VDA Verband der Automobilindustrie

In cooperation with DEKRA VDIK Kraftfahrzeug Gewerbe

Global WLTP roll-out for more realistic results in fuel consumption

Questions and answers regarding the new international test procedure

Content

Lawmakers require standardized test procedures to measure how much fuel a car consumes and whether it complies with the emissions limits. The new “Worldwide harmonized Light-duty vehicles Test Procedure” (WLTP) applies to the type approval of new passenger cars across the EU since September 1, 2017. It succeeds the NEDC (New European Driving Cycle), which has been in force since 1992. It comprises both a new driving profile on test benches as well as more precise and up-to-date conditions for the entire test and is therefore intended to result in more realistic consumption data than was the case with the previous measurement method. What are the implications of the change? Seven questions, seven answers.

Question 1: Why is a new test procedure necessary?

Data on consumption or range are to be determined based on an objective and reproducible test procedure that, under precisely defined laboratory conditions, allows different models to be compared and is as representative as possible of the way people drive today. The NEDC method used in Europe up until now no longer meets these requirements. It was developed in the 1990s as a theoretical measurement run primarily for measuring pollutant emissions. The new WLTP, by contrast, is based on empirical, real driving data from routes in Asia, Europe and the USA, which makes it significantly more representative.

Compliance with emission limits is a prerequisite for granting type approvals for new vehicles, which, in Germany, are issued solely by the Federal Motor Transport Authority (in German: Kraftfahrt-Bundesamt, KBA). Fuel consumption, together with the measured CO_2 value, is a key purchasing criterion for customers. In many countries this is the basis for taxing motor vehicles and has also been used for several years in official monitoring of CO_2 emissions harmful to the climate.

It is up to lawmakers to create a level playing field for all vendors by defining the rules applicable to all market participants so that customers can compare the fuel consumption and emissions of different vehicles realistically. In order to allow the free movement of goods among the European Union's member states, regulations on emission and fuel consumption measurements have been drawn up at a European level since 1970. Both the test cycle – that is, the driving profile used for testing – and the conditions under which the tests are performed follow rules defined across the EU.

The test method used so far in the European Union is based on the so-called "New European Driving Cycle" (NEDC). It was new when it was adopted in 1992, when the cycle was expanded beyond the previous test focus on city traffic. Its purpose at the time was primarily the measurement of pollutant emissions. The NEDC was originally not developed for measuring CO_2 emissions and fuel consumption. It was expanded a few years later to include these measurement objectives in line with the testing capabilities available at the time. However, since the 90s, its dynamic range and meaningfulness on an individual level have not kept pace with parallel developments in automotive engineering, driving options and laboratory conditions.

In order to provide consumers with more modern, i.e. more realistic, fuel consumption figures, the new test procedure was developed on behalf of the United Nations' (UN's) "World Forum for Harmonization of Vehicle Regulations" body. The new driving cycle, abbreviated WLTC (Worldwide harmonized Light-duty vehicles Test Cycle), is of central importance for this test procedure. For the first time, it is based on real driving data from three continents (Asia, Europe, USA) and 12 countries. The necessary measurement runs comprised a total of 750,000 kilometers and were carried out in the cities of emerging countries like India, as well as on highways in Europe and the USA. In a multi-year analysis and negotiation process, the UN Forum created the new driving cycle from this data pool and developed a completely new test procedure: the "Worldwide harmonized Light-duty vehicles Test Procedure" (WLTP). It will apply internationally but there will be some minor regional adjustments due to the differing climatic zones of the UN member states. For example, European lawmakers have supplemented the test temperature of 23 degrees Celsius established by the UN body with an additional test at 14 degrees Celsius to simulate the average temperature in Europe.

The WLTP is now introduced: Since September 1, 2017, it is the mandatory basis for the type approval of new passenger cars and light commercial vehicles in Europe. From September 1, 2018, emission and consumption values measured in the WLTP must be available for all newly registered passenger cars and light commercial vehicle models in Europe. One year later, this directive will also apply to larger, lightweight commercial vehicles.

Question 2: What distinguishes the new test procedure from the old one?

A car's fuel consumption is essentially determined by its driving resistance values, i.e. by its mass, aerodynamic drag and rolling resistance. The new WLTP procedure, which is in force since September 2017 for type approval in Europe, integrates these physically dictated driving resistance values more fully than the NEDC which has been used so far, and is thus considerably more representative. Like the NEDC, the WLTP is also carried out in certified test labs under precisely defined conditions. As a result, the measurement results are both stable and reproducible while enabling a direct comparison of different vehicles regardless of the test bench or test lab used.

