-wide to give accurate information on the fuel economy of their vehicles.
- The European Commission should use its new market surveillance powers that come into force in September 2020 to robustly check carmakers' tests results and take action in cases of manipulation and cheating. Crucially, the facilities of the European Commission's Joint Research Centre (JRC) should be expanded to conduct a sufficient number of tests and an adequate budget provided. The Commission should closely cooperate with third parties, that expose the problems, and use its new legal powers to the fullest to fine and require mandatory recalls.
- As a matter of urgency, laboratory tests should be complemented with on-road compliance and enforcement. The recently agreed CO_2 regulations only envisage monitoring of real-world performance using fuel consumption meters (FCM) with no mandatory compliance necessary until 2030. This should, without delay, be turned into a mandatory compliance mechanism much sooner that the 2030 date foreseen by the Commission. Besides, the real-world checks at type-approval with FCMs should be accompanied by independent JRC and third party tests on in use vehicles to ensure continuous compliance.

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List of abbreviations

ATCT	Ambient Temperature Correction Test (WLTP regulation)
CO_2	Carbon dioxide
CoC	Certificate of Conformity
DPF	Diesel Particulate Filter
DUH	Deutsche Umwelthilfe
EEA	European Environment Agency
EU	European Union
FCM	Fuel Consumption Meter
GDI	Gasoline Direct Injection
GPF	Gasoline Particulate Filter
ICCT	International Council on Clean Transportation
JRC	European Commission's Joint Research Center
KBA	Germany's Kraftfahrt-Bundesamt
LNT	Lean NOx-trap
NEDC	New European Driving Cycle
NGO	Non-Governmental Organisation
NOx	Nitrogen oxides
OEM	Original Equipment Manufacturer
PFI	Port Fuel Injection
PN	Particle Number emissions
RCB	REESS Charge Balance (WLTP regulation)
RDE	EU's Real Driving Emissions test
REESS	Rechargeable Electric Energy Storage System (WLTP regulation)
T&E	Transport & Environment
TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek
TU Graz	Technische Universität Graz
UNECE	United Nations Economic Commission for Europe
VCA	The UK's Vehicle Certification Agency
WLTP	Worldwide Harmonised Light Vehicle Test Procedure

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1. Presentation of the Get Real project

This report details the results of a car testing campaign undertaken as part of the wider 'Get Real' campaign on cars' fuel consumption and CO_2 emissions. The campaign is a joint initiative between German NGO Deutsche Umwelthilfe (DUH) and Transport & Environment (T&E), and is supported by the European Commission's Life programme.[11] The campaign aims to raise awareness among the public and policy makers of real-world CO_2 emissions and fuel consumption data, and to close the gap between advertised and real fuel consumption. As part of the campaign, the aim of this paper is to obtain a better understanding of the transition from the old NEDC test procedure to the new WLTP version.

The previous work undertaken has explained how car manufacturers optimise their cars to perform better during laboratory tests, leading to a growing gap between emissions measured in the lab and on the road.[12] Further work then exposed that carmakers were again optimising the WLTP test but this time to produce high emissions results in an attempt to undermine post-2020 car and van CO_2 standards.[13]

This briefing shows that while the representativeness of WLTP testing compared to NEDC has significantly improved, it still fails to truly reflect on-road, real world driving emissions. It also illustrates the challenges in performing robust third party testing.

[11] 'Get Real – Demand fuel figures you can trust' (LIFE15 GIC/DE/00029, Close the gap) is funded under the Life programme of the European Commission

[12] Get Real, Campaign resources

[13] T&E, Ending the cheating and collusion: Using real-world CO_2 measurements within the post-2020 CO_2 standards, August 2018

Get Real (LIFE15 GIC/DE/000029, Close the gap) is funded under the LIFE programme of the EU Commission.

2. Background information

The biggest failure of the current car CO_2 regulation has been the way targets have been weakened through carmakers radically reducing emissions in the laboratory - but hardly at all on the road. While official emissions data compiled by the European Environment Agency (EEA) based upon official laboratory tests shows a clear trend of average CO_2 emission reduction,[14] real-world data collected by the International Council on Clean Transportation (ICCT) shows emissions have barely improved over the past five years. The gap between the average NEDC new car test value and average new car performance on the road has grown from 8% in 2001 to 17% in 2008 and 39% in 2017.[15]

The widening gap is not the result of cars being driven in a significantly different way from the past, motorists have minimally changed their driving style in the last few years.[16] Nor can the widening gap be explained by the addition of auxiliary equipment (like heated seats), as this kind of equipment is only responsible for around 4% points of the CO_2 divergence between lab tests and real-world conditions.[17] The widening gap is not a statistical anomaly which results from cars becoming significantly more efficient as the industry claims; nor does it arise from the use of an obsolete test; the test procedure has only recently changed to WLTP and the gap is based upon the same NEDC procedure. The primary cause, confirmed by the current Dieselgate cheating revelations, is that carmakers are manipulating the undemanding and poorly prescribed NEDC laboratory test by fitting technology that may be more effective at reducing CO_2 emissions during the laboratory test cycle compared to during real-world on road driving.

As previously illustrated in the Get Real campaign,[18] the most important reason for the growing gap between the NEDC test results and real-world performance is the manipulation of test by car manufacturers. This could cause the CO_2 gap between NEDC results and real-world driving to increase from 17% in 2008 to 49% by 2020 if there was no change to the regulation.[19] This stems from the blatant misuse of poorly drafted rules, from removing parts to lightweight a car prior to testing to modifying tyres and illegal practices of detecting test cycles. The system of regulatory oversight - reliant on 28 national vehicle regulators - has been too weak to prevent this as exposed by the Dieselgate scandal.

[14] EEA, Monitoring of CO_2 emissions from passenger cars – Regulation (EC) No 443/2009, April 2018
[15] The ICCT, From laboratory to road: A 2018 update, January 2019
[16] T&E, Mind the Gap! Why official car fuel economy figures don't match up to reality, March 2013
[17] The ICCT and Element Energy, Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans, for the UK Committee on Climate Change, September 2015
[18] Get Real, Real-world fuel consumption of passenger cars, Part I: Test manipulations & exploitation of loopholes, 2017
[19] The ICCT and Element Energy, Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans, for the UK Committee on Climate Change, September 2015

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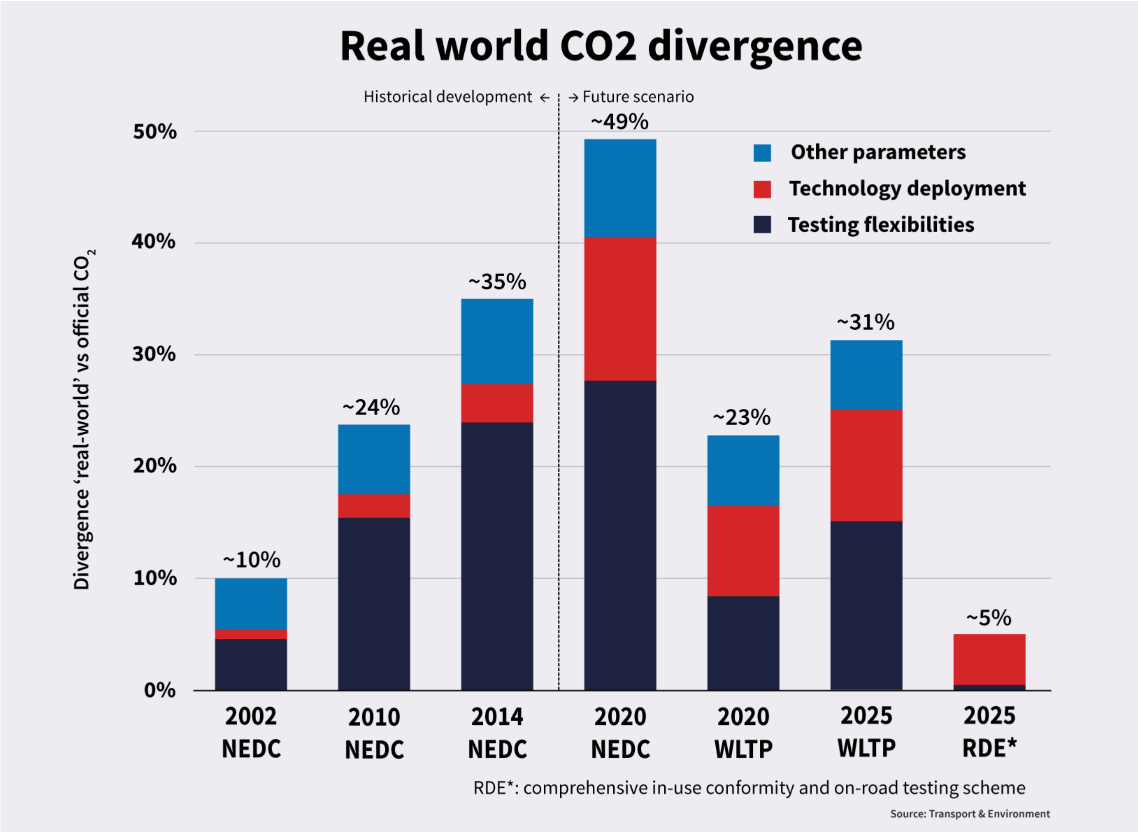

Figure 2

The widening gap has effectively halved the stringency of the car CO_2 regulation, which when it was adopted, was expected to reduce new car CO_2 emissions by 45g/km between 2008 and 2020.[20] The widening gap has eliminated more than half (21g/km) of this improvement.[21] This has, in turn, led to more fuel use with a cost in terms of both increased CO_2 emissions and fuel purchase cost for consumers which is estimated at an extra 400€ per year.[22]

Analysis by T&E shows that had the gap remained at 8% (the difference between test and real world emissions in 2000), there would have been a cumulative total of 264 Mt $CO_{2\,eq}$ emissions avoided by 2017. The additional fuel burned to produce these emissions cost EU drivers an extra €150 billion. German drivers have lost the most due to this test manipulation at €36 billion since 2000, followed by British (€24.1bn), French (€20.5bn), Italian (€16.4bn), and Spanish (€12bn) drivers. Motorists in every country use more fuel because of test manipulation.

[20] European Commission, Results of the review of the Community Strategy to reduce CO_2 emissions from passenger cars and light-commercial vehicles, February 2007

[21] T&E, Ending the cheating and collusion: Using real-world CO_2 measurements within the post-2020 CO_2 standards, August 2018

[22] The ICCT, Real-world vehicle fuel consumption gap in Europe at all-time high, November 2017

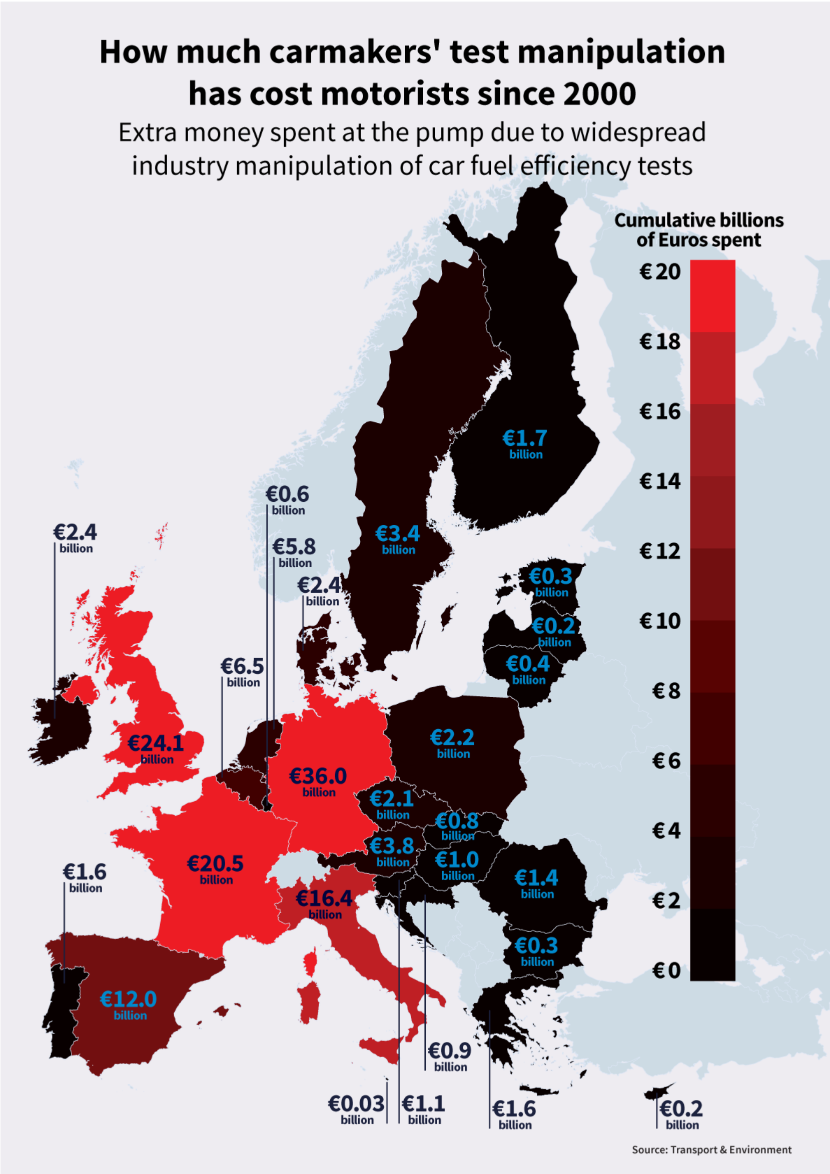

Figure 3

In 2017 alone, EU-wide car emissions were estimated to be 47 Mt $CO_{2\ eq}$ more than what they should have been if the standards were achieved on the road. This is 6 Mt $CO_{2\ eq}$ more than the annual CO_2 emissions of Slovakia. The additional fuel burned cost €23.4 billion.[23]

