The Association
of European
Vehicle Logistics

WLTP, RDE and automotive emissions targets

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automotive emissions targets

Overview

From September 2017 the EU procedure for testing emissions from vehicles changed from the New European Driving Cycle (NEDC) to the Worldwide Harmonised Light Vehicles Test Procedure (WLTP). WLTP is more accurate reflecting current driving trends and technological developments. The introduction of WLTP at European level is aimed at measuring in a more accurate way: fuel consumption, CO_2 emissions related to fuel consumption, pollutant emissions and energy consumption values of alternative powertrains.

Due to the complexity of WLTP, its requirements are phased in. All new passenger car models (PCs) are tested according to WLTP since September 2017. All registrations of PCs require WLTP since September 2018. WLTP is mandatory for Light Commercial Vehicles (LCVs) since September 2019. Further requirements are also mandatory since September 2019 including measurements of emissions deriving from evaporation for example.

The Real Driving Emissions (RDE) test was also introduced as a complementary test to WLTP to measure pollutants such as nitrogen oxides (NO_x) in real life driving conditions. As WLTP, also RDE is being introduced in steps. From September 2017 the RDE test applies to all new PCs model and from September 2019 for all registrations of new PCs. The RDE test was introduced because the NO_x values measured in the lab test when a vehicle get type approved are generally much lower compared to the NO_x amount a vehicle actually emits when driven on the road.

WLTP and RDE, respectively tie in with the EU Regulation setting CO_2 emission targets reductions for vehicles and the EURO 6 Regulation setting acceptable limits for exhaust emissions of new vehicles. The introduction of the two tests represent challenges for car makers in the EU and EEA since they measure more accurately emissions from vehicles while the emissions targets become ever tighter.

Furthermore, WLTP and RDE tests represented a challenge in terms of time for car makers. Many of them were not ready to comply with the requirements of the two tests. Delays and bottlenecks were experienced at EU level in the automotive sector due to the fact that many vehicles had not been homologated in time and therefore could not be sold.

On a larger scale, the impact of WLTP is linked to CO_2 emissions targets which are programmed to be ever more restrictive in the years to come at EU level and will translate into tighter specific CO_2 emissions targets for car manufacturers.

This document provides a detailed overview of WLTP and RDE tests and the main changes that they brought in the EU emissions testing scenario.

1. Introduction

On 1 September 2017, two new European tests came into force modifying the type-approval process[1] of a model of a vehicle: the Worldwide Harmonised Light Vehicles Test Procedure (WLTP)[2] and the Real Driving Emissions (RDE) [3] test. WLTP replaced the NEDC (New European Driving Cycle)[4] which was last updated in 1996. While WLTP laboratory tests measure fuel consumption, CO_2 emissions related to fuel consumption, pollutant emissions and energy consumption values of alternative powertrains (including electric vehicles), RDE complements WLTP tests and measures pollutants such as NO_x emitted by vehicles when driven on roads in different conditions. The reason for the introduction of these tests is well-understood as the previous NEDC cycle did not reflect the technological advancements of the recent decades or current driving conditions. Therefore, the emissions values deriving from the old NEDC testing procedure did not provide realistic CO_2 emission values which are a reference both for consumers and for CO_2 emissions reduction targets.

At EU level, the two tests are introduced by Regulation (EU) 2017/1151. WLTP and RDE are in in principle different and the latter complements the WLTP lab test as it happens in real driving conditions. The new WLTP lab test is also based on real life data collected worldwide which provides more accurate values compared to the old NEDC test. Nonetheless, WLTP still does not account for an individual driver's style (i.e. aggressive or sedate), traffic conditions, weather conditions, gradients or load on the vehicle. This is why it is complemented by the RDE test whose results are used in conjunction with the WLTP lab test to calculate the final figures for each vehicle. It should be reiterated that the RDE complements WLTP tests only with regard to NO_x and particle number (PN) emissions and not for CO_2 emissions.

The two tests have been introduced in stages in the testing scenario of emissions at EU level according to the timeline below.

- From **1 September 2017** the WLTP and RDE tests apply to all new PC models launched on the market
- From **1 September 2018** the WLTP test applies to all registrations of new PCs and LCVs (except for certain end-of-series[5] models)
- From **1 September 2019** the RDE test applies to all registrations of new vehicles with no exception

[1] The type-approval describes the process applied by national authorities to certify that a model of a vehicle meets all EU safety, environmental and conformity of production requirements before authorising it to be placed on the EU market. Once a vehicle is approved, a certificate of conformity (CoC) is issued which certifies that the vehicle corresponds to the type approved and it can be registered anywhere in Europe. The CoC is the vehicle's birth certificate, in which the manufacturer certifies that the vehicle corresponds to the approved type

[2] Regulation (EU) 2017/1151 "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"

[3] The RDE test measures are included in Annex IIIa of the Regulation (EU) 2017/1151.

[4] NEDC is a driving cycle developed at the time to reflect typical vehicle usage in Europe.

[5] 'End-of-series vehicle' means any vehicle that is part of a stock which cannot be registered or sold or entered into service owing to the entry into force of new technical requirements against which it has not been approved.

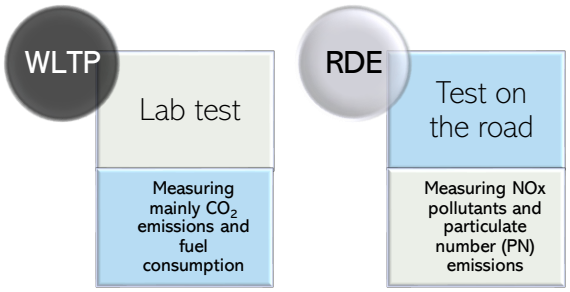


Figure 1 Main differences between WLTP and RDE tests

2. What is WLTP?

WLTP was developed by the United Nations Economic Commission for Europe (UNECE) with the support of the European Commission (EC) to ensure that testing more accurately reflects real world results, especially regarding CO_2 emissions, but also other aspects that are required for vehicle type-approval.[6]

As of September 2017, all new PC models introduced to the market for the first time have been tested according to the requirements of WLTP. Since September 2018 WLTP applies to all registrations of new vehicles. An extension was granted to end of series vehicles which could be sold for 1 more year after September 2018.