A driving cycle defines the speed at which a vehicle is driven on the chassis dynamometer for every second of the test. This results in a so-called velocity profile. The WLTP differs from the NEDC which it will replace in a number of aspects: The new test does not only take longer, namely 30 instead of 20 minutes, it also accelerates up to Germany's recommended highway speed of 130 km/h much more often. The gear shift points during acceleration have also been readjusted. And the amount of vehicle idle time has also been reduced. This results in a significantly more dynamic cycle and a higher average speed of 46.6 km/h compared to the one in the old cycle which was only 33.6 km/h. Physically, this means an increase in the energy expended for mass acceleration and therefore higher fuel consumption.

Another significant change is that, according to the WLTP, measurements must be carried out on a fully equipped vehicle. Until now, was done only with a vehicle's standard equipment. When purchasing a car every additional equipment option can increase the vehicle's weight and thus the energy expended to accelerate the car and keep it in motion. Due to the large number of special equipment packages and their different energy consumptions, car manufacturers will perform additional measurements with other equipment levels in addition to measuring a fully equipped vehicle. Car body versions that influence aerodynamics or different tires with individual rolling resistance values will also be taken into account. This will result in a range of fuel consumption values that is more specific and therefore better reflects real-world driving.

An important detail for technophiles: test bench engineers do not measure the actual volumetric fuel consumption in liters, but the weight of the carbon-containing components, including carbon dioxide (CO_2), in the exhaust gas. Since standardized fuels are used for the bench test, the consumption value can be calculated directly in liters per 100 kilometers based on the CO_2 weight and the distance traveled on the test bench. This form of measurement, which leads to a more exact determination of the greenhouse gas, was already mandatory in the 1990s.

The test specifications for temperature and the tire composition will also become more specific with the roll-out of the WLTP since some external factors that can influence fuel consumption may differ from one of the participating countries to another. For example, the average temperature in Europe is 14 degrees Celsius, and the average idle time of a vehicle is nine hours. This is why an additional test is carried out at 14 degrees Celsius to supplement the general emissions measurement at 23 degrees Celsius. Until now, only a range of 20 to 30 degrees Celsius was used in the NEDC. The vehicle to be tested is therefore parked in a climatic chamber over a defined period of 12 to 36 hours at 23 degrees Celsius in a first step and then at 14 degrees during the subsequent test without being cooled (natural soak). Lowering the starting temperature increases the consumption determined by the test, because the oil in the engine, transmission and axle components become more viscous with decreasing temperature. Moreover, the requirements on tire pressure and tread depth have been made more specific.

These factors raise the fuel consumption values determined in the WLTP compared to the former NEDC values considerably. Nevertheless, the amount of energy that is expended for a given driving profile remains the only decisive factor in determining actual fuel consumption. The nominal consumption value will increase by an average of around 20 percent if the same vehicle is first tested in the NEDC according to the old procedure and then in the WLTP with the new procedure. However, this does not affect fuel consumption at all when the vehicle is operated by the customer. This can be compared to measuring the outside temperature in Celsius and Fahrenheit, regardless of the unit of measurement you will stay just as cold or warm when you go outside.

Question 3: How realistic is the WLTP?

A test bench test under defined boundary conditions is the only way to produce objective and reproducible conditions so that emission and fuel consumption values of different vehicles from different manufacturers can be compared with one another. One important objective is that the test can be representative of average driving behavior, which is why real-world driving data from people around the globe was examined before defining the WLTP that is applicable since September 2017. However, even a representative bench test like the WLTP cannot take into account all the factors affecting fuel consumption in the real world.

The main consumption-increasing factors that can be considered only to a limited extent in a standardized lab test include the individual driving style but also the geographical conditions of the route, the individual load, the climatic conditions, as well as the energy used for accessories such as seat heating and air conditioning. Depending on the outside air's humidity and temperature as well as the driving profile, the air conditioning system can generate an additional fuel consumption of over one liter of fuel per 100 kilometers.

In recent years, suppliers specializing in the development of air conditioning systems have developed solutions to lower this additional consumption, for example by automatically adding a certain amount of pre-cooled recirculated air. Nevertheless, fuel consumption measurements according to the WLTP are always carried out with the air conditioning system switched off. This makes it possible to compare vehicles independently of their air-conditioning solutions. Furthermore, the frequency of use of air conditioning systems is just as variable as the air temperature in temperate zones.