From September 2018, all new cars sold in the EU have to be approved based on a new laboratory test procedure called Worldwide harmonized Light vehicles Test Procedure or WLTP.[24] This new procedure was developed under the umbrella of the United Nations Economic Commission for Europe (UNECE)[25] in order to replace the outdated NEDC procedure. The aim of WLTP is to get fuel consumption and CO_2 emission values that are closer to reality, by having a more representative cycle (longer test, more dynamic driving, less engine idling time) and by using a more robust test procedure by closing some of the loopholes that were used within the NEDC test procedure.[26]

In order to reduce CO_2 emissions from new cars and vans, manufacturers have targets to meet that are based upon the NEDC measured fleet-average CO_2 emissions. Targets vary depending on the average weight of the vehicles sold, with derogations for manufacturers with sales below 300,000 cars per year. Across all manufacturers the target is that 95% of cars sold in 2020 must achieve an average of 95g/km; with 100% of sales applying in 2021.[27] With the introduction of the WLTP tests, in order to maintain 'regulatory stringency', the European Commission developed a tool called

[23] T&E, Ending the cheating and collusion: Using real-world CO_2 measurements within the post-2020 CO_2 standards, August 2018
[24] Official Journal of the European Union, Regulation n°2017/1151
[25] Ibid.
[26] T&E, Introduction of WLTP and RDE tests, September 2017
[27] Official Journal of the European Union, Regulation n°333/2014

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CO_2MPAS in order to convert CO_2 emission values from WLTP tests into a NEDC-equivalent CO_2 value whilst maintaining the equivalence as in the NEDC procedure.[28] Carmakers were also provided with the option to double test cars so that models are tested using both the WLTP and NEDC procedure. To date the indications is that the double testing route is more widely used.

	NEDC	WLTP
Distance	11 km	23 km
Time	20 minutes	30 minutes
Driving dynamism	Very smooth, theoretical and unrealistic	More dynamic but on the lower end of the dynamics of real-world driving
Average speed	34 km/h	47 km/h
Idling time	23% of whole cycle	13% of whole cycle
Optional equipment and tyres	Best possible case always considered (lightest version)	Taken into account for CO_2 emissions

Figure 4

After 2020, new CO_2 targets for carmakers will be defined solely based on WLTP tests with a reduction target expressed as a percentage of the 2021 EU fleet-average levels, rather than with an absolute value. This creates a new opportunity for manipulation by double testing cars to produce low NEDC results for compliance with 2020/21 targets and high results to create a high baseline for the post-2020 WLTP-based regulation.[29]

While the European Commission introduced a new on-road test called Real Driving Emissions test (RDE) for NOx and PN emissions, following the Dieselgate scandal, CO_2 emissions are still measured in the laboratory only.

Finally, the recently agreed 2025/30 CO_2 standards for cars and vans stipulate that, from 2021, fuel consumption meters (FCM) will be used to measure the real-world fuel consumption. This will help monitor the fuel efficiency and CO_2 emissions of new models and how the gap between real-world CO_2 emissions and WLTP develops over time.[30] The WLTP amendments adopted last year include

[28] Official Journal of the European Union, Regulation n°2017/1153
[29] T&E, Ending the cheating and collusion: Using real-world CO_2 measurements within the post-2020 CO_2 standards, August 2018
[30] Council of the European Union, CO_2 emission standards for cars and vans: Council confirms agreement on stricter limits, January 2019

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accuracy requirements that will be checked during type-approval process on WLTP, with a maximum difference of +/-5% between the laboratory and the FCM device.[31] By 2030, the European Commission should come forward with an enforcement mechanism on how to use this real-world data for the purposes of compliance with EU car CO_2 regulations after 2030.

[31] Official Journal of the European Union, Regulation n°2018/1832, Annex X

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3. Testing activities undertaken by the Get Real project

Based on the regulatory context described in the previous section, it is crucial to better understand how the CO_2 emissions measured from cars will evolve with the shift from NEDC to WLTP test procedures and especially if and how this new laboratory test procedure compares with real-world driving. In order to do so, the Get Real project has commissioned independent tests on three different vehicles:

- One NEDC test and one WLTP test done on a chassis dynamometer in a laboratory. However, instead of using declared test parameters described in the Certificate of Conformity (CoC) of the vehicles, the Get Real project has commissioned additional independent measurements of road load parameters[32] to be used for these lab tests.
- In addition, two RDE compliant tests were performed by using the same route but with two different and compliant driving styles, a smooth and a dynamic one.
- Afterwards, data from the independent WLTP test was used in order to calculate the NEDC-equivalent CO_2 value by using the CO_2MPAS tool developed by the European Commission.
- In the end, all these test results were compared with the data available in the CoC provided by the manufacturer.

Due to timing of the test programme, the vehicles were approved under the first act of the WLTP regulation[33] and the three first packages of the RDE regulation,[34] therefore the analysis in this briefing paper is done based on these regulations.

The Get Real Project commissioned Emisia to perform all the testing work on three different cars. Emisia is an independent tester based in Thessaloniki (Greece), linked with the Aristotle University of Thessaloniki and the Laboratory of Applied Thermodynamics. Emisia has been requested to source vehicles from independent rental companies. Emisia's testing report is published alongside this briefing paper.[35]

The aim of this testing campaign was to test three Euro 6d-temp compliant cars from different car segments, different manufacturers and with different engine technologies. The initial objective was to test the most representative vehicles sold on the European market per segment based on 2017 sales data.[36] However, as the testing campaign has been conducted over the summer of 2018, only a few Euro 6d-temp models were available from rental companies. The selected vehicles were:

[32] Road load parameters are needed to simulate the forces that affect a moving vehicle - such as rolling resistance and aerodynamic drag - when performing a stationary chassis dynamometer test. This is done by a coast-down test, the results of which are then used on the chassis dynamometer. Further explanations can be found in section 4.6.
[33] Official Journal of the European Union, Regulation n°2017/1151
[34] Official Journal of the European Union, Regulation n°2017/1151 & 2017/1154
[35] Emisia, Emissions and fuel consumption tests, EMISIA SA Report No: 18.RE.022.V2, November 2018
[36] The EU car sales, from January to October 2017 included, were taken from: Automotive News Europe, Volume 8, Issue 12, December 2017

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- An Opel Adam I fitted with an indirect injection petrol engine (PFI), representing the mini car segment (or A segment). The German type-approval authority, KBA, is responsible for the whole vehicle and emissions type-approvals.[37]
- A Ford Fiesta VII fitted with a direct injection petrol engine (GDI), representing the small car segment (or B segment). The Spanish Ministry of Economy and Business (acting as the national type-approval authority) is responsible for the whole vehicle and emissions type-approvals.[38]
- An Honda Civic X fitted with a diesel engine, representing the lower medium car segment (or C segment). The UK type-approval authority, the VCA, is responsible for the whole vehicle and emissions type-approvals.[39]

More information about the technical details of these vehicles can be found in the Table 1 below. More details about the tests and the in-depth results can be found in Emisia's testing report published alongside this briefing paper.[40]

	Opel Adam I	Ford Fiesta VII	Honda Civic X
Car segment	A (Mini)	B (Small)	C (Lower Medium)
Fuel type	Petrol with indirect injection (PFI)	Petrol with direct injection (GDI)	Diesel
Engine architecture	In-line 4 cylinder Naturally aspirated	In-line 3 cylinder Turbocharged	In-line 4 cylinder Turbocharged
Engine size	1398cm³	998cm³	1597cm³
Engine power	64kW	74kW	88kW
Gearbox	Manual 5	Manual 6	Manual 6
Start-stop system	No	Yes	Yes
Fitted tyres	215/45 R17	195/55 R16	235/45 R17
Euro standard	Euro 6d-temp	Euro 6d-temp	Euro 6d-temp
First date of registration	July 2018	July 2018	March 2018

Source: Emisia

Table 1

[37] From the CoC of the vehicle & ACEA, Access to Euro 6 RDE data
[38] Ibid.
[39] Ibid.
[40] Emisia, Emissions and fuel consumption tests, EMISIA SA Report No: 18.RE.022.V2, November 2018

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4. CO_2 results of different tests and comparison with type-approval data

The Table 2 below summarises the CO_2 emission results from the different tests performed on the three cars and compared (for NEDC and WLTP) with declared values by manufacturers in the Certificate of Conformity (CoC). Table 3 and Table ***4*** summarise the difference in CO_2 emissions as a percentage.

		Honda Civic X	Ford Fiesta VII	Opel Adam I
CO_2 emissions (g/km)		Diesel	GDI	PFI
Type-approval tests	WLTP	118.0	128.0	150.0
	NEDC	93.0	110.0	133.0
Independent laboratory tests	WLTP	135.3	150.0	156.5
	NEDC	131.0	152.6	151.3
	CO_2MPAS	132.9	140.3	155.3
Independent RDE compliant tests	Smooth driving	120.6	153.1	167.7
	Dynamic driving	117.6	177.0	210.1

Source: Emisia

Table 2

		Honda Civic X	Ford Fiesta VII	Opel Adam I	Average
		Diesel	GDI	PFI	
Independent vs type-approval	WLTP	15%	17%	4.3%	12%
	NEDC	41%	39%	14%	31%
Type-approval WLTP vs type-approval NEDC		27%	16%	13%	19%
Independent WLTP vs independent NEDC		3.3%	-1.7%	3.4%	1.7%
CO_2MPAS vs independent NEDC		1.5%	-8%	2.6%	-1.3%
CO_2MPAS vs type-approval NEDC		43%	28%	17%	29%

Source: Get Real Project from Emisia

Table 3

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			Honda Civic X	Ford Fiesta VII	Opel Adam I	Average
			Diesel	GDI	PFI	
Independent RDE vs type-approval WLTP	RDE	smooth	2.2%	20%	12%	11%
		dynamic	-0.3%	38%	40%	26%
Independent RDE vs independent WLTP	RDE	smooth	-11%	2.1%	7%	-0.5%
		dynamic	-13%	18%	34%	13%
Independent RDE vs type-approval NEDC	RDE	smooth	30%	39%	26%	32%
		dynamic	26%	61%	58%	48%
Independent RDE vs independent NEDC	RDE	smooth	-8%	0.3%	11%	1.1%
		dynamic	-10%	16%	39%	15%

Source: Get Real Project from Emisia

Table 4

4.1. Comparison of type-approval test and laboratory test results

The independent laboratory tests have systematically higher CO_2 results when compared to the official values declared in the CoCs. The difference in CO_2 emissions between independent and type-approval WLTP tests is on average 12%, ranging from 4% for the Opel Adam to 17% for the Ford Fiesta. This difference is even higher for NEDC CO_2 values with an average of 31%; ranging from 14% for the Opel Adam to 41% for the Honda Civic. It is widely recognised that the NEDC test procedure contains many flexibilities that could result in lower results and allow significant room for optimisation. The results above indicate that there are, as expected, fewer flexibilities in the WLTP test procedure, but these are still significant.

4.2. Differences between NEDC and WLTP test values

The difference in CO_2 emissions between WLTP and NEDC tests is much smaller with the independent tests than for the type-approval values. On average there is a difference of 2% in the independent tests (from -2% for the Ford Fiesta to 3% for the Honda Civic and the Opel Adam). In contrast, the difference is on average 19% for type-approval values (from 13% for the Opel Adam to 27% for the Honda Civic).

The petrol Ford Fiesta had lower CO_2 emissions on WLTP than on NEDC, which is an unexpected result. A possible explanation for the results of the Ford Fiesta could be that despite being driven on a more dynamic cycle, the engine worked more efficiently at higher loads on WLTP than on NEDC, as demonstrated in a previous JRC paper.[41]

[41] Jelica Pavlovic, Alessandro Marotta & Biagio Ciuffo, CO_2 emissions and energy demands of vehicles tested under the NEDC and the new WLTP type approval test procedures, Applied Energy, Volume 177, pp.661-670, September 2016

The CO_2MPAS tool was used by Emisia to derive an NEDC-equivalent value using data from the independent WLTP tests. This was then compared against the independent NEDC test results. For the Honda Civic and Opel Adam, the CO_2MPAS tool deviated from the measured NEDC value by +1.5% and +2.6% respectively.[42] For the Ford Fiesta, the deviation was -8%.[43] This bigger difference is very likely to be because of the independent WLTP test, used as an input, that has a lower CO_2 emission result compared with the independent NEDC test. The results suggest that the CO_2MPAS tool appears to produce a reasonably robust NEDC equivalent value, with an average difference of -1.3%. However, when the official type-approval NEDC results declared by OEMs are used for comparison, there are huge deviations (on average 29%). This could suggest that carmakers are double testing cars on NEDC and WLTP, optimising cars for each of the tests separately, to produce higher WLTP values to inflate the 2021 baseline.