The WLTP test is longer, more dynamic and takes into account more real-world factors than the NEDC test. The vehicle is, for example, tested at higher speeds and the weight and aerodynamics of optional equipment is included in the test's measurements (see Table 1).

	NEDC	WLTP
Test cycle	Single test cycle	Dynamic cycle more representative of real driving
Cycle time	20 min	30 min
Cycle distance	11 km	23.25 km
Driving phases	2 phases: 66% urban and 34% non-urban driving	4 more dynamic phases: 52% urban and 28% non-urban driving
Average speeds	34 km/h	46.5 km/h
Maximum speed	120 km/h	131 km/h
Influence of optional equipment	Impact on CO_2 and fuel performance not considered under NEDC	Additional features are taken into consideration
Gear shifts	Vehicles have fixed gear shift points	Different gear shift points for each vehicle
Test temperatures	Measurements at 20-30˚C	Measurements at 23˚, CO_2 values corrected to 14˚C

Table 1 Main differences in parameters measured in NEDC and WLTP tests

In November 2018 WLTP was further amended (often referred to as WLTP 2).[7] The amendments introduce additional requirements which apply since September 2019 for all type approvals and all

[6] Regulation (EU) 2017/1151, supplementing Regulation (EC) No 715/2007 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"

[7] Commission Regulation (EU) 2018/1832 "amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) 2017/1151 for the purpose of improving the emission type approval tests and procedures for light passenger and commercial vehicles, including those for in-service conformity and real-driving emissions and introducing devices for monitoring the consumption of fuel and electric energy"

first vehicle registrations. These requirements include amongst others: a revision of the test procedure to check fuel evaporation (EVAP) in vehicles with a petrol engine to measure escaping hydrocarbon vapors when parked over a 48-hour period[8]; an obligation as of 2021 for all new PCs and LCVs to have standardised and accessible fuel and energy consumption monitoring on board the vehicle; a requirement to measure emissions to see whether the emission limits are still met during vehicle operation (In Service Conformity, ISC).[9]

Despite the fact that the newly introduced WLTP lab test represented an improvement from the NEDC lab test, WLTP has still its limitations when measuring CO_2 emissions. Although through WLTP more parameters are measured, it remains a laboratory test which inevitably does not accurately represent real-world emissions that are estimated to be generally 23% higher. The gap arises from test flexibilities (10%), technologies that perform better in the test than on the road (8%) and the non-use of auxiliary equipment during the test (5%). This gap is expected to grow to 31% by 2025 as more test flexibilities are exploited (15%), technologies performing better in the test (10%) and more equipment fitted to cars (6%).[10]

On the positive side, the WLTP is becoming the standard fuel economy and emissions test not only for EU countries, but also India, South Korea and Japan have implemented the same test process. This means that OEMs can use the same test results for type-approval in all these different regions which will in turn reduce the cost and time taken to get type-approval because there will no longer be a need to perform multiple tests in each of these countries separately. Consequently, this will also reduce the costs of R&D for OEMs and suppliers in designing vehicles and parts, because having a single test for numerous different markets negates the need for different powertrain calibrations for example.

3. What is RDE?

One of the production requirements that car manufacturers must meet for a model to be type-approved is pollutant emission testing regulated by the 'Euro emissions standards' currently EURO 6.[11] This Regulation sets the emission limits for cars for regulated pollutants in particular for NO_x.

The RDE test which came into force on 1 September 2017 is a "more realistic" emissions test which happens in real driving conditions with the purpose of measuring pollutants such as NO_x and other particulate emissions which are a major cause of air pollution.

The RDE test is carried out with a Portable Emission Measuring System (PEMS)[12] that is attached to the car while driving in real conditions on the road. This test is carried out in very different conditions which are summarized in Table 2. Consequently, the RDE does not replace the WLTP

[8] The test for evaporation emissions is aimed for petrol engines as diesel is not volatile

[9] From September 2019 vehicles up to five years old will be subjected to a random WLTP test. This field monitoring is carried out on selected vehicles with a mileage of up to 100,000 kilometres

[10] Transport and Environment, (2018), "CO2 Emissions from Cars: the facts", report published in April 2018.

[11] The EURO 6 Regulation came into force in 2009 and it indicates that since 1 September 2015 all new vehicles have to fulfill the EURO 6 requirements

[12] The PEMS used for regulated emissions are complex pieces of equipment that integrate advanced gas analyzers, exhaust mass flow meters, weather station, Global Positioning System (GPS) and a connection to the vehicle networks. There is no standard PEMS equipment and equipment manufactured by different suppliers can deliver slightly different results. In practice, OEMs must set their design objectives well below the legal limit to be certain of complying and to account for the risk that PEMS on any particular day may have an even higher error margin.

test which is a dynamometer test, but it complements it as it measures the amount of NO_x emitted by a vehicle in real driving conditions.