The geographical characteristics of individual routes cannot be influenced by humans either. Not only does every vehicle that drives uphill have to fight against gravity. Traversing narrow mountain passes also increases fuel consumption due to the required steering effort. This is because tires build up cornering forces, without which the vehicle would drift out of the curve, and thereby increase the rolling resistance. Additionally, almost all modern cars have power steering assistance. The development of electromechanical steering aids, which are increasingly replacing traditional power steering systems, has allowed the automotive industry to reduce fuel consumption significantly. However, both the steering system and the topography are omitted from the WLTP, since it is impossible to create a bench test simulation which is representative worldwide. People plan their own routes and have their own driving behavior.

Despite these limitations, the roll-out of the WLTP will reduce the gap between the average fuel consumption values determined and standardized by lawmakers and the individual fuel consumption of many motorists. Experts estimate that the values measured and standardized in the WLTP are on average 20 percent higher than the values determined in the NEDC. The fuel consumption values determined in the WLTP are therefore more realistic because they are more up to date, although they are not "real" in the sense of being applicable to every driver.

Question 4: How are plug-in hybrids and electric cars measured?

In order to obtain type approval, electrified vehicles will also have to be tested according to the new WLTP rules in Europe. Just as the fuel consumption figures for vehicles with internal combustion engines will change with the WLTP's roll-out, the same will apply to the range specifications of pure electric cars and plug-in hybrid vehicles. The range specifications are more representative with the WLTP. The electrical range that is actually usable for customers will not change.

For purely battery operated electric vehicles, this means that the higher average speed of the new test cycle leads to a higher energy consumption. This energy is stated, however, not in liters, but in kilowatt-hours (kWh) per 100 kilometers. The measurement is carried out as prescribed in the previous fuel consumption measurement specification: the battery must be fully charged at the start of the bench test. Immediately after testing, test engineers reconnect the vehicle to a charger. The cable is equipped with an electricity meter. This meter measures the total amount of current, which has the advantage that the battery's energy losses during charging are detected as well. The resulting value is divided by the range determined in bench testing.

Roll-out of the WLTP signifies a major change for plug-in hybrid vehicles, which have both an electric drive and a combustion engine and can be externally recharged. These vehicles complete the test several times. They start up with a full battery. The cycle is repeated until the battery is empty. The combustion engine operates for a longer time each cycle. Emissions are measured with each cycle. This is followed by a measurement with an empty battery in which the drive energy originates solely from the combustion engine and regenerative braking. This multi-stage measurement can not only be used to determine fuel consumption and CO_2 emissions more precisely, but the electrical range and total range as well. The CO_2 value to be determined is then calculated as the ratio of the electrical range to the total range. At the same time, a so-called "utility factor" (UF) is introduced.

The UF represents the proportion of vehicle distance traveled electrically. In the case of pure electric vehicles, a UF of 100% applies, while with traditional internal combustion engines, the UF is 0%. In the case of plug-in hybrid vehicles, the UF increases with their electrical range. Lawmakers thus use the UF to evaluate a vehicle's ability to drive without emissions. The higher the electrical range, the lower the CO_2 emissions. This is quite close to real-life conditions since the driver of a plug-in hybrid will have to refuel less often when he or she has sufficient current available, e.g. to drive typical commutes purely electrically. In practice, the actual consumption behavior of a car with plug-in hybrid drive will vary widely from one user to another. In the case of long-distance trips, the electrical distance traveled is negligible and the consumption will be on a par with the traditional combustion engine. On the other hand, many short-distance trips and commutes can be covered almost entirely electrically, with actual fuel consumption close to 0 l/100 km.

Question 5: What are the steps used to roll out the WLTP?

Since September 1, 2017, type approval in Europe is possible for new passenger car types only if the results of valid CO_2 measurements according to the new WLTP are available. Certified WLTP measurements must be available for all newly registered cars just one year later, on September 1, 2018. The regulation shall apply a year later for larger, light commercial vehicles as well. The European Union will be assuming a pioneering role internationally with the prompt implementation of the WLTP after its ratification by the relevant UN body. The test procedure, in modified form in some cases, will also be established in other regions of the world.