4.3. Differences between laboratory and on-road tests

On-road tests were also performed for the Get Real project: for the petrol-powered Ford Fiesta and Opel Adam, the CO_2 emissions from RDE compliant tests were higher than both the independent and type-approval WLTP tests. The gap varied between 2% and 34% between real-world and independently performed WLTP tests; whereas the gap with the type-approval WLTP tests varied from 12% to 40%. These gaps were smaller than for the former NEDC (26% to 61% difference with the performed RDE tests), but indicate, as expected, that WLTP is not representative of real-world performance. The CO_2 results of the real-world tests with the diesel Honda Civic were surprisingly similar to those of the type-approval WLTP tests and even lower when compared with the independent WLTP tests. However, the CO_2 emissions gap for the Honda between the on-road tests and the type-approval WLTP test should be bigger as the type-approval CO_2 emissions were increased by two factors: the official WLTP CO_2 result includes the K_i factor, however during the on road testing, no regeneration of the particle emissions system (DPF) happened. Besides, as explained in the next section, the stop-start system fitted on the Honda was deactivated during laboratory testing while it was active on the road.

4.4. Stop-start deactivation

As already reported by T&E,[44] based on the European Commission's evidence, the car industry is currently producing higher CO_2 test results in order to inflate their WLTP CO_2 fleet average in 2021, i.e. the baseline for the 2025/30 car CO_2 targets. One strategy to achieve this is the deactivation of the stop-start system during laboratory tests. Among the three tested cars, the Ford Fiesta and the

[42] The K_i factor takes into account the extra-fuel consumption, and therefore CO_2 emissions, during periodic regeneration events of an aftertreatment system, e.g. a Diesel Particulate Filter (DPF). For the Honda Civic X, no K_i factor was included by Emisia either for the independent WLTP and NEDC tests or the CO_2MPAS simulation. For the Opel Adam I, no K_i factor needs to be applied as three-way catalysts do not have any periodic regeneration events.

[43] No K_i factor is applied on the Ford Fiesta as it is assumed that the fitted Gasoline Particulate Filter uses only passive regeneration events.

[44] T&E, Ending the cheating and collusion: Using real-world CO_2 measurements within the post-2020 CO_2 standards, August 2018

Honda Civic are both fitted with stop-start systems and these are operational during real world driving. However, once the dyno mode is activated, in order to perform laboratory tests, stop-start systems are completely deactivated thus confirming the European Commission's findings. Switching off stop-start has been outlawed by the latest amendments to the WLTP regulation[45] adopted to close this loophole. If these two models are going to be sold in 2020/21, Ford and Honda will have to re-approve these cars with a WLTP test where stop-start is active.

4.5. Lack of data to fully explain the independent CO_2 test results

The CO_2 results, from the independently testing performed as part of the Get Real test programme are not comparable with the official type-approval values. A number of reasons can explain the CO_2 gap between the results, notably:

1. The WLTP regulation includes several corrections that manufacturers can perform at different steps of the test process. The aim of the corrections is to make the CO_2 results from different vehicles or brands as comparable as possible. It is hugely complex for a third party to use the raw test data to derive the independent CO_2 results which take into account all the regulatory corrections that manufacturers can chose to perform (as these are not disclosed) and therefore provide CO_2 values that are derived in the same way as the CO_2 values from the type-approval process.
2. When all the corrections are performed and accounted for, the remaining CO_2 gap is largely due to the test optimisation (and loopholes) deployed by carmakers during type-approval testing, such as the stop-start deactivation described in the previous section. The aim of the independent tests is to quantify and explain as much as possible the optimisations that have an impact on CO_2 emissions.
3. There is always a small divergence in results between testing conducted on different laboratory equipment. This is the case even when the same vehicle is tested in the same laboratory. The lab and on-road tests for the Get Real project were performed by an experienced independent tester and in line with the latest EU regulations. However, this should not be used as the main explanation for the gap between official and independent testing results as in practical terms, the difference could never be corrected for.

On the first point, the WLTP regulations specify the different correction and calculation steps that need to be performed from the raw CO_2 results in order to obtain the final values for a WLTP cycle.[46] Below is a short summary of these different steps from the 1st act of the WLTP regulation:

A. The CO_2 emissions over the WLTP cycle are calculated based on the raw emissions from each phase of the cycle measured during a test. This is a compulsory step.

[45] Official Journal of the European Union, Regulation n°2018/2043
[46] Official Journal of the European Union, Regulation n°2017/1151, Annex XXI, Sub-Annex 7

B. A first correction called 'RCB correction' is applied to normalise for the different battery states of charge. This is done under certain conditions.

C. A second correction using the K_i factor may be applied in order to take into account the extra-fuel consumption during periodic regeneration events of an aftertreatment system. The K_i factor is applied to the Honda Civic because is fitted with a DPF. The K_i factor is not applied to the Opel Adam as this car is only equipped with a three-way catalyst. The Get Real project assumes that only passive regeneration happens on the GPF, fitted on the Ford Fiesta, meaning there is no need to apply the K_i factor to this vehicle.

D. A third correction using the Ambient Temperature Correction Test (ATCT) factor is used in order to normalise CO_2 emissions at a temperature of 14°C (considered in the regulation as being the average EU ambient temperature) rather than the regulatory ambient temperature in labs of 23°C under which the WLTP test is performed. This compulsory correction increase CO_2 emissions. This is due to higher fuel consumption during a cold start at 14°C vs. 23°C.

Within the remit of the Get Real project, Emisia performed independent road load measurements and used these results for the configuration of the laboratory for NEDC and WLTP testing as per the legislative requirements. Additional tests, performed in order to determine the K_i and ATCT factors for each tested vehicle, were not undertaken due to complexity, time and budget constraints. In the framework of this project, steps A and B described were performed in accordance with the regulations. Regarding step C (K_i factor), the regulation allows to use of a fixed K_i factor of 1.05 for CO_2 emissions as an alternative to test-derived K_i factors. The absence of publicly available ATCT correction factors from each manufacturer for each vehicle model (step D) does not allow independent CO_2 results to be corrected therefore making it difficult to fully compare the results to type-approval values.

CO_2 emissions (g/km)		Honda Civic X	Ford Fiesta VII	Opel Adam I
Independent WLTP tests	Measurement	135.3	150.0	156.5
	With RCB correction (if applicable)	135.3	150.0	156.5
	With K_i factor (if applicable)	142.1	150.0	156.5
	With ATCT factor	?	?	?
Type-approval WLTP tests	With all applicable corrections	118.0	128.0	150.0
Gap between corrected independent and type-approval result (%)		20%	17%	4.3%

Source: Get Real Project & Emisia

Table 5

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However, despite the WLTP 1st act increasing the amount of information regarding testing parameters and CoC available to third parties and the public (e.g. road load coefficients, test mass and frontal area),[47] this independent test programme has exposed that there is still not enough information about the four steps described above to derive the comparable CO_2 test results. This means that it is not possible to trace a CO_2 declared value back to the 'raw' CO_2 test results, nor to compare independently determined K_i and ATCT factors to the ones declared at type-approval.

Similarly, despite published NEDC CO_2 figures in the CoC, there is no further information provided regarding how the values were obtained; specifically, if it was obtained from the European Commission's CO_2MPAS tool or from double testing the vehicle on the NEDC cycle. Furthermore, no information is available regarding the values of the road load parameters used during type-approval testing, what tyres were fitted or which vehicles were used to determine these parameters, etc.

Another layer of complexity for third parties comes with the concept of CO_2 interpolation families in the WLTP regulation. The manufacturer can choose to group vehicles into interpolation families to avoid testing every possible variant of a vehicle. Vehicles are grouped into interpolation families by engine, gearbox and same number of powered axles, etc. Differences in CO_2 emissions within families arise due to the mass of optional equipment, tyres and aerodynamics and are permissible between 5 to 30g/km. This could potentially also include different model vehicles, however on this point the regulation is unclear. In order to quantify the CO_2 emissions of each vehicle within the family, one vehicle with the lowest (called 'vehicle low') and one vehicle with the highest CO_2 values (called 'vehicle high') within the family are selected for WLTP testing. The CO_2 results of these vehicles are then used to construct an interpolation line of CO_2 emissions. Thus the CO_2 emissions of every possible vehicle variant within the family can be determined by their position on the interpolation line. The difficulty for third parties arises from the lack of information on how this concept is used by different OEMs. There is no data to show if vehicles are grouped into interpolation families, which families they are grouped into and which vehicles are selected for testing. This lack of information makes it difficult for third parties to verify the accuracy of the interpolation or whether vehicles have been correctly grouped into interpolation families based on the regulatory criteria.

Given the criteria of the regulation and the carmakers' model ranges,[48] it is likely that the Ford Fiesta is part of an interpolation family. The Honda Civic and the Opel Adam are more likely to be approved only on the basis of the 'vehicle high' configuration. At the moment, the following points, which are necessary for the determination of representative CO_2 results, remain unclear:

- If the Honda and the Opel are examples of vehicle 'high' configurations and therefore the measured CO_2 emissions, once corrected, should be fully comparable with the values in the

[47] Official Journal of the European Union, Regulation n°2017/1151, Annex XVIII
[48] ADAC, PKW-Modelle mit der Abgasnorm Euro 6d-TEMP / Euro 6d, February 2019

CoC, as the official type-approval results should also correspond to the vehicle 'high' configuration.

- If the measured CO_2 emissions from the Ford, even when corrected, will not be fully comparable with the values from the CoC, as the official results are calculated by interpolation between the 'high' and 'low' vehicles tested at type-approval. If this is the case, it means that, to be fully comparable, the Get Real project would have to test both the vehicle 'high' and 'low' of this family and then compute its own interpolation line.

As a result, it is effectively impossible for third parties to reproduce a fully comparable WLTP test. The continuing lack of transparency in the type-approval process makes it hugely difficult for independent third parties to verify WLTP test results or to explain the differences in CO_2 emissions between their own tests and official data. The latest WLTP 2nd act and RDE 4th package, published late last year, goes in the right direction in addressing these issues. A new scheme for in-service conformity will kick in as of this year and includes, for the first time, third party testing.[49] As a consequence, independent testing laboratories will have access to more information thus ensuring independent testing is performed as closely as possible to the type-approval process. In order to exchange this information, the European Commission is working on an electronic platform which should be a better solution for this purpose than endlessly updated CoCs. It remains to be seen how this new scheme will work in practice, and especially whether the necessary information will be publicly accessible to third parties (NGOs, consumer organisations, etc.), which is not clear yet. This point is crucial for independent organisations who want to go beyond simply providing test results by allowing the analysis of gaps in CO_2 performance between their own tests and official data. This would make the data more relevant for use in policy making and for scrutiny of official test results. From this test programme, it would appear that the list of information provided in the new WLTP and RDE regulations is insufficient to answer all of the questions mentioned above, notably the NEDC CO_2MPAS correlation or the WLTP interpolation lines.

4.6. Issues with road load parameters

The sections above have addressed the lack of information available to third parties and the difficulties that this poses in the effective analysing of test results. As mentioned above, the lack of information makes it difficult for third parties to fully explain the differences in terms of CO_2 emissions between independent and official tests. This next section moves on to consider the quality of the road load parameters which are already provided in the CoC. Information on road load is especially important given that the European Commission's JRC estimates that road load determination accounts for up to a third of the gap in CO_2 emissions between NEDC and WLTP.[50]

[49] Official Journal of the European Union, Regulation n°2018/1832, Annex II

[50] J. Pavlovic, B. Ciuffo, G. Fontaras, V. Valverde & A. Marotta, How much difference in type-approval CO_2 emissions from passenger cars in Europe can be expected from changing to the new test procedure (NEDC vs. WLTP)?, Transportation Research Part A: Policy and Practice, Volume 111, pp.136-147, May 2018

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Testing on a chassis dynamometer conducted within a laboratory, is designed to simulate the vehicle driving on the road. The wheels of the vehicle roll but the vehicle itself remains stationary due to this there is no contact of the tyres with a real road and no air resistance which the vehicle experiences while driving on the road. In order to take into account these factors, the chassis dynamometer is set with 'road load parameters' to reproduce the rolling resistance and aerodynamic drag which is experienced by the vehicle on the road. In order to establish these parameters, a coast-down measurement is performed on a test track. The vehicle is driven up to 130km/h, the gearbox is then put in the neutral position and the deceleration of the car is measured over time. As the track used should be flat, the deceleration of the vehicle is assumed to be only due to rolling resistance and aerodynamic drag. Coast-down tests should be performed in both directions of the test track in order to avoid the influence of wind. The WLTP 1st act now opens the possibility for car manufacturers to do these tests indoors in a wind tunnel instead of on a test track.[51] It remains to be seen what effect this has on the road load parameters or CO_2 emissions vs. track-derived road load parameters. From these coast-down tests, the road load parameters are determined through a simplification of the driving resistance experienced by the vehicle into the following equation:

$$Deceleration\ forces = f_0 + f_1 \times v + f_2 \times v^2$$

(with: f_0, f_1 and f_2 being the road load parameters in N, N/(km/h) and N/(km/h)² respectively, v is the vehicle speed in km/h, deceleration forces are reported in N)

The road load parameter f_0 is related to inertia and rolling resistance, this is influenced by the vehicle mass and its tyres, with the largest effect at low speeds. The road load parameter f_2 is related to the aerodynamic drag which is more significant at higher speeds and influenced by changes in vehicle aerodynamics.[52]

Dieselgate confirmed how lab tests undertaken during the type-approval process were manipulated by carmakers in order to get lower CO_2 values, the determination of road load parameters being one of the main ways to manipulate results.[53] This optimisation is estimated to account for one fourth of the overall CO_2 gap between official tests and real-world driving.[54] This is why the Get Real Project asked Emisia to do their own independent coast-down tests rather than testing the cars with the car manufacturer's own road load parameters. These measurements were done twice for each vehicle: once for the NEDC test and once for the WLTP test in order to follow the respective

[51] The ICCT, The impact of official versus real-world road loads on CO_2 emissions and fuel consumption of European passenger cars, May 2016

[52] Ibid. and J. Pavlovic, B. Ciuffo, G. Fontaras, V. Valverde & A. Marotta, How much difference in type-approval CO_2 emissions from passenger cars in Europe can be expected from changing to the new test procedure (NEDC vs. WLTP)?, Transportation Research Part A: Policy and Practice, Volume 111, pp.136-147, May 2018

[53] T&E, Mind the Gap 2016 - Report, December 2016

[54] The ICCT and Element Energy, Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans, for the UK Committee on Climate Change, September 2015

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regulations. The Table 6 below provides a comparison of the parameters applied for the independent testing compared to the official road load parameters as published in the CoC.