RDE test
Low and high altitudes
Year-round temperatures
Additional vehicle payload
Up- and down-hill driving
Urban roads (low speed)
Rural roads (medium speed)
Motorways (high speed)

Table 2 Conditions in which the different parameters are tested

The legislative process introducing the RDE tests began in 2015 with the definition of the procedure and its use for monitoring purposes. In 2016, the so-called RDE Act 2 introduced the obligation to measure NO_x through RDE tests for type approvals issued at national level. The implementation of this legal obligation was envisaged in two steps:

- September 2017 for all new vehicle models coming to market
- September 2019 for all first registrations of new vehicles

RDE legislation is further integrated by the co-called RDE Act 3 and RDE Act 4. The latter entered into force from 1 January 2019 together and were integrated in the amended version of the WLTP Regulation (EU) 2017/1151.[13]

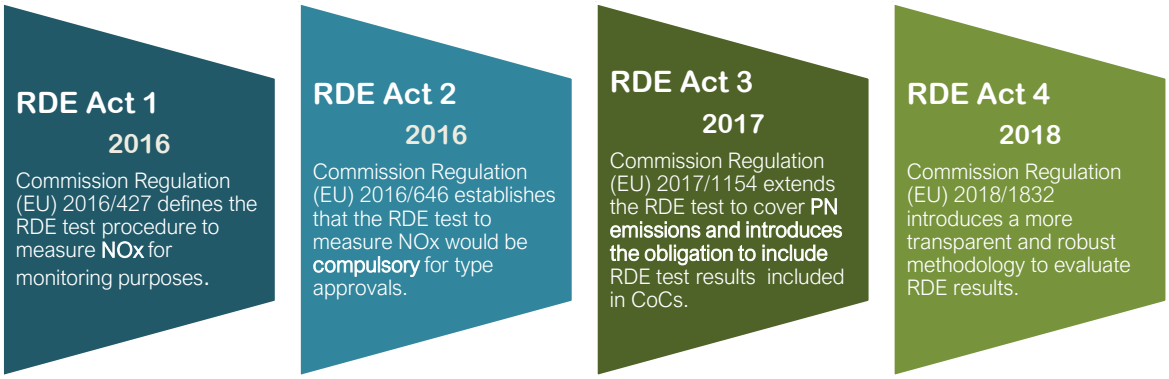


Figure 2 RDE legislation development and main measures introduced

In the EURO 6 legislation the combined emissions limit of NO and NO_2 is set to 80 mg/km for diesel cars.[14] Given the novelty of RDE test measurements and the technical limits to improve the real-world emission performance of current production diesel cars Member States agreed, in

[13] See footnote 2
[14] Regulation (EC) 2007/715, "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"

October 2015, a phasing-in period. This is aimed at reducing the divergence between the regulatory limit measured in laboratory conditions by the WLTP test and the values of the RDE procedure.[15]

The phasing-in period practically means that RDE requirements are introduced by taking into consideration a conformity factor (CF). The conformity factor is used to determine the not-to-exceed (NTE) limits of NO_x through an equation which determines the NO_x amounts for the two phases based on the EURO 6 legislation's limit of 80 mg/km.

During **RDE phase I**, the conformity factor is set at 2.1 meaning that the RDE value of NO_x and PN cannot exceed the WLTP value measured in the lab test by more than 2.1 times. Car manufacturers have to comply with these requirements beginning from 1 September 2019 until 31 December 2019 and they apply to all new vehicle models. During this phase the EURO labelling is **EURO 6d-TEMP EVAP-ISC.**[16]

During **RDE phase II**, the conformity factor is amended and lowered to 1.43 as a result of a revision of the PEMS measurement uncertainty. Car manufacturers have to comply with these requirements from 1 January 2020 for all newly type-approved vehicle models. As of 1 January 2021, this will be extended for all new car registrations. The EURO labelling for this phase is **EURO 6d**.

To take account of future improvements of the measuring technology, this factor is subject to annual reviews. The first review was implemented in 2018 when the conformity factor was reduced for RDE phase II from 1.5 to 1.43. As the technology improves, the conformity factor will be reduced further with the aim of bringing it to 1 as soon as possible and at the latest by 2023 when the RDE requirements will be the same as the WLTP.

4. What's new?

The introduction of WLTP and RDE at EU level changed the emissions testing scenario. This is tied in with Regulations setting specific targets for CO_2 emissions and pollutants like NO_x. The consequences of the introduction of these two tests were visible in 2018 when the WLTP testing requirements entered into force. However, long term consequences of the new testing procedures are less evident. In the following sections some of the aspects of the entry into force of these new requirements are discussed.

4.1 WLTP September 2018

The new WLTP procedure increased demand for testing capacity which led in 2018 to bottlenecks and disruptions in production as different derivatives and optional equipment which may be fitted

[15] Contrary to a pre-defined laboratory test cycle, the intrinsic characteristics of the PEMS measurement equipment in RDE tests lead to a higher variation and wider range of the quantitative emission results of different RDE trips. With a conformity factor, the focus is put on the vehicle's average compliance with emission limits. For example, regulatory emission limits may be exceeded when driving up a steep hill, which then must be compensated by emissions below the regulatory emission limits under different conditions, such as driving moderately in the city, so that the average emissions, when weighting these conditions according to their statistical occurrence, are not above the limits

[16] EVAP and ISC are introduced from September 2019 with the so-called WLTP 2. See pp. 4-5

into a car had to be tested. The effects of the entry into force of WLTP as of September 2018 have been calculated at €1 billion for car manufacturers through lost sales and higher incentives.[17]

In August 2018 1.1 million vehicle registrations were recorded representing a 31.2% increase year on year.[18] The trend reversed in September when the European car market suffered a decline of 23.4%.[19] One of the major issues which caused this disruption was that all car registered after 31 August 2018 had to be tested according to WLTP. On 1 September many models had not been homologated in time and could not be sold. The effect of WLTP introduction continued for months.

The September 2019 deadline for the additional WLTP testing requirements will further increase costs for car manufacturers as the vast majority of engine-transmission variants will have to be tested again to pass the EVAP requirements. Despite car manufacturers being generally optimistic about the deadline, it is expected that, just as in 2018, some models will be temporarily unavailable during the second half of 2019.[20] Beyond the EVAP measurement, the other requirements introduced by WLTP do not require a re-testing of the vehicles, rather they will be processed through revised algorithms and confirmed as re-certified.[21]

4.2 RDE and NO_x limits

To cope with the new requirements of the RDE legislation and meet the values as set in the EURO 6 Regulation, OEMs need to adopt efficient systems to reduce these emissions such as selective catalytic reduction (SCR) for diesel engines and particulate filters for petrol cars. However, these solutions can actually increase the CO_2 emissions. For example, when BMW introduced its AdBlue system to the model X1 1y6d in March 2018, the old NEDC CO_2-value of 104g/km jumped to 118g/km WLTP-derived NEDC value. This is because the SCR technology uses a chemical reaction to reduce the levels of NO_x but, in so doing, it also releases nitrogen, water and small amounts of CO_2 to achieve this. This technology can thus achieve NO_x emission reductions of as much as 90% but can increase CO_2 emissions.