The WLTP's rapid roll-out represents an ambitious goal for the participating testing organizations, the authorities responsible and automotive industry companies. It was not permitted to issue the official certificates on the fulfillment of the type-approval requirements until after the EU directive had been published and entered into force. This formal legislative act took place only recently on July 27, 2017. Furthermore, strict requirements have been placed on the test implementation, results evaluation and their documentation. The effort required for each individual test according to the WLTP procedure is also significantly greater than before: not only because the new test cycle itself takes 50 percent longer, but primarily because several versions of a vehicle have to be tested. As a result, the influence of numerous individual equipment options, wheels and tires on CO_2 emissions must be determined separately in advance of the actual laboratory tests and must be witnessed by the technical testing services that accompany the measurements. Experts speak of approximately twice the effort involved for the determination of fuel consumption values.

Certified WLTP measurements must be available for all newly registered cars just one year later, on September 1, 2018. Of course, not every single vehicle produced is tested. Instead, cars are put on the test bench as sample vehicle types. Once the values are available, the manufacturer guarantees that the newly produced vehicles are technically equivalent to the type tested in the approval procedure with a certificate of conformity. This certificate is the prerequisite for the authorities to issue a motor vehicle title, which is used to register the vehicle later. The European directive does not allow for any exceptions to this procedure. Even passenger car models that are produced only in small quantities must go through the entire WLTP procedure. For larger light commercial vehicles, which often are technically based on passenger car models, the deadline will be extended by one year.

The European Union has assumed the pioneering role internationally in order to incorporate the new test procedure, which has been drawn up by a United Nations body, fully into existing legislation. In the coming years, India, Japan and South Korea are expected to follow with their roll-out of the WLTP. Japan is likely to waive the high-speed part of the new driving cycle due to its local road conditions. A modified WLTP procedure is currently under discussion in China, the largest passenger car market in the world. Although the USA was initially involved in the development of the WLTP, it is not yet clear that the new test cycle will be adopted into national law there.

Question 6: What does the WLTP mean for motorists?

Even though the WLTP cannot depict the full range of actual vehicle usage, it provides a better basis of information for making decisions when buying a car by providing a greater approximation to real-world driving conditions. In order to be able to compare vehicles of all manufacturers in the legal transitional period from one test procedure to the other, the European Commission recommends a uniform revision of published information for customers and consumers in the EU as of January 1, 2019. The corresponding "Regulation for Energy Consumption Labeling" applies to the implementation schedule in Germany.

A car's fuel consumption is not constant, but dependent on driving style, weather and driving distance. Other important determining factors include whether winter tires have been fitted, the air conditioning is running at full speed or holiday luggage is on board. Nevertheless, car buyers understandably want fuel consumption data that is as exact as possible. This data must have been produced under absolutely objective and reproducible measuring conditions in order to be able to compare vehicles from different manufacturers. Furthermore, the declared fuel consumption should be as realistic as possible to make an accurate estimate of the operating costs arising after purchase. Yet even the WLTP will not be able to reflect the full range of actual vehicle usage. However, the new test procedure, while retaining objectivity, reflects real-world driving better than the previous statutory driving cycle and thus provides a better basis for purchasing decisions.

The question as to when all car dealers in Europe will be able to declare the emission values determined according to the new procedure is not yet finalized. The EU member states decide independently when WLTP values may or must be displayed. In order to ensure comprehensive comparability even when the first WLTP certified vehicles are on the market, the EU Commission recommends to its member states a uniform revision of published standard values as of January 1, 2019. In Germany, the cut-off date for this revision is determined by the statutory change in the "Regulation for Energy Consumption Labeling." The German Federal Government has not yet defined this cut-off date.

Since the differences between the test bench results and actual fuel consumption will continue to exist, car manufacturers are currently conducting a detailed evaluation as to whether it may be appropriate to offer new car buyers – in addition to the WLTP value – customer-specific fuel consumption figures on a voluntary basis in the future. This way it would be possible to offer transparent information on the fuel consumption range of a particular vehicle. This range of anticipated customer-specific consumption depends on various factors such as driving style, route profile, climatic conditions or air conditioning usage. In this context, one possible idea is to participate in the establishment of an institute that could determine and declare this consumption range in the role of a voluntary body and in cooperation with testing organizations.

In many member states of the European Union, vehicle CO_2 emissions are also the basis for calculating the amount of vehicle tax, duties or incentives. Defining these kinds of financial instruments is the responsibility of national governments. Since the CO_2 values according to the WLTP test procedure are higher than according to the old NEDC standard, the tax rate for Germany's motor vehicle tax would actually have to be reduced by 20 percent as it is calculated based on the unit of "grams of CO_2 per kilometer". However, the revision of the vehicle tax has already been decided for all newly registered vehicles as of September 1, 2018, without such an adjustment, which will be equivalent to a tax increase.