WLTP road load parameters		Honda Civic X Independent test	Honda Civic X Type-approval	Ford Fiesta VII Independent test	Ford Fiesta VII Type-approval	Opel Adam I Independent test	Opel Adam I Type-approval
Test mass	kg	1567	1503	1400	1311	1265	1242
f_0	N	162.7	83.5	140.4	119.7	136.0	76.5
f_1	N/(km/h)	-0.084	0.400	0.463	0.601	-0.142	0.903
f_2	N/(km/h)²	0.03380	0.03031	0.03140	0.02935	0.03840	0.02900

Source: Emisia

Table 6

The objective of the independent coast-down tests was to determine the road load parameters for the worst case scenario (vehicle 'high' configuration) for each car. As a consequence, the masses of the vehicle high configurations (and NEDC configurations) were estimated based on the available information in the CoCs, the Certificates of Registration and the WLTP 1st act regulation used as a basis for the approval of these vehicles.

The main difference that can be seen in the Table 6 above between independent and type-approval WLTP road load parameters is the coefficient f_0. This is especially true for the Honda Civic and the Opel Adam as the f_0 parameter nearly doubles for the Honda, while the increase is almost +80% for the Opel. The difference is smaller for the Ford with an increase of almost +20%. Regarding the coefficient f_2, all independent WLTP coast-down measurements result in a higher value than at type-approval. This could mean that the aerodynamics of the rented vehicles was worse than during homologation, especially for the Opel with the largest gap. While it is difficult to directly quantify the effect of road load parameters on the CO_2 gap, it nonetheless points out to the potential optimisation of coast-down measurements by carmakers at type-approval.

In order to determine the CO_2 emissions, the independent road load results need to be fully comparable with the official type-approval data. Therefore, regulatory corrections need to be applied as per the WLTP regulation. This includes corrections for test mass, rolling resistance, wind speed, ambient air temperature and pressure to the reference conditions of 20°C and 1bar.[55] The Get Real project implemented the regulatory road load corrections on Emisia's coast-down measurements in order to assess the effect of the corrections on road load parameters. Next the effect on the gap between these and official type-approval road loads was evaluated. The wind speed correction was not performed due to the high complexity of the measurements that need to take place. This includes a continuous wind speed measurement, especially in order to determine

[55] Official Journal of the European Union, Regulation n°2017/1151, Annex XXI, Sub-Annex 4

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the wind speed alongside the road. All the results are presented in the Table 7 to Table ***9*** below. It has to be noted that, by analysing the information available in the CoC's and by following the definition of test mass written in the WLTP regulation, the Get Real project found different results for test mass compared to the values declared in the CoC. This should not happen, the difference is between 3 to 11kg depending on the vehicle. However, the road load parameters in the tables below show that this small difference in test masses does not have an important impact on the CO_2 gap.

WLTP road load parameters		Honda Civic X Independent coast down measurement	Corrected incl. test mass from CoC	Corrected incl. test mass by Get Real	Type-approval	Measured after independent WLTP test
Test mass	kg	1567	1503	1511	1503	1590
f_0	N	162.7	158.7	159.6	83.5	170.9
f_1	N/(km/h)	-0.084	-0.086	-0.086	0.400	-0.409
f_2	$N/(km/h)^2$	0.03380	0.03322	0.03322	0.03031	0.03694

Source: Get Real Project & Emisia

Table 7

WLTP road load parameters		Ford Fiesta VII Independent coast down measurement	Corrected incl. test mass from CoC	Corrected incl. test mass by Get Real	Type-approval	Measured after independent WLTP test
Test mass	kg	1400	1311	1322	1311	1421
f_0	N	140.4	143.9	145.1	119.7	143.3
f_1	N/(km/h)	0.463	0.507	0.507	0.601	0.396
f_2	$N/(km/h)^2$	0.03140	0.03218	0.03218	0.02935	0.03210

Source: Get Real Project & Emisia

Table 8

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WLTP road load parameters		Opel Adam I				
		Independent coast down measurement	Corrected incl. test mass from CoC	Corrected incl. test mass by Get Real	Type-approval	Measured after independent WLTP test
Test mass	kg	1265	1242	1245	1242	1284
f_0	N	136.0	142.7	143.1	76.5	144.1
f_1	N/(km/h)	-0.142	-0.152	-0.152	0.903	-0.397
f_2	N/(km/h)²	0.03840	0.03900	0.03900	0.02900	0.04129

Source: Get Real Project & Emisia

Table 9

The corrected road load parameter values are very close to the raw measured figures. Therefore, while the corrections applied slightly change the road load parameters, they do not close or explain the gap with type-approval values for all vehicles, especially for the Honda Civic or the Opel Adam. In order to better visualise the difference, the Figure 5 to Figure ***7*** below show the deceleration forces calculated from the road load parameters values above and the simplified equation presented at the beginning of this section.

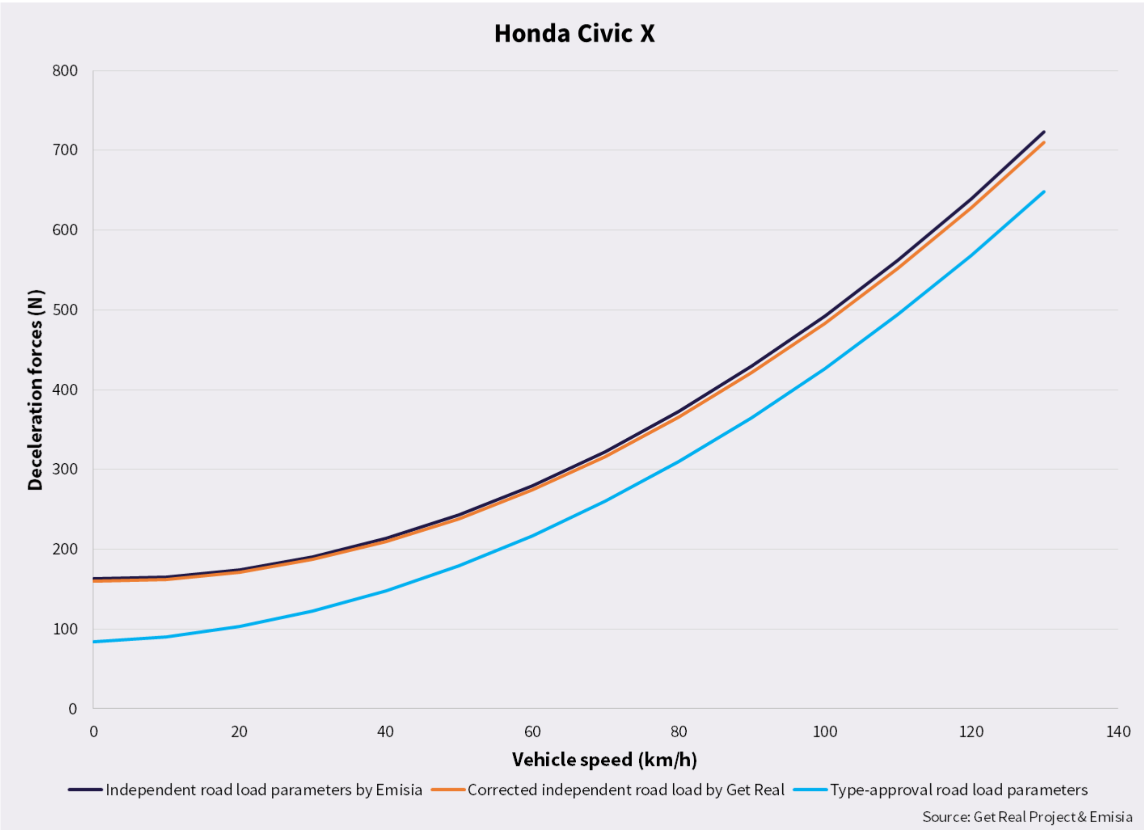

Figure 5

Get Real (LIFE15 GIC/DE/000029, Close the gap) is funded under the LIFE programme of the EU Commission.