Furthermore, if the new RDE test results differ significantly from the old ones it could have an impact on the type approval of cars. In the worst case, some cars previously type approved with the old test might not get approved by the new tests if they breach their pollutant emission limits too severely. This is because to certify a vehicle under the RDE rules an OEM must confirm – undertaken by an approved test facility or by the OEM themselves - that it complies and achieves a certain performance level with all RDE conditions, which include now a broader set of parameters such as year-round temperatures (-7 C to + 35 C), altitude (of up to 1,300 m), and high speeds (up to 131km/h). Under the RDE a vehicle is driven on public roads (instead of laboratory testing) and

[17] Automotive News Europe, (2019), "VW, Daimler brace for new WLTP headache". Accessed at: https://europe.autonews.com/automakers/vw-daimler-brace-new-wltp-headache

[18] ACEA, (2018), "Passenger car registrations: +6.1% eight months into 2018; +10.5% in July and +31.2% in August". Accessed at https://www.acea.be/press-releases/article/passenger-car-registrations-6.1-eight-months-into-2018-10.5-in-july-and-31

[19] JATO Dynamics, (2018), "Knock-on effects of WLTP sinks European car market during September and causes major shakeup in the industry rankings". Accessed at https://www.jato.com/knock-on-effects-of-wltp-sinks-european-car-market-during-september-and-causes-major-shakeup-in-the-industry-rankings/

[20] Automotive News Europe, (2019), "VW, Daimler brace for new WLTP headache"

[21] Fleet News, (2019), "WLTP Second Act should not affect September supply, says Cap HPI". Accessed at https://www.fleetnews.co.uk/news/manufacturer-news/2019/08/12/wltp-second-act-should-not-affect-september-supply-says-cap-hpi

over a wide range of different conditions to verify that legislative caps for pollutants such as NO_x are not exceeded.

The regulatory governance will be completed from 1 September 2020 with a new EU vehicle type-approval framework. In May 2018 a new regulation on type-approval and market surveillance system for motor vehicles amended the existing framework which was in place since 2007.[22] The new rules were proposed by the EC in the wake of the so-called 'Dieselgate' scandal.

These new rules will significantly raise the quality level and independence of vehicle type-approval and testing, increase checks of cars that are already on the EU market and strengthen the overall system with European oversight. These check obligations will require each Member State to conduct a minimum number of checks on vehicles each year from which at least 20% of the checks will have to be emission-related tests, with verification of emissions under real driving conditions. In addition, the EC will be enabled to carry out tests and inspections of vehicles to verify compliance and react to irregularities immediately. In case of non-compliance of a vehicle, the EC can impose administrative fines of up to €30,000 per non-compliant vehicle on manufacturers and importers.

4.3 CO_2 emission targets at EU level

The WLTP test ties in with Regulation (EC) 2009/443 that sets manufacturer-specific CO_2 targets. Regulation (EC) 443/2009 established that the CO_2 overall limit emission for new PCs **until the end of 2019 is 130 g CO_2/km.** From 2020 onwards, the same Regulation sets a target of 95 g CO_2/km for the average emissions of the new car fleet.[23] This translates to a fuel consumption of around 4.1 l/100 km of petrol or 3.6 l/100 km of diesel.

Based on these targets, specific emissions of CO_2 are calculated for each car manufacturer according to different formulas which take into consideration the CO_2 emission limits set out by the Regulation, the mass of the vehicle and the average mass of new passenger cars.[24] **During 2020 the CO_2 emission target of 95 g/km must be met by 95% of each manufacturers' new passenger cars registered in 2020. From 2021 this applies to 100% of the vehicles sold in Europe.**

The specific CO_2 emission targets that car manufacturers must meet by 2021 are based on the old NEDC test. Therefore, since September 2017, the CO_2 values measured through WLTP are translated back to NEDC-equivalent values to monitor compliance against these specific targets set by the EU. The new values deriving from the WLTP diverge inevitably from the NEDC values because through WLTP more parameters are measured according to a greater range of conditions. In order to convert the WLTP values back to NEDC equivalent values in such a way to ensure comparable stringency when defining WLTP based CO_2 emission averages, the EC adopted the

[22] Directive 2007/46/EC, "Establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (Framework Directive)"
[23] Regulation (EC) No 443/2009, "setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles"
[24] The formulas to be used in order to calculate the specific emission limit for each manufacturer are in Annex I of Regulation (EC) 443/2017

CO2MPAS[25] methodology for determining the correlation between the two set of values.[26] Manufacturers' compliance with those specific targets will continue to be assessed on the basis of NEDC values until 2020 by using the CO2MPAS. From 2021 on, the specific emissions reduction targets will only be based on WLTP values.

The difference between the NEDC and WLTP measurements of CO_2 emissions of PCs and LCVs has been estimated by the EC's Joint Research Centre who used a combination of simulations at individual vehicle level across a fleet of 1,200 cars[27]. Results *(see Annex 1)*, show an average WLTP to NEDC CO_2 emissions ratio in the range 1.1 - 1.4 depending on the powertrain and on the NEDC CO_2 emissions (e.g. a figure of 1.22 would mean a vehicle measured at 100 g/km under NEDC would be 122g/km under WLTP). In particular, the ratio tends to be higher for vehicles with lower NEDC CO_2 emissions in all powertrains, the only exception being plug-in hybrid electric vehicles (PHEVs). In this case, indeed, the WLTP to NEDC CO_2 emissions ratio quickly decreases to values that can be also lower than 1 as the electric range of the vehicle increases.