The higher WLTP values must also be taken into account when classifying vehicles into so-called efficiency classes, which are declared at the retail level and in internet configurators. The following applies to the requirements in Germany: which class a vehicle is assigned to, ranging from A+ (green = very efficient) to G (red = less efficient), depends on how much its CO_2 emissions deviate from a reference value that applies to equally heavy vehicles. Since the reference value is still based on the old NEDC, while the WLTP cycle now produces higher standard values, a vehicle would now automatically be classified into a poorer efficiency class without any adjustment to the reference value – even though its actual fuel consumption will, of course, not change on account of the new test procedure.

If and when lawmakers will adjust the reference value upwards is currently unknown. What is certain, however, is that there will be no ambiguities for German customers who want to compare the consumption values of different vehicles, e.g. when purchasing a car. As with the declaration of emission and consumption values, there will also be a fixed cut-off date for labeling from which all updated efficiency classes will be declared across Germany. This cut-off date for the revision has not yet been finalized by the German legislature. Since EU states decide on these cut-off dates autonomously, model may be labeled differently across different countries for a transitional period.

Question 7: How will fleet emission limits be calculated in the future?

When the more realistic WLTP test cycle was implemented starting in the fall of 2017, nominal CO_2 emissions will increase – experts assume by around 20 percent. However, since the EU has already defined fleet targets based on the NEDC up to and including 2020, and the world's already most stringent CO_2 fleet limit values will not be made even more stringent, the European Union will be prescribing a new conversion procedure.

In 2016, the average emissions of all newly registered vehicles in Europe continued to decline. The most recent figure was 118 grams CO_2 per kilometer. In 2005, this figure was still at a level of 181 grams per kilometer, which corresponds to a saving of around 35 percent within a mere eleven years – despite a growing market share of so-called "sports utility vehicles" (SUVs), which, due to their greater mass and larger cross-sectional area, have less favorable physical prerequisites. However, the figures also show: achieving the ambitious EU targets will require further substantial efforts.

Up to now, CO_2 emissions and the derived fuel consumption of individual passenger car models have been determined in the "New European Driving Cycle" (NEDC). The fleet limit value of 95 grams CO_2 per kilometer, which the European Union has set for the automotive industry for 2020, also refers to this cycle. Fleet limit value does not mean that the emissions of individual vehicles are restricted but that the total fleet of each manufacturer is weighted against its registration figures. How high the individual emissions target of a manufacturer will turn out to be also depends on the weight of the vehicles sold by the manufacturer. The limit value increases when a manufacturer sells a particularly high amount of large and heavy vehicles.

When the more realistic WLTP test cycle was implemented starting in the fall of 2017, nominal CO_2 emissions will increase on paper. Experts assume an increase by around 20 percent on average. Since an exact average value will not be available before all vehicles are certified according to the WLTP procedure, the European Commission has decided to not adjust the CO_2 limit value for new passenger car models until the end of 2020, but to convert the emission values determined in the WLTP on a case by case basis as if they were NEDC values. This will be done using software developed by the EU's "Joint Research Center" (JRC). However, since these NEDC values are based on the more stringent framework conditions of the WLTP test procedure, they will be slightly higher than those according to the original test sequence. It is therefore important for anyone comparing CO_2 emission values in the future to consider whether the vehicle has been certified according to the existing NEDC requirements or already according to the WLTP.

Which fleet consumption values will actually be achieved beyond a transitional recalculation in the coming decade depends less on a new test procedure, but to a great extent on two factors: firstly, on how quickly partially or fully electrified vehicles can establish themselves on the market, and secondly on the feasibility of producing and using liquid or gaseous fuels from regenerative solar and wind energy. Taking these factors into account is a prerequisite for future realistic emissions legislation.

Imprint

Publisher	German Association of the Automotive Industry (VDA) Behrenstraße 35, 10117 Berlin www.vda.de
Copyright	German Association of the Automotive Industry (VDA)
Design/Layout	DANGEROUS. Werbeagentur GmbH
Status	September 1, 2017

Note on data protection: We store and use your contact data in order to provide you with current information from VDA e.V. by regular mail or email. In order to avoid sending mail to the wrong addresses, we pay attention to ensuring that contact data stored with us are correct. Therefore, please notify us in good time if your contact data should change. You can send this notification by email to politikbrief@vda.de or by regular mail to Verband der Automobilindustrie e.V., Behrenstr. 35, 10117 Berlin, Germany. You can also write to this address to request the saved data or to object to the use of your data for the purpose of sending information.

VDA | Verband der Automobilindustrie