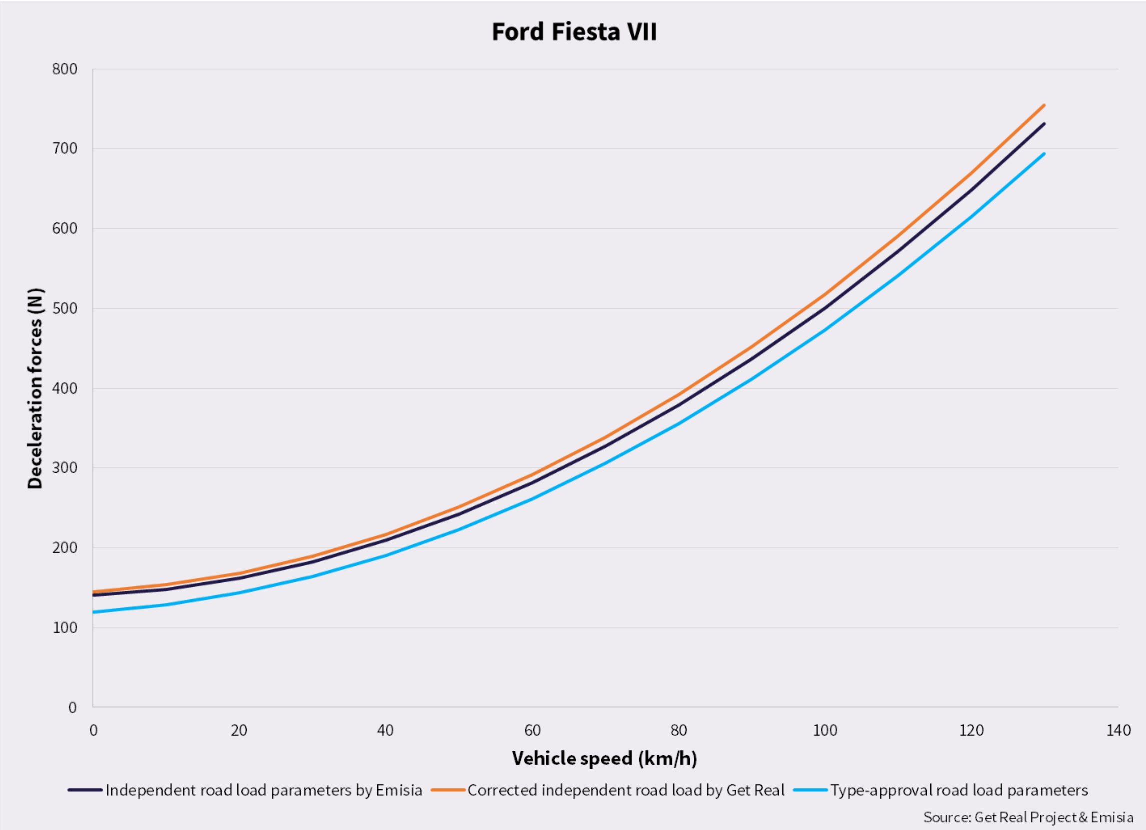

Figure 6

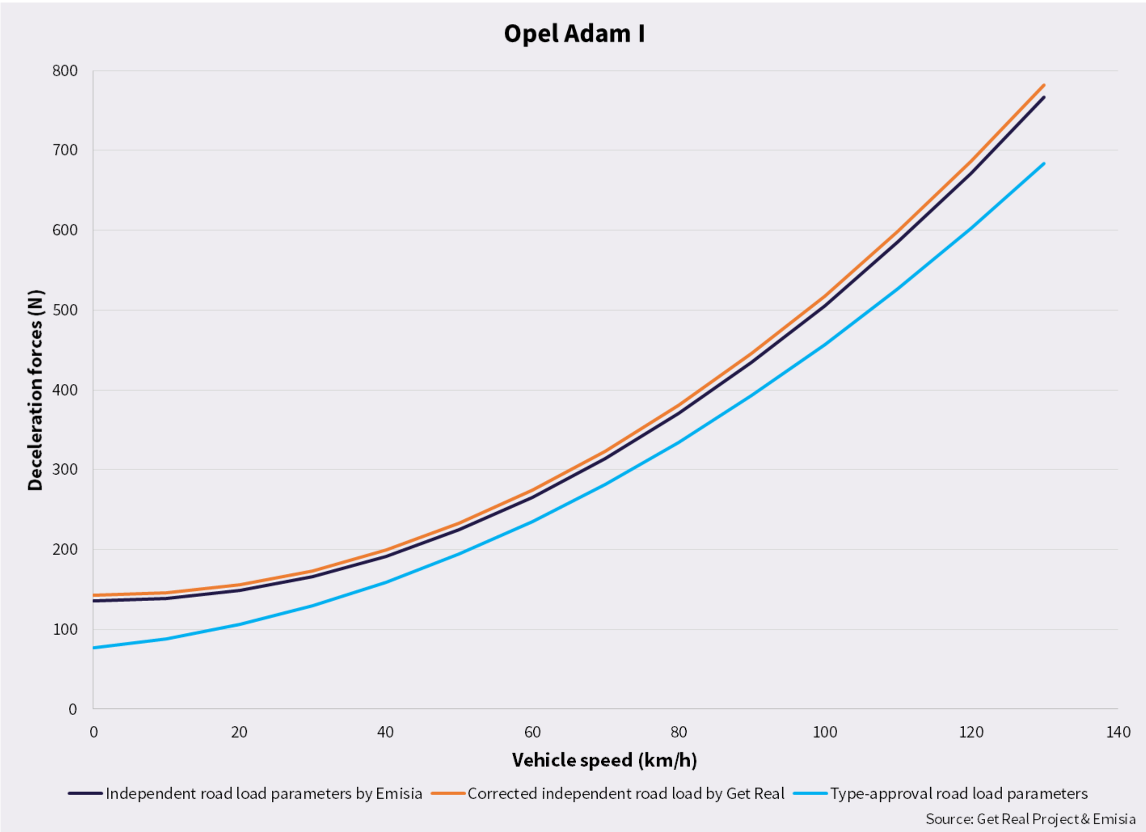

Figure 7

Get Real (LIFE15 GIC/DE/000029, Close the gap) is funded under the LIFE programme of the EU Commission.

The graphs above show that there are wide discrepancies in the deceleration forces for the Honda Civic, between the independent coast-down test and the type-approval results. The gap is also significant for the Opel Adam, the Ford Fiesta has the smallest gap. Once the road load parameters are converted into energy demand over the WLTP cycle,[56] about 10% less energy is demanded by the Honda Civic and the Opel Adam with the type-approval road load parameters vs. the independent road load parameters. The difference is about 7% for the Ford Fiesta.

		Honda Civic X	Ford Fiesta VII	Opel Adam I
Energy demand over the WLTP cycle (kWh/100km)	Independent road load corrected by Get Real	14.3	14.2	13.8
	Type-approval road load as given by the car manufacturers	13.0	13.3	12.5
Difference of energy demand between independent and type-approval road load parameters (%)		10.1%	6.9%	10.2%

Source: Get Real Project from Emisia

Table 10

There is not enough information provided in the CoCs to explain the gaps, especially regarding the type and tread wear of tyres fitted during the type-approval process. For all the tested vehicles, the same size tyres were fitted during the official and independent coast-down measurements. However, for the Opel Adam, the tyres fitted at type-approval had less rolling resistance (rolling resistance class B) than the ones fitted on the rented car (rolling resistance class C). Furthermore, for the Honda Civic, the load index and speed rating of the tyres fitted on the rented car are higher. However, due to the lack of publicly available information of the effect of tread depth on rolling resistance and whether or not the coast down results were performed in a wind tunnel, it is impossible to evaluate the effect that these have on the wide gap between road load parameters.

On paper, the WLTP regulation is better than NEDC as it closes many loopholes regarding the determination of road load parameters which have a great influence on the final CO_2 emission results.[57] However, independent coast-down tests performed on the Ford Fiesta and the Opel Adam show that the independent NEDC road load parameters lead to similar or even higher deceleration forces than what was applied on WLTP at type-approval (graphs available in annex). In the case of the Honda Civic, the type-approval road load parameters are significantly lower than for either the NEDC or WLTP independent coast-down tests. This is also true to a smaller extent for the Opel Adam. These results are highly suspicious and could suggest an attempt to optimise the road load

[56] Official Journal of the European Union, Regulation n°2017/1151
[57] T&E, Mind the Gap 2016 - Report, December 2016

parameters in order to get lower laboratory CO_2 emissions. It is known that Honda is at significant risk of fines for failing to meet CO_2 limits - as highlighted in T&E's previous report.[58]

4.7. Impact of road load parameters on CO_2 emissions

After making a comparison between independent and official road load parameters for WLTP and the effects of regulatory corrections, it is necessary to understand how this impacts the CO_2 emissions of the cars tested.

To do so, the Get Real project used a method firstly developed by TNO and TU Graz to correct the CO_2 emissions against the target road load, distance and speed of the WLTP regulation.[59] Last year, JRC proposed to include this method into the 2nd act of the WLTP regulation, based on the work done by TNO and TU Graz with some additional inputs, but in the end the method established in the regulation only applies to target distance and speed, not road load.[60]

The correction methodology, developed by TNO and TU Graz and in the WLTP 2nd act regulation, are both based on the same concept of 'vehicle specific CO_2 linear equation' interpolation (or 'Veline'). The aim is to create a linear interpolation for each vehicle between measured CO_2 emissions and the average power at the wheels needed to drive the tested vehicle. A value on the Veline is derived for each phase of the WLTP cycle. Calculating the power at the wheels is advantageous as it relies on information already available during a test: the road load parameters, the test mass, vehicle speed and acceleration. The correction is then based on the difference between the target power at the wheels (i.e. with the target speed and distance that should have been applied) and the power at the wheels from the actual test. This is necessary as there are always small deviations during the test within allowed tolerances.

To quantify the impact of road load parameters on CO_2 emissions, the Get Real project followed the methodology described in the WLTP 2nd act with modifications to account for road load as described above. This was done by applying TNO's and TU Graz's road load corrections to the actual speed profiles from the independent WLTP testing and not the theoretical WLTP speed profile: the objective of this simulation is to only estimate the impact of road load parameters on CO_2 emissions. The CO_2 corrections were calculated using:

- The actual power at the wheels calculated from the actual road load parameters measured during the coast down test done directly after the WLTP cycle (see Table 7 to Table ***9***);
- The target power at the wheels calculated from:
    - The corrected road load parameters from Emisia's coast down measurements with the use of the test mass calculated by Get Real;
    - The type-approval road load parameters.

[58] T&E, CO2 emissions from cars: The facts, April 2018
[59] TNO, Correction algorithms for WLTP chassis dynamometer and coast-down testing, Report n°2015 R10955, July 2015
[60] Official Journal of the European Union, Regulation n°2018/1832, Sub-Annex 6b introduced in Annex IX

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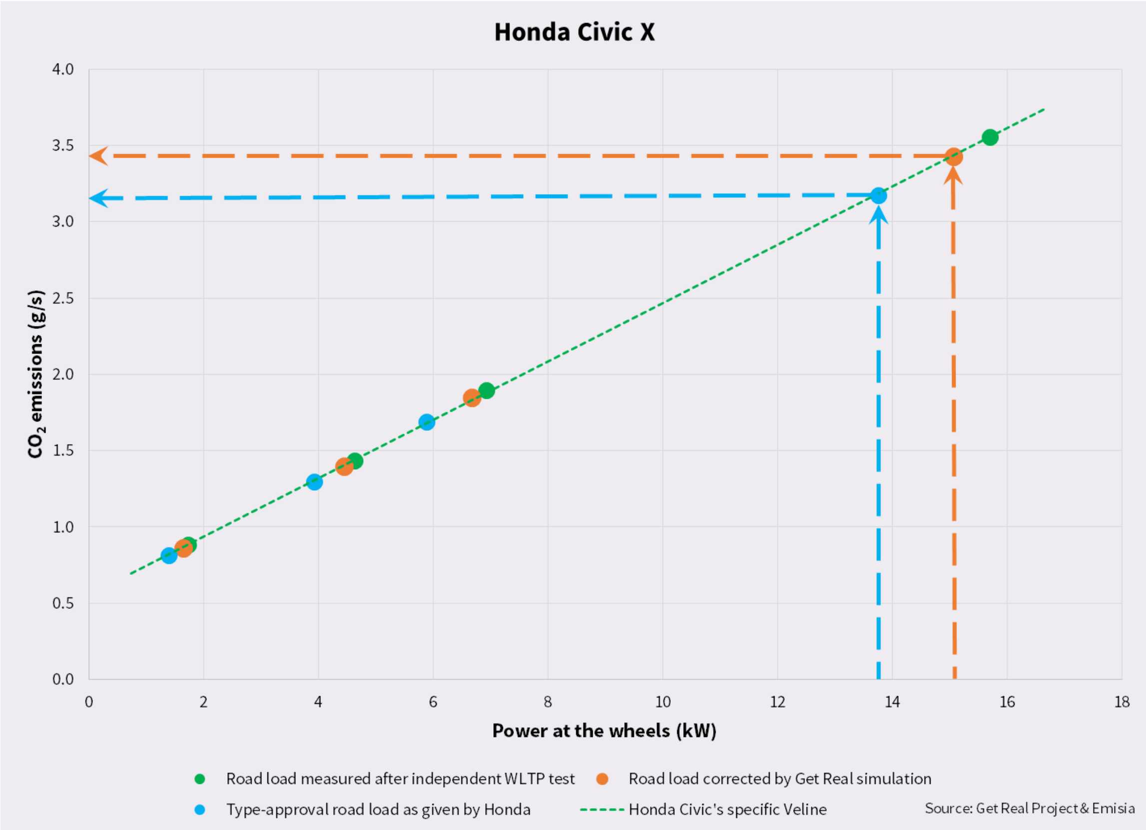

Figure 8

The Figure 8, above, gives a graphical example of how the Veline is constructed and applied for the Honda Civic. For all vehicles, the Veline was determined in accordance with the method described in the WLTP 2nd act regulation.[61] The blue dots are the values of the average power delivered at the wheels (in kW) for each WLTP phase. This is calculated from the road load parameters measured after the WLTP test (given in Table 7) and the actual speed profile vs. the measured CO_2 emissions in g/s. From these four points, the vehicle specific CO_2 linear equation (or Veline) for the rented Honda can be constructed. In Figure 8, this is represented by the blue dotted line and is used to simulate the CO_2 emissions for the other sets of road load parameters.

In order to determine the CO_2 emissions, using the Veline, for the corrected independent and type-approval road load parameters (given in Table 7), the average power delivered at the wheels was calculated for each WLTP phase. The actual speed profile from the independent WLTP testing was used. As the average power delivered at the wheels can be calculated from the data available for any vehicle tested, the Veline can be used to determine the corresponding CO_2 emissions for each WLTP phase. As demonstrated in Figure 8, for the 'extra-high' phase of the WLTP cycle, the independent corrected road load parameters deliver an average power at the wheels of 15.1kW; this corresponds to 3.4g/s of CO_2 emissions. This is represented by the orange dot and dashed lines in the graph. When official type-approval road load parameters are used, represented by the grey dot and dashed lines, the average power at the wheels for the 'extra-high' phase of the WLTP cycle is 13.8kW which corresponds to 3.2g/s of CO_2 emissions.

[61] Official Journal of the European Union, Regulation n°2018/1832, Sub-Annex 6b introduced in Annex IX

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Once the CO_2 emissions in g/s are known, the actual distances driven during each phase of the independently performed WLTP test and the time of each phase is used to convert the CO_2 emissions into g/km for the whole WLTP cycle. The results are presented in the Figure 9 to Figure ***11*** below.