On 17 April 2019, the European Parliament and the Council adopted Regulation (EU) 2019/631 setting CO_2 emission performance standards for new PCs and LCVs in the EU for the period **after 2024**. New EU fleet-wide CO_2 emission targets are set for the years 2025 and 2030, both for PCs and LCVs. These targets are defined as a percentage reduction from the 2021 reference target of 95 g CO_2/km. The reduction percentage for PCs and LCVs emissions reduction from 2025 is set to 15% while from 2030 on to 37.5%.

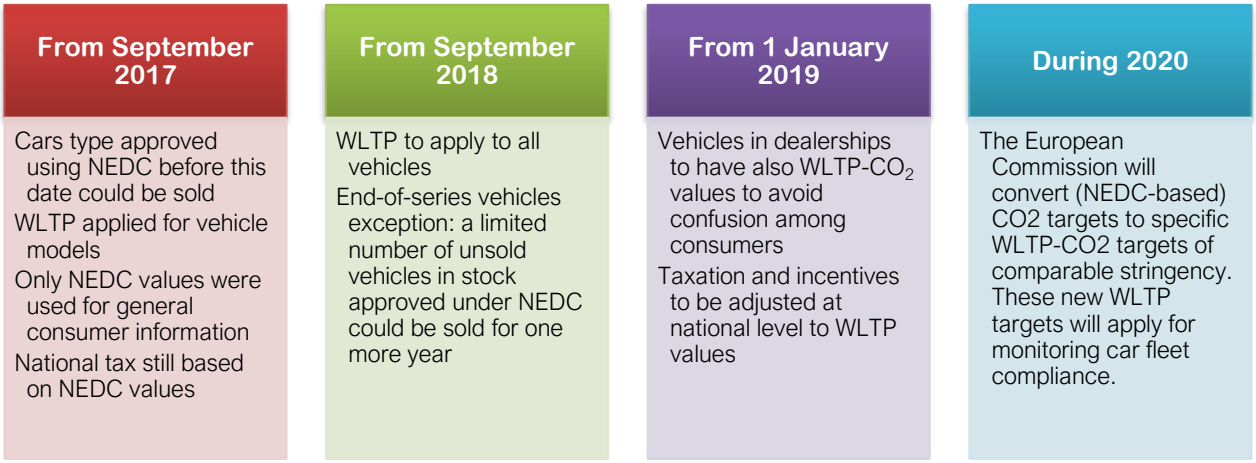


Figure 3 NEDC-WLTP transition process

Implications for car manufacturers

According to the European Environment Agency (EEA), the overall average CO_2 emissions in the industry has been decreasing for some years, but for the last three years this decrease has been very marginal (one or two points only) and in 2017 increased by 0.4 g/km to 118.5 g/km[28]. For 2018 the

[25] Commission Implementing Regulation (EU) 2017/1152, "setting out a methodology for determining the correlation parameters necessary for reflecting the change in the regulatory test procedure and amending Regulation (EU) No 1014/2010

[26] This methodology is also complemented by physical tests should there be the need to check input data

[27] JRC, (2017), "From NEDC to WLTP: effect on the type-approval CO_2 emissions of light-duty vehicles", JRC Science for Policy Report

[28] EEA, (2018), data found in: www.eea.europa.eu/data-and-maps/data/co2-cars-emission-14

average CO_2 emissions also increased by 2 grammes to 120.4 g/km[29] requiring significant reductions to meet the targets for 2020 and 2021. The reasons for the increase are, at least, two-fold:

1. The steady shifting away from diesel to petrol cars further to the Dieselgate scandal[30]: a 9% decrease in diesel cars was registered in 2018 compared to 2017.[31] JATO Dynamics found a direct correlation between diesel car registrations and average CO_2 emissions especially when analysing data country by country.[32] Only in countries where electric and hybrid cars' sales increased, did CO_2 emissions go down.
2. The increase in SUVs and MPVs: in 2018 the market share of these vehicles grew from 25% to 31% compared to 2017. The average CO_2 emissions grew by 1.4 g/km as a result of this increase.[33] Furthermore, SUVs are expected to have a third of the market share in EU27 by 2020.[34]

Car manufacturers need to significantly reduce CO_2 emissions before 2020 when costly penalties start to apply for limit's exceedance. Until 2019 fines were applied of €95 per gramme of exceedance of the 130 g CO_2/km limit. In 2020, the average of CO_2 emissions of each manufacturer will be calculated only by taking into consideration 95% of new cars registered, however the limit of 95 g CO_2/km is substantially lower compared to 2019.

If the European fleet average of CO_2 emissions exceed 95 g/km by 2021 for all registered vehicles, manufacturers failing to achieve their targets will be subject to fines of €95 per gramme per newly registered vehicle for every gramme their average is over the limit. [35]

A report conducted by Transport & Environment (T&E), addresses the issue by looking at each OEM separately[36]. This research puts the OEMs into three different groups based on their progress towards achieving their 2021 targets (*see Annex 2*). In the first group of 9 OEMs you have companies such as Peugeot-Citroën, Toyota and Daimler who are in a good position to respect their targets. In 2018 Toyota registered an average of below 100 g CO_2/km putting itself in a good position to reach the 2021 target. The second group consists of BMW, Ford and Volkswagen who are, according to T&E, one or two years behind target, assuming that there will be no use of flexibilities and acceleration in the up-take of electric vehicles. Finally, the third group consists of eight OEMs - Hyundai, Fiat-Chrysler, Honda, Subaru, Kia, Opel-Vauxhall, Mazda and Suzuki – who are furthest from their targets. From this group, the first three in particular may face severe challenges in reaching their targets and avoiding large penalties. However, with the flexibilities in