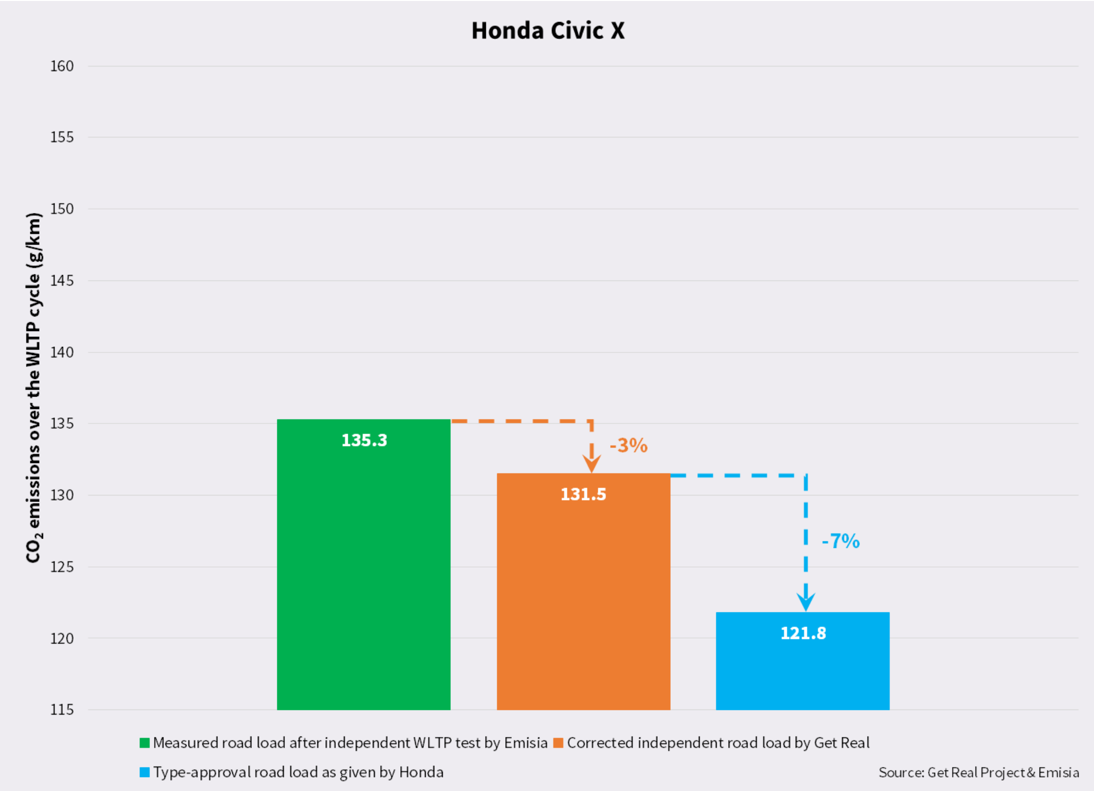

Figure 9

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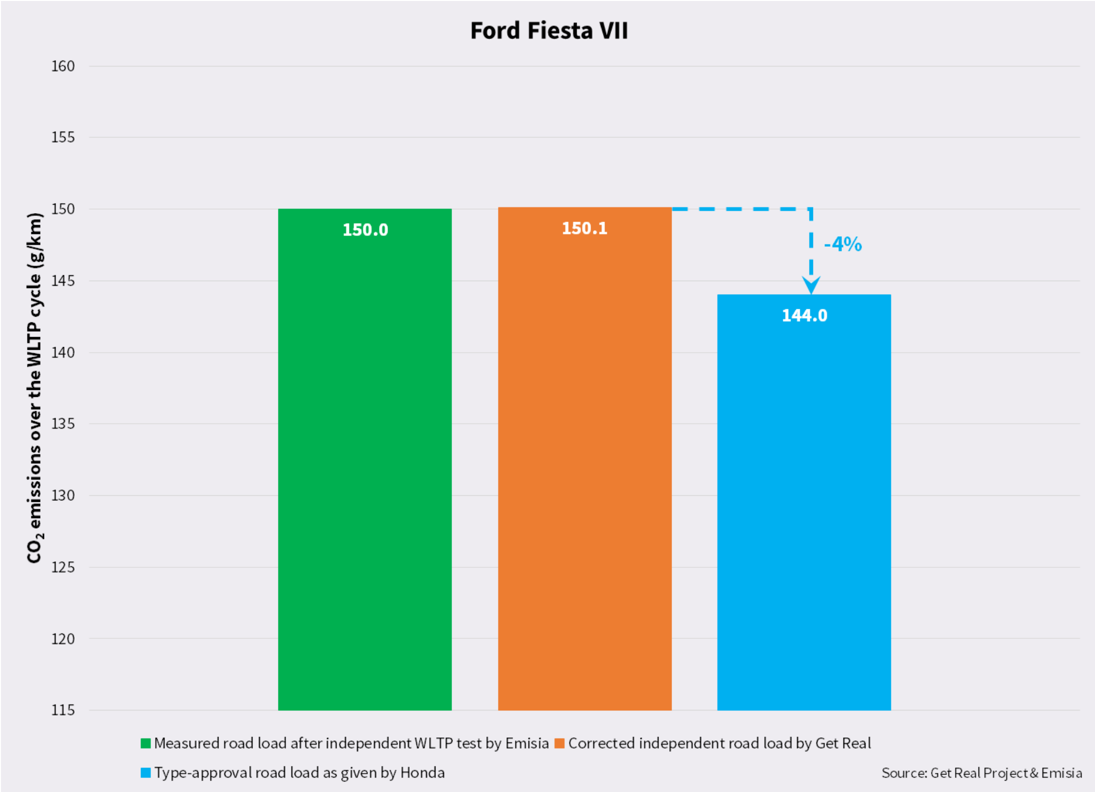

Figure 10

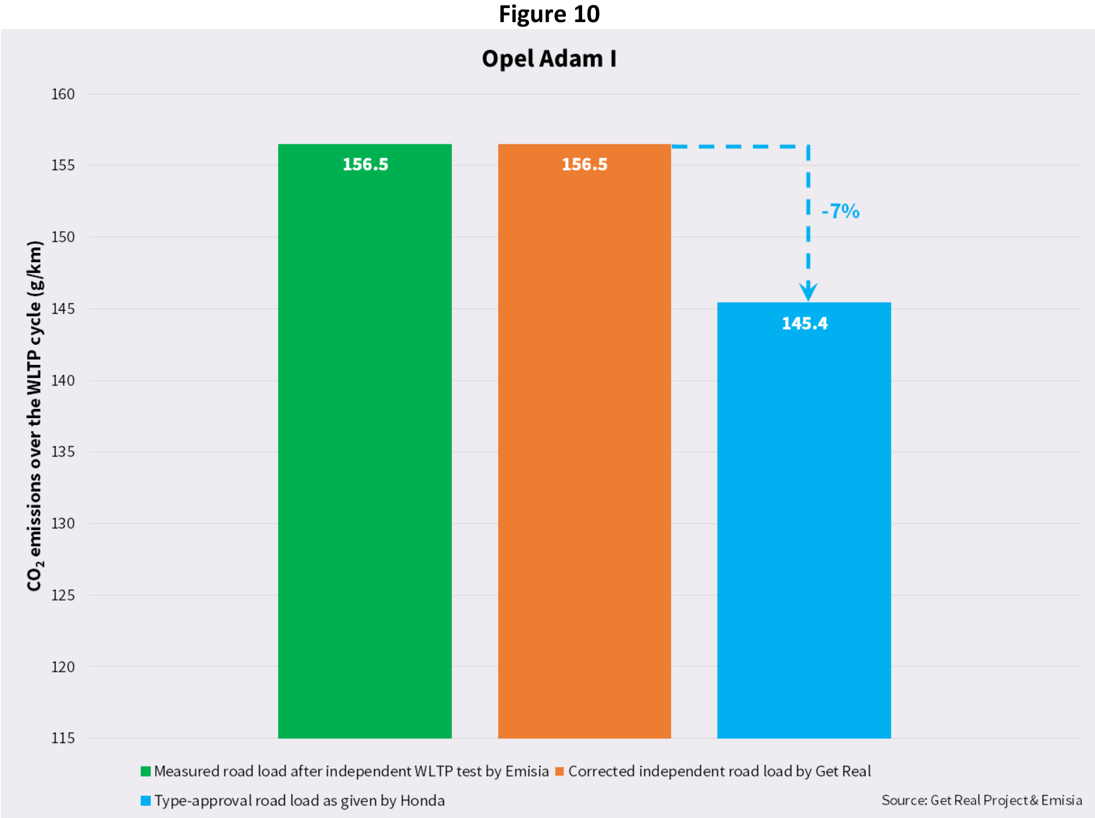

Figure 11

The Figure 9 to Figure ***11*** above show that road load parameters have a significant influence on CO_2 emissions. When the results calculated from the type-approval road load parameters are compared to the results calculated from the corrected independent road load parameters, the CO_2 emissions are reduced by 7% on the Honda Civic and the Opel Adam. The reduction is smaller for the Ford

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Fiesta at 4%, as the gap in the road load parameters is smaller as well. Next when the CO_2 emissions derived using the power at the wheels methodology from the type-approval road load parameters are compared with the official type-approval CO_2 values, each tested car shows a different situation:

- For the Honda Civic, the remaining gap, after accounting for road load optimisation, is +3% which is lower than the initial +15% (Table 3). This appears to confirm the suspicion that carmakers obtain lower type-approval CO_2 results by influencing road load parameters. The simulation in this report shows that correction of the road load for the Honda significantly reduces the CO_2 gap. However, as mentioned in section 5.5, the CO_2 gap is expected to increase once the following corrections are included; RCB, the K_i factor (either 1.05 by default or determined by Honda) and the ATCT. As mentioned earlier, due to the lack of information available, it is impossible for Get Real to quantify the effect these factors may have. In summary, the remaining gap of 3% shows that differences in **road load parameters are only one of the factors that can be used to explain the CO_2 gap between independent testing and type-approval and further test optimisations are likely to be used.**
- For the Opel Adam, the remaining gap, once the road load optimisation is accounted, is reduced from around +4% to -3%. The negative result is to be expected, since as mentioned above, the emissions would increase again once the ATCT factor is applied. Unfortunately, as the Get Real project cannot quantify the order of magnitude of such a correction factor, it is therefore impossible to estimate the size of the final gap. **In any case, the road load parameters appear to explain a large chunk of the difference in CO_2 emissions.**
- The Ford Fiesta is an outlier: the gap following the simulation remains high, around +12% compared with the initial +17%. Especially when the potential increase from application of the ATCT and the RCB corrections would be expected to further increase this gap. **It appears that in this case the road load optimisation is not a significant cause of the gap between independent and type-approval WLTP tests. This means that potentially other test flexibilities exploited during testing or in the application of interpolation families could be allowing the manufacturer to obtain lower type-approval values which cannot be explained further in this report.**

4.8. Comparison of driving dynamism between the different tests

This section compares the driving dynamism of the performed laboratory tests with on-road data to understand how realistic and how representative laboratory cycles are, especially that the WLTP speed profile has been developed by analysing real driving data.[62] In terms of the influence of driving dynamism on CO_2 emissions, a recent analysis by JRC estimated that the change of laboratory cycle, and the associated increase in driving dynamism, is one of the drivers in the increase of CO_2

[62] UNECE, Global Technical Regulation 15, ECE/TRANS/180/Add.15, May 2014

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emissions during the shift from NEDC to WLTP. However, overall, the road load determination is estimated to have a bigger impact on CO_2 emissions.[63]

Figure 12 to Figure ***14*** below compare the driving dynamics for each tested vehicle. Each graph includes the upper regulatory limit regarding driving dynamism allowed for cars from the RDE regulation, as well as the 95th percentile of vehicle speed times positive acceleration for the urban, rural and motorway phases for the independent NEDC, WLTP and RDE compliant tests. The regulatory limit and the calculations were undertaken following the RDE regulation.[64] The values for NEDC and WLTP tests are illustrative only (not for compliance purpose) but allows a comparison with the on-road test results. The data and calculations are based on the vehicle speed information from the OBD port of the vehicles. Data for each vehicle has also been compared with PSA Group's equivalent models tested in real-driving conditions.[65] During PSA's real-world driving the average driver is targeted for these on-road tests.[66]

Two key findings can be obtained from these graphs:

1. WLTP driving dynamism is comparable with real-world tests, which is not the case for NEDC tests;
2. The dots representing WLTP are close to the commissioned RDE 'smooth' tests and at the bottom end of driving dynamics range when compared with equivalent models from the PSA Group.

It is reasonable to conclude that whilst the WLTP test is more representative of real-world driving than the NEDC it replaced, it does not represent an average driver on three different car segments. The dynamism of the average driver is derived from PSA data. This is part of reason that there remains a gap between CO_2 emissions and fuel consumption between WLTP lab test and real-world driving. However, as reminded in the beginning of this section, driving dynamism is only one aspect of the full picture of the gap between laboratory tests and the reality.

[63] J. Pavlovic, B. Ciuffo, G. Fontaras, V. Valverde & A. Marotta, How much difference in type-approval CO_2 emissions from passenger cars in Europe can be expected from changing to the new test procedure (NEDC vs. WLTP)?, Transportation Research Part A: Policy and Practice, Volume 111, pp.136-147, May 2018

[64] Official Journal of the European Union, Regulations n°2017/1151, n°2017/1154 and n°2018/1832

[65] These real-world fuel consumption tests were realised within the framework of the ongoing testing campaign jointly done by PSA Group with T&E, France Nature Environnement (FNE) and Bureau Veritas. The data showed in these graphs are taken from the following joint report: Real-world fuel economy measurements: technical insights from 400 tests of Peugeot, Citroen and DS cars, September 2017.

[66] PSA Group, The Groupe PSA, NGOs T&E and FNE, and Bureau Veritas publish the protocol for measuring real-world fuel consumption, March 2018

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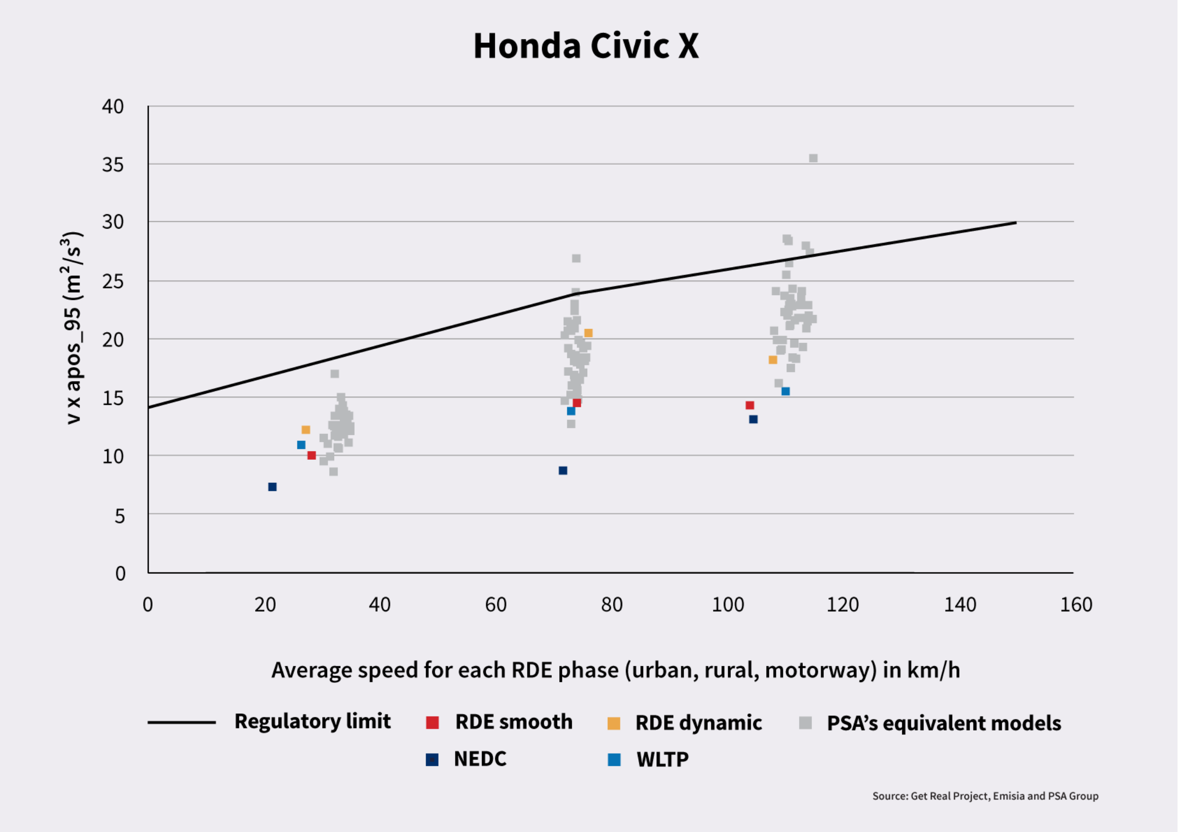

Figure 12

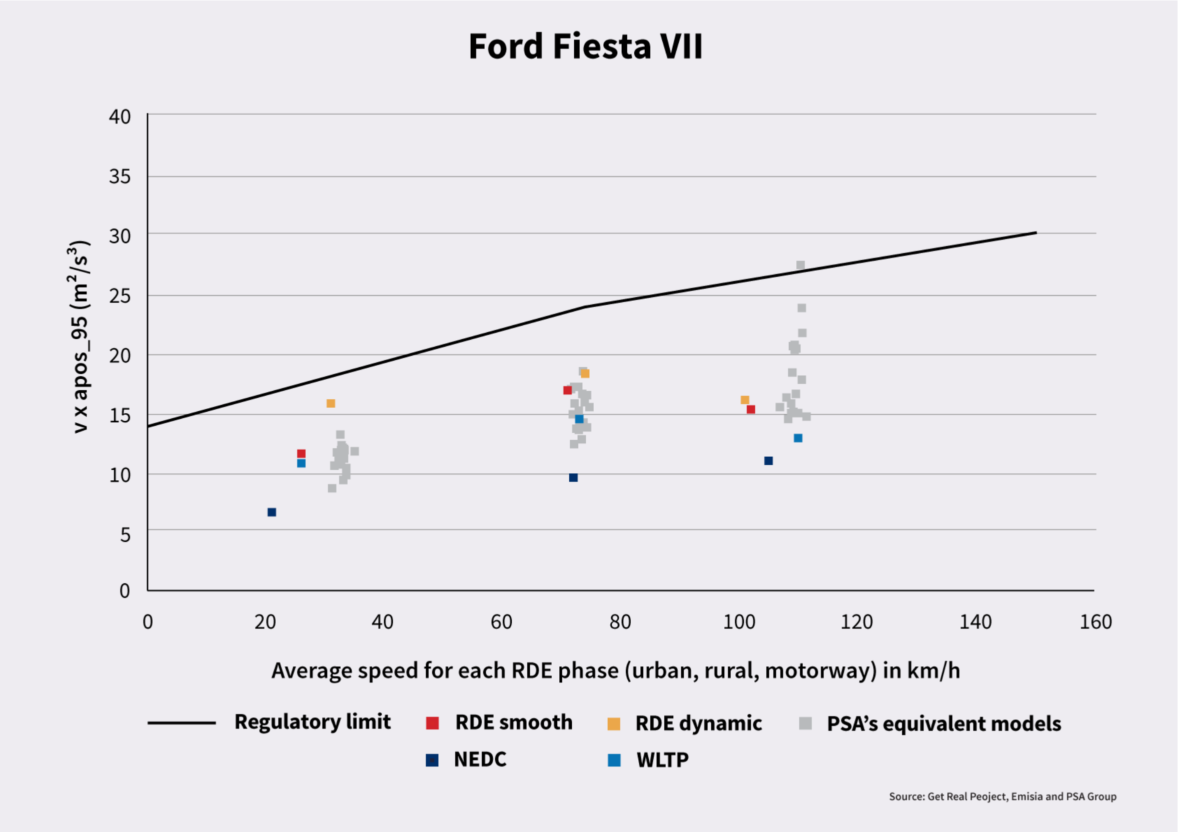

Figure 13

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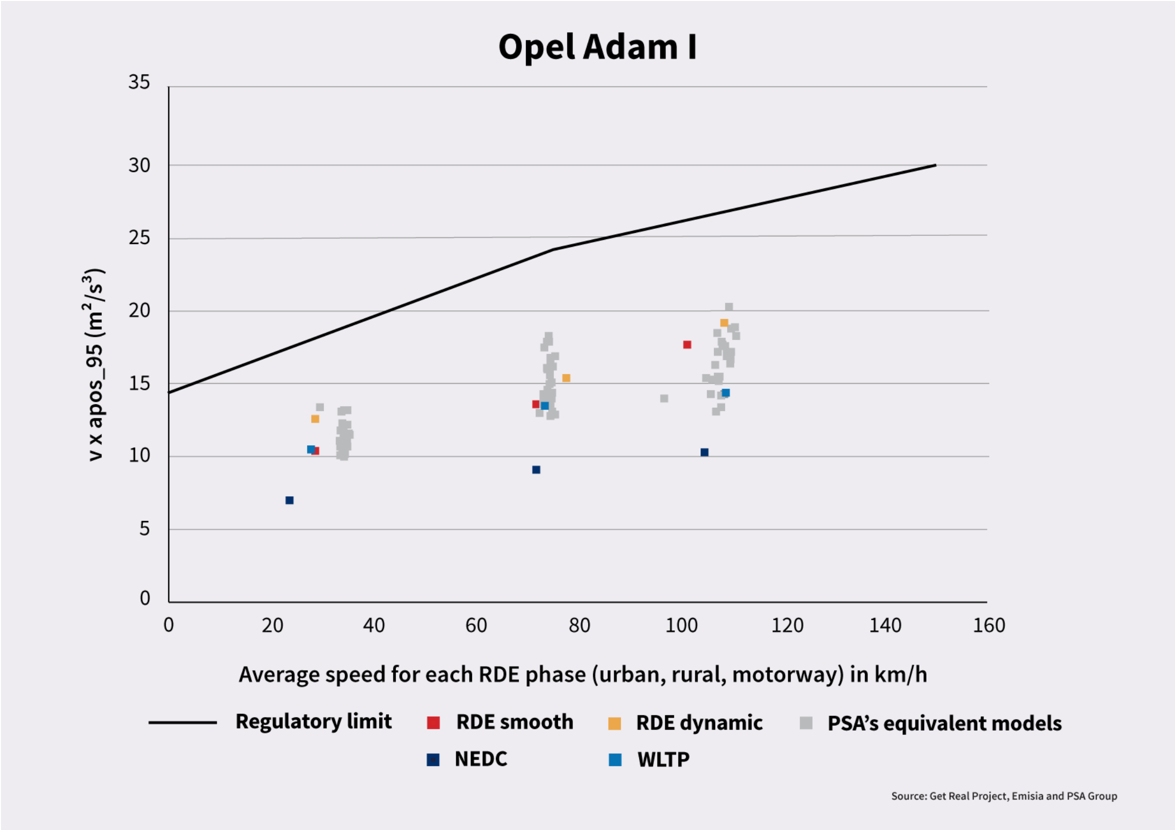
Opel Adam I
v x apos_95 (m²/s³)
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
Average speed for each RDE phase (urban, rural, motorway) in km/h
Regulatory limit
RDE smooth
RDE dynamic
PSA's equivalent models
NEDC
WLTP
Source: Get Real Project, Emisia and PSA Group

Figure 14

5. Conclusions & Policy recommendations

Despite the failure of the previous and existing CO_2 regulations to deliver the expected emission reductions on the road, the EU legislators failed to introduce effective real-world CO_2 testing as part of the agreement on post-2020 CO_2 standards for cars and vans reached in late 2018. Considering that the European Commission's own Scientific Advisory Mechanism proposed a solution to do so,[67] EU Commission's strong opposition to the Parliament's amendments on this topic was particularly disappointing.

An increasing body of evidence, including these tests, show that the WLTP procedure will not close the gap between emissions measured on the laboratory and on the road. Even more alarmingly, as this report shows, there are new ways to manipulate tests with the introduction of WLTP, which cannot be fully explained by independent third parties. This can only be solved if a mandatory real-world enforcement mechanism is put in place. Concretely, the continuing gap means consumers will continue to pay higher fuel bills than anticipate based on the advertised fuel consumption and transport climate targets will be missed.

The tests performed on the three selected vehicles for the Get Real project demonstrate:

- The CO_2 emissions gap between the independently performed WLTP and NEDC tests is small, only 2% on average, compared with a 19% difference from the official CO_2 values declared by car manufacturers.[68] This suggests the new WLTP test procedure is likely not sufficient to reduce or close the gap between official and real-world CO_2 emissions (which today is about 40%).
- The CO_2MPAS simulation tool used to turn WLTP values into the NEDC equivalent gives comparable results. The difference between the simulated NEDC-equivalent values and the independent NEDC tests on the three vehicles tested is around 1% on average, or as expected when the tool was designed. This suggests that the big discrepancies currently claimed by carmakers are 1) either a result of them manipulating downwards NEDC-declared CO_2 values (as the test results in this paper show) or 2) manipulating upwards WLTP values to inflate the 2021 starting point for 2025/30 CO_2 reduction targets (as underlined in the European Commission's non-paper),[69] or both. But the discrepancy cannot be blamed on the CO_2MPAS tool.
- Despite the shift to the WLTP regulation (more representative of real-world driving, higher vehicle test mass, use of the lowest rather than highest prescribed tyre pressure, tyre tread depth closer to brand new tyre specifications), the road load determination at type-approval is optimised compared to independent measurements, even when the regulatory

[67] European Commission, Scientific Advice Mechanism, Closing the gap between light-duty vehicle real-world CO_2 emissions and laboratory testing, Scientific Opinion No. 1/2016, November 2016

[68] Calculated from the official WLTP and NEDC CO_2 values in the Certificates of Conformity of the tested vehicles

[69] T&E, Ending the cheating and collusion: Using real-world CO_2 measurements within the post-2020 CO_2 standards, August 2018

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corrections are included. The biggest gap is for the Honda Civic X and the Opel Adam I, with an energy demand over the WLTP cycle underestimated by 10% with type-approval road load parameters compared to independent parameters; while the gap is 7% for the Ford Fiesta VII.

- In the end, the road load optimisation plays an important role in the CO_2 gap. When the road load parameters used during type-approval are simulated by the Get Real project on the tested vehicles, CO_2 emissions are reduced by 7% on the Honda Civic X and Opel Adam I, the reduction is smaller for the Ford Fiesta VII: 4%. For all the tested vehicles, road load optimisation is only one of the factors that can explain the CO_2 gap. Other test optimisations are also used.
- Driving dynamics on a WLTP cycle is higher and more representative than the NEDC cycle it replaces. However, even though WLTP driving dynamics is comparable with some real-world data, the new laboratory cycle is in the lower end of the driving dynamics range of an average PSA customer, representing a very smooth driving style. However, driving dynamics is not the only factor in real-world fuel consumption and cannot on its own be used to judge test's representativeness.