[29] The increase of CO_2 in the industry is calculated based on NEDC correlated values i.e. WLTP values translated back to NEDC values through the CO2MPAS system
[30] Latest data can be found from Eurostat:
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_carmot&lang=en
[31] In 2017 of the new fleet, almost 60% of petrol cars were sold compared to 36% of the diesel ones
[32] JATO Dynamics, (2019), "CO2 emissions rise to highest average since 2014, as the shift from diesel to gasoline continues". Accessed at: https://www.jato.com/wp-content/uploads/2019/03/CO2-Europe-2018-Release-Final.pdf
[33] JATO Dynamics, (2019), "CO2 emissions rise to highest average since 2014, as the shift from diesel to gasoline continues".
[34] JATO Dynamics, (2017)," The future of the car industry as WLTP bites"
[35] Three different flexibilities, eco-innovations, super credits and pooling, can introduce a maximum of 14.5 g/km per year deduction in fleet average CO_2 emissions per manufacturer
[36] Transport and Environment, (2018), "CO_2 Emissions from Cars: the facts", report published in April 2018

place T&E concludes that in the end most of the OEMs will probably achieve their targets. Flexibilities available for OEMs are:

- Emission credits up to 7 g/km per year per manufacturer can granted for vehicles equipped with innovative technologies
- Super credits are given to car manufacturers which produce cars emitting less than 50 g/km. For the purpose of calculating a manufacturer's average specific emissions, such cars will then be counted as: 2 vehicles in 2020; 1.67 vehicles in 2021; 1.33 vehicles in 2022
- Manufacturers can pool their emissions to meet their targets. Notably Fiat Chrysler Automobiles (FCA) signed an agreement of billions of euros with Tesla to form an open pool
- Different derogations and exemptions are granted to niche manufacturers and small volume manufacturers

The 2025 CO_2 emissions targets will be even more difficult to meet for car makers. One way to achieve these will require an increase of production of EV models. In 2018 about 60 alternative fuel vehicle (AFVs) models were available at EU level and about 90 models in 2019. According to production forecasts, this number will notably increase in 2020 and 2021 when there will be 176 and 214 models respectively. In 2025 about 333 models are expected marking a drastic increase from 2018 with more than 250 new AFV models being put on the market.[37] Should the forecasts be achieved, car manufacturers would have almost certainly done enough to meet the CO_2 emissions reduction of 15% as established in Regulation (EU) 2019/631 *(see Annex 3)*.

5. Final considerations

The introduction of WLTP for all registrations of new vehicles led to a market disruption mainly because of lack of testing capacity in 2018. However, in September 2019 car manufacturers have not been profoundly hit by RDE phase I as its testing requirements have gradually been implemented by car makers for new models since September 2017 when RDE was introduced with WLTP.

There should be therefore a certain degree of preparedness with regard to the compliance with RDE I requirements. An analysis by T&E shows that a significant amount of cars on sale in 2019 are already emitting less than the 80 mg/km of NO_x established by the EURO 6 Regulation.[38] Furthermore, as of January 2021 the RDE II phase applies but car manufacturers can still exceed the 80 mg/km of NO_x of the EURO 6 Regulation by applying a conformity factor of 1.43 meaning that they can effectively continue to exceed the WLTP NO_x limit. With regard to the requirements of WLTP 2 some kind of disruption is expected, however it should not reach the levels of the second half of 2018.

The introduction of WLTP and RDE at EU level should be considered as one of the steps towards drastically reducing CO_2 and other pollutants' emissions. Setting very challenging CO_2 emissions

[37] Transport and Environment, (2019), "Electric surge: Carmakers' electric car plans across Europe 2019-2025" Accessed at: https://www.transportenvironment.org/sites/te/files/publications/2019_07_TE_electric_cars_report_final.pdf

[38] Transport & Environment, (2019), « EU must withdraw carmakers' 'license to pollute' as data shows new cars meet limits". Accessed at: https://www.transportenvironment.org/newsroom/blog/eu-must-withdraw-carmakers'-'license-pollute'-data-shows-new-cars-meet-limits

targets at EU level along with costly fines should these not be met, is an explicit push for car manufacturers to invest more in alternative fuel vehicles and technologies which allow the reduction of polluting emissions.

The conclusion of all this for the automotive industry could be that some manufacturers have to stop selling certain car models or derivatives that emit high levels of emissions and push to bring more hybrids, especially PHEVs, and full battery electric vehicles (BEVs) to the market in order to first comply with the new type-approval and secondly to avoid costly fines from 2021 onwards. JATO Dynamics estimated that car manufacturers selling vehicles in Europe would have to pay fines of up to €34 billion for the excess emissions per g/km should they not implement less polluting technologies or at least expand their fleets with electric models for example.[39]