However, the key finding is that there remains too much uncertainty and secrecy surrounding the testing procedure. This includes how the cars are optimised, tested and corrected for the purposes of the type-approval process, and a large amount of data is still missing in order to enable third parties to simulate the results and explain the real-world gap. Currently, as an example, no information is available for third parties to understand how CO_2 interpolation families are used by car manufacturers, how the corrections on the final CO_2 results were done or how road load determination has been determined, etc. As a general rule, much more data should be made publicly accessible. When the data required to interpret the test results is difficult or sensitive, the data should be provided to third parties involved in vehicle testing by carmakers or by the European Commission upon request. Accredited testing laboratories will, under the new WLTP 2nd act and RDE 4th package regulation, be able to request some of the data. However, as the legislation currently stands, this does not cover all third parties.

A continuous assessment and control of the evolution of real-world CO_2 emissions compared to official type-approval values is needed to ensure the fuel consumption gap does not grow again between 2021 and 2030 and remains in the same order of magnitude, or ideally is reduced. Notably, the monitoring now agreed in the 2025/30 CO_2 regulations should be turned into an enforcement tool without delay. This should be done as part of the review in 2023 and enforced much earlier than the current regulations stipulates, i.e. before 2030. This, as demonstrated by T&E,[70] can be done by setting a margin between WLTP and the real-world emissions as measured by fuel consumption meters. The type-approval CO_2 emissions of carmakers should then be automatically corrected - in the same way as they are adjusted for vehicle mass today - in case the real-world CO_2

[70] T&E, How Fuel Consumption Meters can be used to deliver real-world CO_2 improvements as part of post-2020 CO_2 standards, November 2018

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emissions overshoot the margin. Crucially, the real-world check at type-approval with FCMs should be accompanied by independent third party tests once vehicles are in use. This are by far the most important measures to restore the trust in car CO_2 regulations and finally ensure that consumers benefit in full from the fuel savings promised to them years ago.

Furthermore, the obsolete 1999 EU Directive on fuel consumption information for consumers should be finally reviewed by 2020, as agreed during the negotiations on the 2025/30 CO_2 standards for cars and vans. It should include information, provided to drivers, on the real-world model-specific fuel consumption. The directive should also introduce a fuel economy and CO_2 emissions labelling scheme for vans.

Last but not least, the European Commission should use its new market surveillance powers that come into force in September 2020 to robustly check carmakers' tests results and take action in cases of manipulation and cheating. Crucially, the facilities of the European Commission's Joint Research Centre (JRC) should be expanded to conduct sufficient number of tests and adequate budget provided. The Commission should closely cooperate with third parties that expose the problems and use its new legal powers to fine and require mandatory recalls to its fullest.

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Annex

Road load parameters		Honda Civic X Indpt NEDC	Honda Civic X Indpt WLTP	Honda Civic X TA WLTP	Ford Fiesta VII Indpt NEDC	Ford Fiesta VII Indpt WLTP	Ford Fiesta VII TA WLTP	Opel Adam I Indpt NEDC	Opel Adam I Indpt WLTP	Opel Adam I TA WLTP
Test mass	kg	1470	1567	1503	1250	1400	1311	1130	1265	1242
f_0	N	169.0	162.7	83.5	125.2	140.4	119.7	102.1	136.0	76.5
f_1	N/(km/h)	-0.495	-0.084	0.400	0.542	0.463	0.601	0.250	-0.142	0.903
f_2	N/(km/h)²	0.03550	0.03380	0.03031	0.02850	0.03140	0.02935	0.03400	0.03840	0.02900

Source: Emisia

Table 11

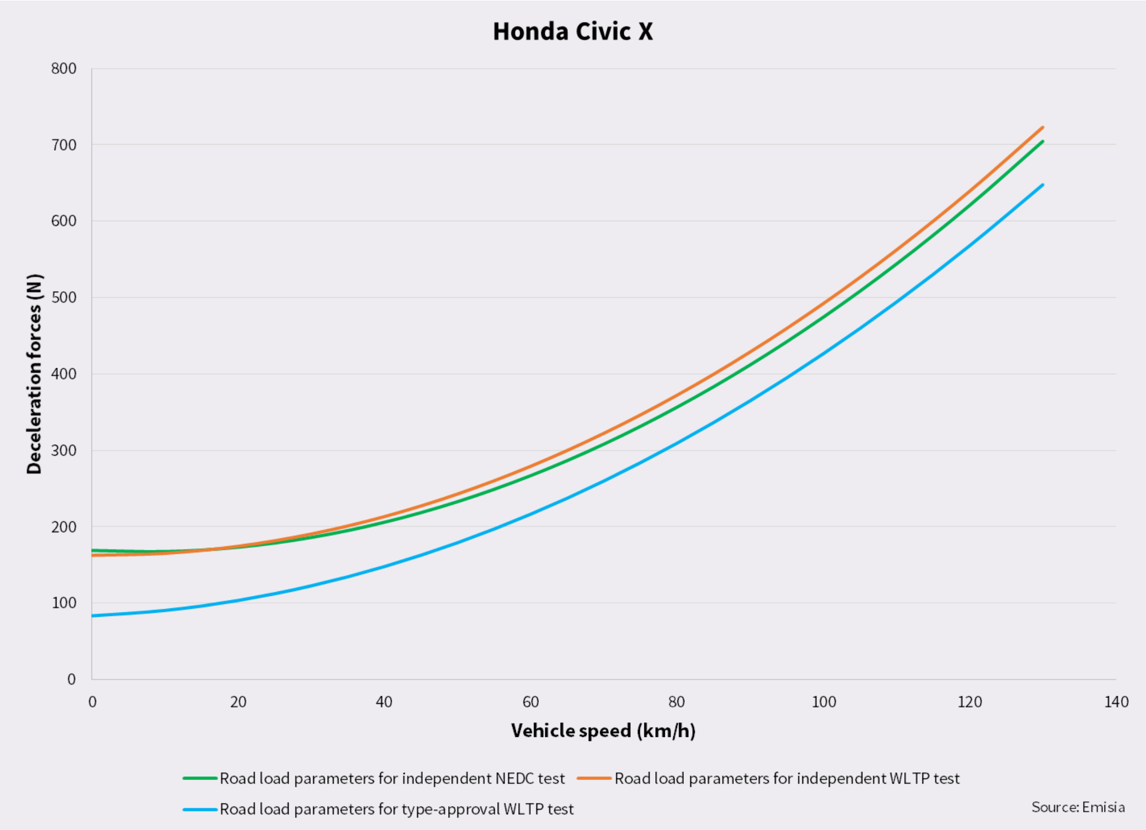

Figure 15

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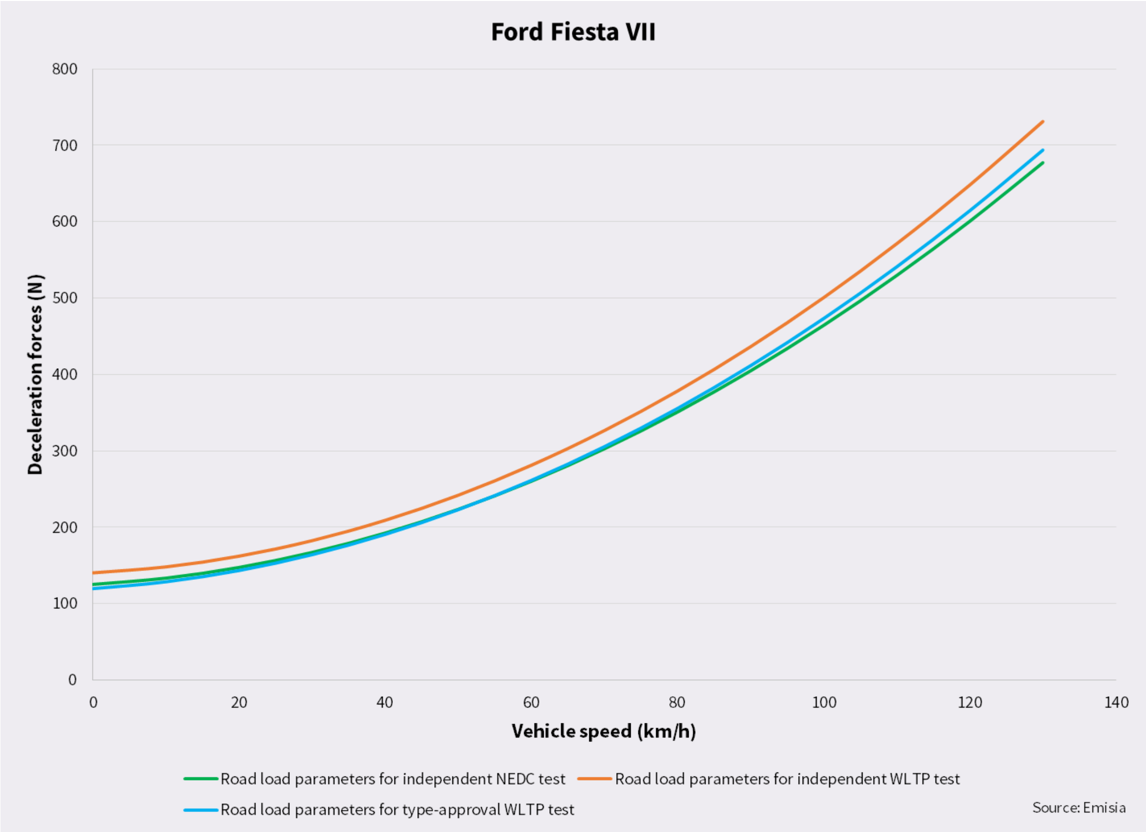

Figure 16

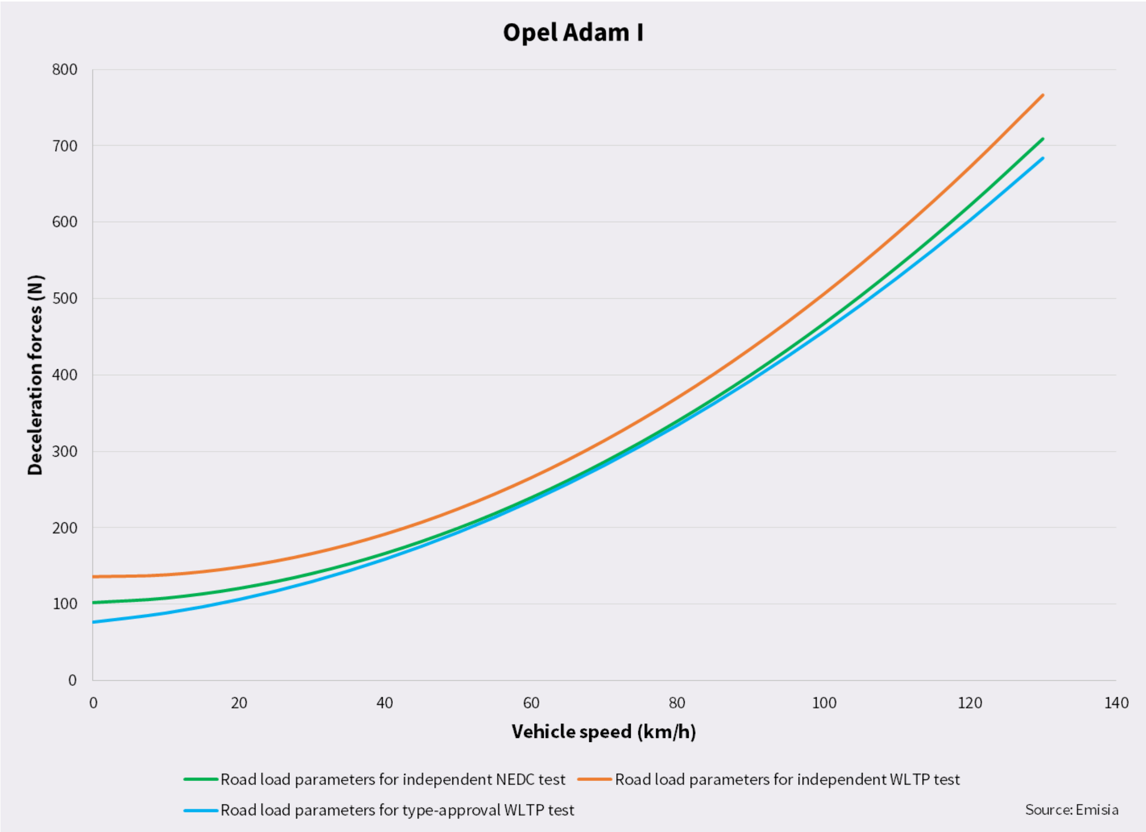

Figure 17

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Get Real is a joint project by:

Deutsche Umwelthilfe e.V.
Hackescher Markt 4
10178 Berlin, Germany

www.duh.de

Eva Lauer
Project Manager
Phone: +49 (0)30 2400 867-76
e-mail: lauer@duh.de

Anna Breitkreuz
Project Manager
+49 (0)30 2400 867-735
breitkreuz@duh.de

Transport & Environment
2nd floor, 18 square de Meeûs
Brussels, 1050, Belgium

www.transportenvironment.org

Yoann Le Petit
Clean Vehicles and Emobility Officer
Phone: +32 (0)2 851 02 08
e-mail: yoann.lepetit@transportenvironment.org

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