Summary table WLTP, RDE & CO_2 emission targets

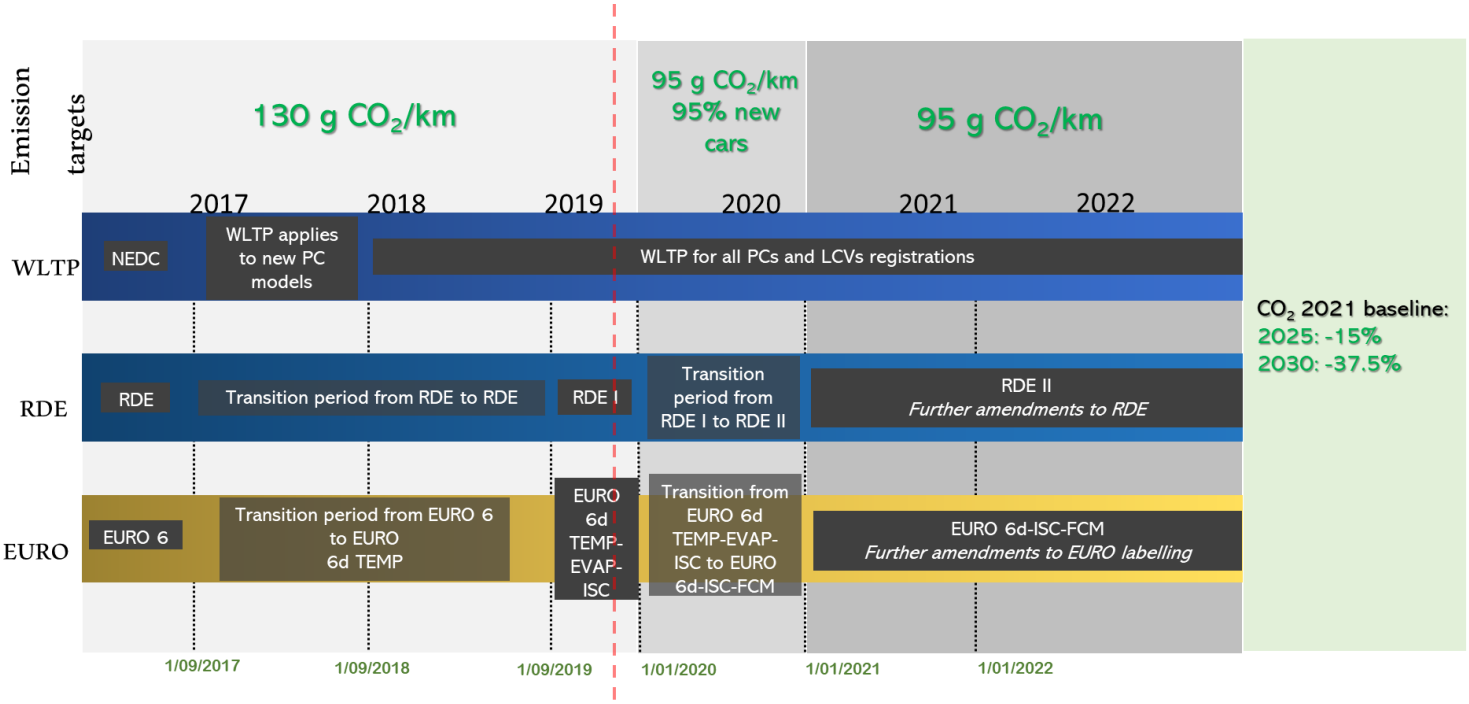


Figure 4 Transition periods and implementation dates of WLTP and RDE legislations, EURO labelling and CO_2 emission targets. Transition periods in this case means that the new emission testing procedure were firstly introduced for new vehicle models. The transition period ends when the requirements need to be applied for all first registrations of new vehicles.

[39] JATO Dynamics, (2019), "2021 CO2 targets would generate €34 billion euros in penalty payments within Europe"

Possible consequences for the vehicle logistics sector

For the vehicle logistics sector, the introduction of WLTP, RDE and CO_2 emissions targets at EU level may include:

Delays in EVs and PHEVs sales in the second part of 2019

Some car manufacturers may delay the sales of EVs and PHEVs until 1 January 2020 when the new more stringent 95 g CO_2/km for the average emissions of the new car fleet will apply. In 2020 zero- and low-emission vehicles emitting less than 50g CO_2/km will count as two vehicles. Delaying the sales of EVs and PHEVs until 2020 will help OEMs in meeting their specific emissions reduction targets and avoiding paying €95 per gramme of exceedance.

Ending production of some car models/engines

RDE tests measure more accurately emissions of NOx, therefore some engines or car models may not get type approval as they do not meet the emission standards set at EU level by the EURO 6 legislation. Therefore, some OEMs are planning to cease sales of certain models or derivatives.

Delays in production and vehicle approval

In 2018, after the introduction of WLTP, the bottlenecks in testing capacity resulted in some OEMs building vehicles that could not be sold. Some delays are expected in the last quarter of 2019 because of the mandatory EVAP test to run on all petrol-powered vehicles registered. The length of the procedure may again cause bottlenecks and thereby increase lead times and limit availability. However, the level of disruption should be lower compared to the second part of 2018.

Higher manipulation of vehicle models available on the market

In order to comply with their own specific emissions reduction targets, car makers will manipulate what models will be available for sale. In order to meet their targets from 2020 onwards, they may decide to stop the sales or restrict the supply of certain derivatives which emit too much CO_2 and would increase the CO_2 emissions fleet average.

Load factor

For the vehicle logistics sector, the swing towards electrification means increased weight and decreased load factors which is already impacting both on road transport and shipping.

Annex 1 Relationship between WLTP and NEDC CO_2 emissions for different passenger cars

Passenger Cars		NEDC Type Approval Emissions (g/km) (official 2015 data)	Ratio WLTP/NEDC
All ICEV		123	1.21
Gasoline	All	125	1.22
	< 1.4 l	115	1.24
	1.4-2.0 l	148	1.15
	> 2.0 l	225	1.07
Diesel	All	121	1.20
	< 1.4 l	93	1.26
	1.4-2.0 l	114	1.21
	> 2.0 l	159	1.14
LPG		116	1.16
Gas		104	1.36
HEV Gasoline	< 1.4 l		1.37
	1.4-2.0 l		1.32
	> 2.0 l		1.23
HEV Diesel	< 1.4 l		1.38
	1.4-2.0 l		1.34
	> 2.0 l		1.30
PHEV			1.00
BEV/FCV*	Small		1.258
	Medium		1.283
	Large		1.299

Source: JRC (2017)

Annex 2 Influence of the use of flexibilities on the CO_2 compliance year

	Without using flexibilities	With using flexibilities		
		Minimum level	Moderate level	Maximum level
Volvo	2017	2017	2017	2017
Mitsubishi	2018	2018	2017	2017
Toyota-Lexus	2019	2018	2017	2017
Daimler	2020	2019	2019	2017
Jaguar-Land Rover*	2020	2019	2019	2018
Peugeot	2020	2019	2018	2017
Citroën-DS	2020	2019	2018	2017
Nissan-Infiniti	2020	2019	2018	2017
Renault Group	2021	2020	2019	2017
Volkswagen Group	2022	2021	2020	2018
BMW Group	2023	2022	2021	2018
Ford	2023	2022	2021	2018
Suzuki*	2025	2024	2022	2020
Mazda*	2026	2024	2023	2021
Opel-Vauxhall	2027	2026	2024	2021
Kia	2028	2026	2025	2022
Subaru*	2028	2026	2025	2022
Honda	2029	2028	2026	2023
Fiat-Chrysler	2030	2028	2026	2022
Hyundai	2033	2030	2028	2024

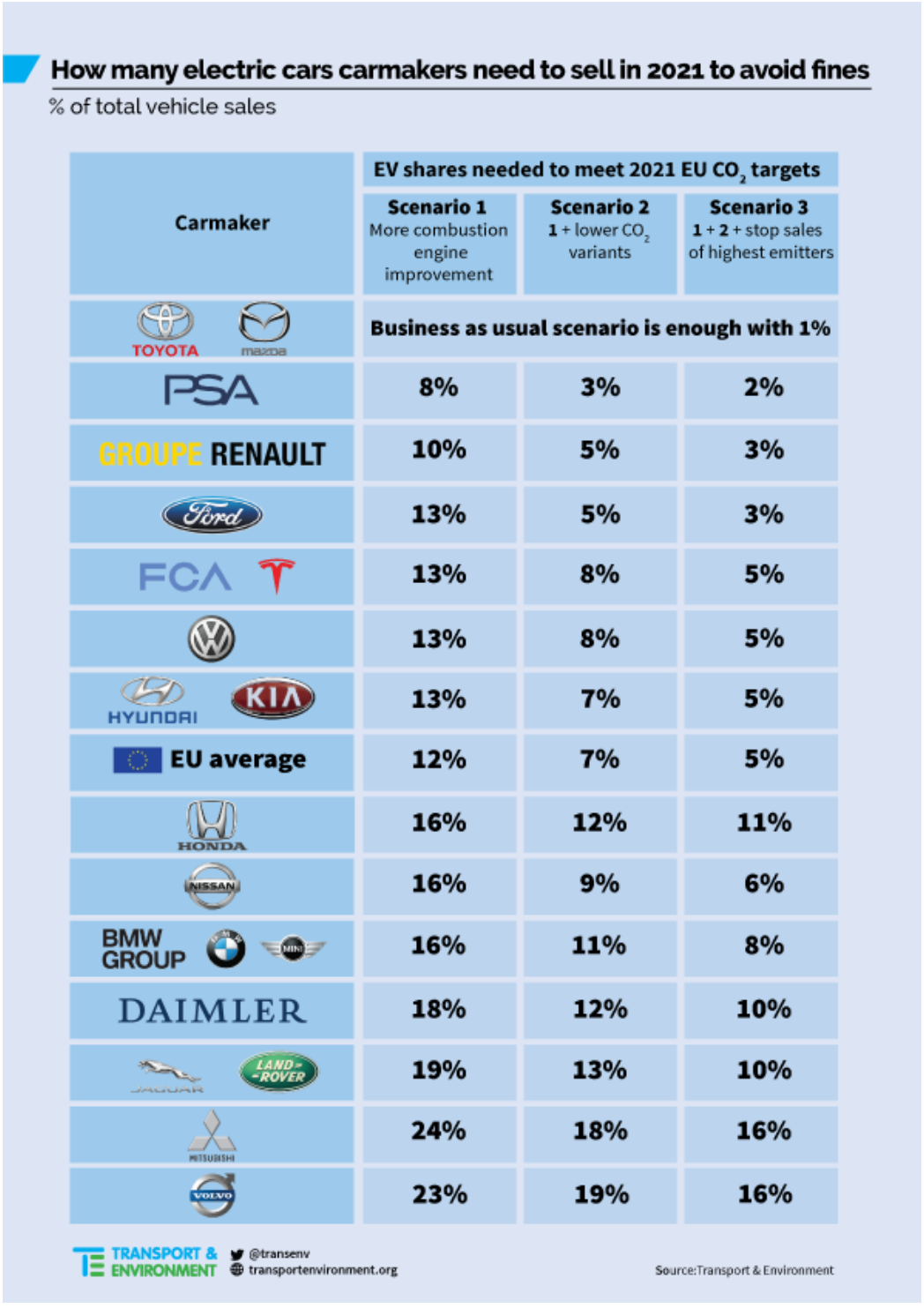
*Manufacturers with a niche derogation target

Note: dates before 2020 are illustrative – super-credits cannot be earned and used before 2020

Source: T&E (2018)

(Minimum level of flexibilities = 3.5g/km; Moderate level of flexibilities = 7g/km; Maximum level of flexibilities = 14.5g/km)

Annex 3 EV shares needed to meet 2021 EU CO_2 targets



How many electric cars carmakers need to sell in 2021 to avoid fines

% of total vehicle sales

Carmaker	EV shares needed to meet 2021 EU CO_2 targets		
	Scenario 1 More combustion engine improvement	**Scenario 2** 1 + lower CO_2 variants	**Scenario 3** 1 + 2 + stop sales of highest emitters
TOYOTA, mazda	**Business as usual scenario is enough with 1%**		
PSA	8%	3%	2%
GROUPE RENAULT	10%	5%	3%
Ford	13%	5%	3%
FCA, Tesla	13%	8%	5%
VW	13%	8%	5%
HYUNDAI, KIA	13%	7%	5%
EU average	12%	7%	5%
HONDA	16%	12%	11%
NISSAN	16%	9%	6%
BMW GROUP, MINI	16%	11%	8%
DAIMLER	18%	12%	10%
JAGUAR, LAND ROVER	19%	13%	10%
MITSUBISHI	24%	18%	16%
VOLVO	23%	19%	16%

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Source:Transport & Environment

Source: T&E (2019)